DOE/OR/20717--11-VOL.5

DOE/OR/20717--11 Vol. 5

DE83 000168

The BRECKINRIDGE PROJECT

Initial Effort

REPORT XI

VOLUME 5

CRITICAL REVIEW OF THE DESIGN BASIS

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PREPARED FOR
UNITED STATES DEPARTMENT OF ENERGY
UNDER COOPERATIVE AGREEMENT
NO. DE-FC05-80OR20717

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

The information and data contained in this report are the result of an economic evaluation and a preliminary design effort and because of the nature of this work no guarantees or warranties of performance, workmanship, or otherwise are made, either expressed or by implication.

Volume Introduction and
Table of Contents

REPORT XI
VOLUMES 4 AND 5

INTRODUCTION

Report XI, Technical Audit, is a compendium of research material used during the Initial Effort in making engineering comparisons and decisions.

Volumes 4 and 5 of Report XI present those studies which provide a Critical Review of the Design Basis. The Critical Review Report, prepared by Intercontinental Econergy Associates, Inc., summarizes findings from an extensive review of the data base for the H-Coal process design.

Volume 4 presents this review and assessment, and includes supporting material; specifically, Design Data Tabulation (Appendix A), Process Flow Sheets (Appendix B), and References (Appendix C).

Volume 5 is a continuation of the references of Appendix C.

Studies of a proprietary nature are noted and referenced, but are not included in these volumes. They are included in the Limited Access versions of these reports and may be reviewed by properly cleared personnel in the offices of Ashland Synthetic Fuels, Inc.

INITIAL EFFORT REPORTS REFERENCE

Report I - Executive Summary

Report II - Breckinridge Project Design Basis

Report III - Specifications
Volume 1 - Specifications A through J
Volume 2 - Specifications K through W

Report IV - Process Units
Volume 1 - Plants 26, 27 and 1
Volume 2 - Plants 2, 3 and 4
Volume 3 - Plants 5, 6 and 17
Volume 4 - Plant 7
Volume 5 - Plants 8, 9 and 10
Volume 6 - Plant 12
Volume 7 - Plants 15 and 18

Report V - Utilities and Offsites Units
Volume 1 - Plants 19, 20, 21, 22, 23 and 30
Volume 2 - Plants 31, 32, 33 and 34
Volume 3 - Plant 35
Volume 4 - Plants 36, 37, 38, 39, 40, 41, 42 and 44

Report VI - Project Management Plan

Report VII - Environmental, Socioeconomic, Safety and Health
Volume 1 - Introduction and Background
Volume 2 - Environmental Baseline
Volume 3 - Cultural and Socioeconomic
Volume 4 - Health and Safety

Report VIII - Capital Cost Estimate

Report IX - Operating Cost Estimate

Report X - Economic Analysis and Financial Plan

Report XI - Technical Audit
Volume 1 - Engineering Comparisons
Volume 2 - Engineering Comparisons
Volume 3 - Critical Design Areas
Volume 4 - Critical Review of the Design Basis
Volume 5 - Critical Review of the Design Basis

REPORT XI
TECHNICAL AUDIT

VOLUMES 4 AND 5
CRITICAL REVIEW OF THE DESIGN BASIS

TABLE OF CONTENTS

VOLUME 4

CRITICAL REVIEW REPORT

Objectives
Summary
Conclusions
Recommendations
Introduction
H-Coal® System
Data Base Assessment
List of References

APPENDIX A - DESIGN DATA TABULATION

APPENDIX B - PROCESS FLOW SHEETS

APPENDIX C - REFERENCES

Catalysts
Corrosion/Materials
H-Coal® Reactor Conditions
H-Coal® Design Basis
HRI Simulations
H-Coal® Reactor Yields
Hydroclones
Physical Properties
Recycle Oil

VOLUME 5

APPENDIX C - REFERENCES (CONTINUED)

Slurry Heater
Slurry Mixing
H-Coal® Naphtha
H-Coal® Pilot Plant
Miscellaneous

REFERENCES

TABLE OF CONTENTS

CATALYSTS

1.	Metcalf to Davis, et. al.	9/18/80	Catalyst Usage Report 1
2.	Metcalf to Davis, et. al.	10/27/80	Catalyst Usage Report 2
3.	Metcalf to Davis, et. al.	11/10/80	Catalyst Usage Report 3
4.	Metcalf to Davis, et. al.	11/12/80	Catalyst Usage Report 4
5.	Metcalf to Chapman, et. al.	10/23/80	Price of H-Coal® Catalyst
6.	Comoli, Johanson & Huibers (HRI)	----	The Evaluation of Selective H-Coal® Catalyst

CORROSION/MATERIALS

7.	Oak Ridge National Laboratory	7/25/80	Workshop on Corrosion in Fractionation Areas of Coal Liquefaction Pilot Plants (5/29/80)
8.	Institute of Mining and Minerals Research (IMMR)	12/13/79	SRC Corrosion
9.	Institute of Mining and Minerals Research (IMMR)	9/26/80	Sagues to Tampa (ASFI)
10.	Institute of Mining and Minerals Research (IMMR)	April 1980	Distillation Tower Corrosion
11.	Institute of Mining and Minerals Research (IMMR) (Sagues to Searles)	1/15/81	Preliminary Corrosion Coupon Measurements
12.	Institute of Mining and Minerals Research (IMMR) (Sagues to Searles)	12/5/80	Preliminary Corrosion Coupon Measurements
13.	Oak Ridge National Laboratory	6/20/80	Workshop on Corrosion in Fractionation - Effect of Water Washing in Corrosivity of Fort Lewis Middle Distillate
14.	Malone to Wigglesworth	11/7/80	Corrosion of N-202 (Fractionator)
15.	ASFI CN-189	11/17/80	H-Coal® Pilot Plant, Fractionator (N-202) Corrosion

H-COAL® REACTOR CONDITIONS

16.	Metcalf to MacArthur	11/13/79	Alternate Calculations of Reactor Conditions PDU5 - Period 29
17.	Metcalf to MacArthur	10/17/79	Reactor Conditions PDU5 - Period 29
18.	Metcalf to MacArthur	12/7/79	Recalculation of Phase Zero Reactor Conditions

TABLE OF CONTENTS (Continued)

H-COAL® DESIGN BASIS

19.	Metcalf to MacArthur	11/30/79	Recommended Changes to H-Coal® Reactor Design Basis
20.	Lehman to Metcalf	9/4/79	Design Basis for H-Coal® Plant
21.	Metcalf to Hicks	12/12/79	Flush Oil Rates

HRI SIMULATIONS

22.	HRI	7/22/80	H-Coal® Design Computer Simulation
		8/8/80	H-Coal® Design Computer Simulation (Plant 17 only)

H-COAL® REACTOR YIELDS

23.	Metcalf to MacArthur	10/4/79	Recalculations of H-Coal® Yields
24.	Metcalf to Abrams	7/20/79	Liquefaction Reactor Product Composition & Rate
25.	Metcalf to Hicks	3/26/80	Relative Yield of Light Hydrocarbon PDU Runs 4, 5, & 9
26.	Metcalf to Wellman	4/2/80	Conversion of CO in H-Coal® Reactor
27.	Metcalf to Shou	7/2/80	No title
28.	Metcalf to Wellman	11/7/79	Visit with Jim Shou (IMMR)

HYDROCLONES

29.	Metcalf to Wellman	4/26/79	Requirements for Hydroclones in Phase Zero

PHYSICAL PROPERTIES

30.	Metcalf to MacArthur	11/27/79	Reactor "K" Factors
30A.	Metcalf to Wellman	8/6/80	Calculation of Vapor/Liquid Composition and "K" Factors for the Reactor Separator and the Reactor in PDU Run 9, Period 28
31.	Bechtel	----	Evaluation of Recent Physical Property Data (no dates)
32.	T. L. Wu	May 1980	Design Data Base for the Breckinridge Project - A Technical Data Book for Coal Liquefaction Processes

TABLE OF CONTENTS (Continued)

33. J. F. S. Firth, et. al.	August 1979	Solvent Refined Coal: Data Correlation and Analysis (The Lummus Company under contract to EPRI)

RECYCLE OIL

35. Metcalf to Abrams, et. al.	7/30/79	Residuum content

SLURRY HEATER

36. Metcalf to Hicks	8/12/80	Estimate of Reactor Feed Reheating and Heat of Reaction from PDU
37. Hicks to Distribution	5/15/81	Design Data for Plant 3 Fired Heaters

SLURRY MIXING

38. Ashland Synthetic Fuels, Inc. (ASFI)	April 1980	Report on State of the Art

H-COAL® NAPHTHA

45. UOP Process Division	April 1981	UOP Pilot Plant Data Fractionation, Hydrotreating and Platforming of H-Coal® Naphtha
46. Moore (APC) to Kreuding (UOP)	5/23/80	Properties of Material to be Tested by UOP

H-COAL® PILOT PLANT

47. Ashland Synthetic Fuels, Inc. (ASFI)	5/20/81	Topical Report (T-8) Coal Run No. 6 with Illinois Coal in Syncrude Mode
48. HRI	June 1981	Supporting Data From PDU Run #5 and Other PDU Runs

TABLE OF CONTENTS (Continued)

MISCELLANEOUS

34.	Hicks to Distribution	5/15/81	Design Data for Plant 4 - Primary Separation Decanter
39.	HRI	November 1977	Integrated Pilot Plant Phase I - Final Report
40.	EPRI	December 1976	Hydrogen Production from Coal Liquefaction Residues
41.	Texaco Development Corp.	November 1980	Texaco C Package Proprietary Design Data
42.	Haldor-Topsoe		Proprietary Design Data Package
43.	Haldor-Topsoe		Proprietary Design Data Package
44.	Allied Chemical		Proprietary Design Data Package
49.	Dames and Moore	4/13/81	Preliminary Geotechnical and Geohydrological Studies

ESTIMATION OF REACTOR FEED PREHEATING
AND HEAT OF REACTION FROM PDU DATA

METCALF TO HICKS
(ASFI)
8/12/80

REF. 36

The memoranda and reports in Reference 36 are included only in the limited access version because they contain proprietary information.

DESIGN DATA FOR PLANT 3

FIRED HEATERS

HICKS TO DISTRIBUTION

(ASFI)

5/15/81

REF. 37

The memoranda and reports in Reference 37 are included only in the limited access version because they contain proprietary information.

Slurry Mixing

SLURRY PREPARATION

REPORT ON STATE OF THE ART

APRIL 1980

REF. 38

This reference is included in

Report XI

Volume 1

Engineering Comparison

H-Coal® Naphtha

U. O. P. PILOT PLANT DATA
FRACTIONATION, HYDROTREATING, AND PLATFORMING OF H-COAL® NAPHTHA

APRIL 1981

BY:

U. O. P. PROCESS DIVISION

REF. 45

JOB 14222 BRECKINRIDGE PROJECT

COMMERCIAL H-COAL COAL LIQUEFACTION PLANT

PILOT PLANT RESULTS - FRACTIONATION, HYDROTREATING AND PLATFORMING OF H-COAL NAPHTHA

CONTENTS

1) Abstract

2) Description of Processing Sequence

3) Fractionation of As-Received Coal Liquid

4) Hydrotreating of Naphtha Cut

5) Platforming of Naphtha

6) Summary and Conclusions from Pilot Plant Work

(1) ABSTRACT

Estimates for product yields and catalyst stability for hydrotreating and Platforming H-coal derived naphtha had been made earlier based on a 1-gallon sample provided by Ashland. This report covers the pilot plant work that was carried out to confirm these estimates.

Analyses revealed significant differences between the properties of the original sample and those of a sample drawn from the liquid made available for the pilot plant work. These feedstock differences made a higher severity hydrotreating necessary than that expected based on the original sample. The catalysts used for both hydrotreating and Platforming demonstrated good stability at the processing conditions selected.

Revised product yield estimates, utility requirements and capital cost estimates were made to incorporate the pilot plant data made available.

(2) DESCRIPTION OF PROCESSING SEQUENCE

This section provides a brief overview of the processing sequence used. Each step is dealt with in greater detail in the subsequent sections.

The as-received coal-liquid sample had an end-point of around 576°F and was therefore fractionated to obtain a naphtha cut. The overhead product collected from the fractionator had an end-point of around 380°F. This material (which was to be hydrotreated), was observed to have a distinct black bottom phase that contained some solid matter. The black phase was removed by several decantations. The solid particles were removed by filtration.

The hydrotreating of the decanted and filtered material was done in two stages: the first was conducted at conditions to saturate the dienes (potential gum-formers at the operating conditions of the second stage) and the second at conditions to desulfurize and denitrify the naphtha to meet Platformer feedstock specifications.

The hydrotreating step revealed that a higher severity level was needed to meet the product specifications than envisioned. The analytical results received up to this point indicated significant differences in the properties of the naphtha as compared to those expected based on the 1-gallon sample. After a reassessment of the properties of the hydrotreated naphtha as a potential Platformer feedstock, it was felt that the high end-point of ~380°F might lead to poor Platformer catalyst stability and might create difficulties in comparing the earlier estimates of product yields. The hydrotreated naphtha was therefore rerun with the intention of collecting a ~355°F end-point overhead material.

The Platforming work conducted on this rerun naphtha included a yield octane study to confirm yields at 103 and 105 octane and an accelerated catalyst stability test to confirm predicted catalyst life and regeneration requirements.

A schematic overview of the confirmatory pilot plant work undertaken is shown in Figure 1.

(3) FRACTIONATION OF AS-RECEIVED SAMPLE

Ten drums of coal liquid were obtained from Ashland in drums marked "Ashland Coal and Oil Mixture Plant, South Point, Ohio". The total amount of coal liquid contained in them was approximately 443 gallons.

On checking with Ashland, it was determined that the coal liquid had been stored for a "long" time in the drums without an inert gas blanket. The liquid appeared to be black in color and opaque. No suspended solids were readily visible. The liquid had an extremely strong, phenolic odor that made it difficult to handle without the use of gas-masks.

Prior to fractionation, the as-received material was analyzed to characterize it. The results of the analyses are shown in Column 1 of Table 1. Of interest are the high values for the oxygen content (1.57 wt-%), nitrogen content (5000 ppm) and the diene value (8.43).

During the fractionation, a heavy dark phase separated out in the overhead product receiver and in the overhead product samples that were drawn. An S.O.P. was implemented to drain the undesirable lower phase from the product receiver, while a series of two fulflo filters were installed on the product to remove particulates. The malodorous nature of the liquid was a serious problem and fans had to be installed to permit sampling of liquid streams. Frequent samples were taken to monitor the fractionation. There was excessive foaming during the distillation of the last 20% liquid during the ASTM distillation of one of the samples. There was evidence of cracking at 379°F in a similar distillation of another sample. While these observations are not conclusive, they indicate the need for further investigations to determine and resolve potential problems during fractionation.

During subsequent inspection of the overhead "clear" product collected, a black phase was noticed at the bottom of the storage tank. It was removed by decantation but with time a fresh layer seemed to form. Since the black phase contained suspended solids, the overhead product was filtered. At the present time, the source and/or the cause of the black phase formation is not clear. The H-coal liquid had been exposed to air during storage even before it was sent to UOP, and gum formation as a result of oxidation of phenols and other gum-precursors is a distinct possibility. It is possible that some heavy products may have been formed due to thermal reactions during fractionation. Although reasonable care was taken in handling, it is also possible that the coal liquid may have picked up contamination from the equipment and piping it was in contact with as a result of its superior solvent properties.

The results of analyses conducted on the overhead product from the fractionator are summarized in Column 2 of Table 1. For the sake of comparison, this table also shows in Column 3 the results of similar analyses conducted on a naphtha sample sent earlier by Ashland, that was supposed to be representative. These earlier results had formed the basis for the initial product yield estimates and cost predictions. A comparison between Columns 2 and 3 of Table 1 shows that the naphtha cut from the 10-drum shipment had a slightly higher boiling range as compared to the earlier "representative" sample. However, it had a significantly

higher (almost double) nitrogen and phenolic content than the earlier representative sample. Moreover, it contained a lower percentage of aromatics (15.8 vol-% by M.S. as against 22.1% in the earlier sample) but a significantly higher percentage of di-, bi- and tri cyclo paraffins (12.44 vol-% as against 0.61 vol-% in the earlier sample). The naphtha in question also contained significantly higher levels of metals notably Fe (24 ppm versus 0.34 ppm) and Pb (13 ppm versus <0.05 ppm) than the "representative" sample. The large difference in the metal concentrations raises the possibility of contamination from the storage containers.

(4) HYDROTREATING OF NAPHTHA CUT

As mentioned before, the hydrotreating was done in two stages. The objective of the first stage was to hydrogenate polymer and gum-forming diolefins present. The objective of the second stage was to reduce sulfur and nitrogen contents below 1 ppm. No unexpected operational problems were encountered during the hydrotreating work. Analyses of the hydrotreating feedstock (the decanted, filtered naphtha) and product are shown in Columns 4 and 5 of Table 1, respectively. The appreciable differences between the properties of the naphtha used for the pilot plant work and that sent earlier as a "representative" sample were probably responsible for the higher severity level that was found to be necessary.

Operation of the hydrotreating plant for over a month at operating conditions necessary for meeting product sulfur and nitrogen specifications showed no abnormal catalyst deactivation. Operating conditions and product properties such as Bromine Index and sulfur and nitrogen concentrations were monitored regularly over the 35-day operating period.

A composite analysis of the hydrotreater product showed approximately 0.8 ppm sulfur, 0.22 ppm nitrogen and 32.1 ppm oxygen - significant reductions from the levels in the feed. The oxygen level, however, is relatively high compared to values expected for petroleum derived feedstocks. The higher sulfur level in the product than the nitrogen level is an indicator of complex sulfur bearing compounds which defy desulfurization at the process conditions deployed. A comparison of the M.S. analyses results for the naphtha before and after hydrotreating shows that the hydrotreating converted all of the tricyclo-paraffins into lighter components. Some of the aromatics were saturated too.

Based on the new information generated, the product yield estimates made earlier were revised and are shown in Table 2. The change in the severity level naturally implies a change in the utility and curved capital cost estimates. Revised values for these estimates are shown in Table 3(A) and 3(B). The essential features of the revisions include an increase in the estimated capital cost from $16 million (4th quarter 1980) to $19.5 million (April 1981 dollars) and an increase in the catalyst inventory from $1,451,000 (4th quarter 1980) to $2,472,000 (April, 1981 dollars) reflecting the higher processing severity required. The catalyst inventory estimate includes a recent increase in the unit cost of the catalyst to be employed in the proposed unit.

(5) PLATFORMING OF NAPHTHA

Platformer Feed: Upon reflecting on the analytical results obtained for the second stage hydrotreated product, it was felt that the appreciable levels of sulfur and oxygen still present (0.8 and over 30 ppm respectively) and the higher than targeted distillation end-point together could pose problems. The product yield estimates (and capital cost and utility estimates) made earlier were based on a 355°F end-point naphtha. It was suspected that a disproportionately high fraction of the sulfur and oxygen contaminating species might be concentrated in the 355-380°F boiling range. The detrimental effect of these species on process performance and catalyst stability could conceivably make a confirmation of the yield estimates difficult if a 380°F end point naphtha was used. It was therefore decided to rerun the hydrotreated naphtha to ~355°F end-point. The overhead product collected was analyzed and the results are shown in Column 6 of Table 1.

This overhead product was used as the feedtsock for the Platforming work. In some respects, its properties were significantly different from those expected based on analytical results of the earlier 1-gallon sample. In particular, the aromatics content was only two-thirds that in the earlier sample, while the naphthene content was significantly higher (see Columns 2 and 3 of Table 1 for a comparison). This helps to explain the higher hydrogen yield observed as compared to the earlier estimate. The higher naphthene content of the feedstock and the endothermic nature of the naphthene-to-aromatics reaction also made it necessary to specify a four-reactor system rather than a three-reactor system to efficiently provide the necessary heat of reaction. The revised estimated product yields and properties are, however, not significantly different from those specified earlier. Estimated product properties are shown in Table 4 while revised product yields are shown in Table 5A and 5B.

The catalyst in the Platformer section showed relatively good stability in processing the coal-liquid. In fact, the deactivation (primarily due to coke laydown on the catalyst) was lower than that anticipated based on the earlier analyses. This implies that a smaller sized regenerator would suffice for the Platformer in question.

The effect of these factors on the capital cost for the proposed Platformer is not expected to be sizeable. The fourth reactor would add to the cost while the smaller regenerator size would help mitigate this increase. At this stage, the cummulative effect of these is not expected to change the curved-cost estimates supplied earlier. The estimated catalyst inventory investment is the same as that indicated earlier.

The Platformer utility requirements are slightly different from those anticipated earlier due to the changes in the number of reactors and the size of the regenerators. The revised utility estimates are shown in Tables 6A and 6B.

(6) SUMMARY AND CONCLUSIONS

The H-coal naphtha used in the pilot plant hydrotreating and Platforming operations for this project had appreciably different properties from that used for making initial product yield estimates. There was some difficulty in fractionating the as-received liquid to obtain the desired end-point. A heavy black phase repeatedly appeared in the overhead product and had to be separated.

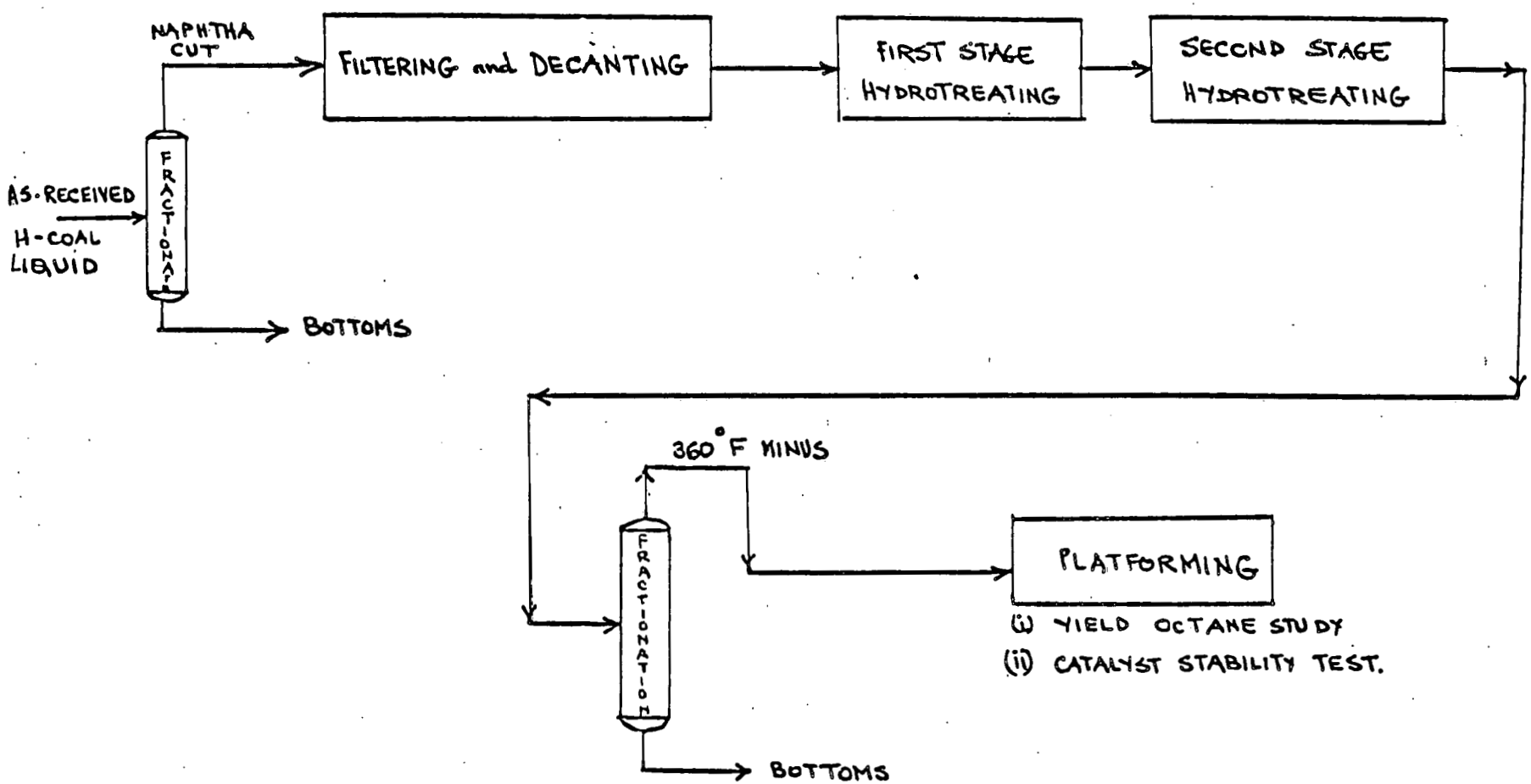
The catalysts employed for the hydrotreating and Platforming showed no signs of abnormally high deactivation. The Platforming catalyst, in fact, showed an even better stability than expected.

A higher severity level was required for the hydrotreating than anticipated mainly because of the feedstock property differences. Revised curve-cost estimates for the commercial hydrotreater unit indicate a total cost of ~$19.5 million (April 1981 dollars) as against $16 million (4th quarter 1980 dollars) originally anticipated. The utility requirements for the hydrotreater are also higher and the earlier estimates were revised accordingly.

The pilot Platforming work indicated a need for a fourth reactor to handle the higher naphthene content. Catalyst stability was demonstrated to be better than anticipated at the set of processing conditions used. No net change in the curve cost estimate for the Platforming section is projected. Revised utility estimates were, however, made to incorporate the data generated from the pilot plant work.

FIGURE 1.

SCHEMATIC REPRESENTATION OF CONFIRMATORY PILOT PLANT WORK ON H-COAL NAPHTHA



LIST OF TABLES

1. Analytical Results

2. Revised Hydrotreating Yield Estimates

3.(A) Revised Hydrotreating Capital Cost Estimates

(B) Revised Hydrotreating Utilities Requirement Estimate

4. Platforming Product Properties

5.(A) Revised Platforming Yield Estimates - 103 RON

(B) Revised Platforming Yield Estimates - 105 RON

6.(A) Revised Platforming Utilities Estimate - 103 RON

(B) Revised Platforming Utilities Estimate - 105 RON

TABLE 1

ANALYSES OF H-COAL LIQUID FOR THE BRECKINRIDGE PROJECT

Column Number	1	2	3	4	5	6
Liquid Description		Naphtha Cut of H-Coal Liquid		Naphtha Cut After Decantation and Filtering (Hydrotreater Feed)		
Analysis	As-Received H-Coal Liquid	Current Sample	"Earlier" Sample		Hydrotreater Product	Rerun Hydrotreater Product
UOP Number	70-2623	70-2623A	50-2019	70-2623	3794-61	70-2623D
API Gravity at 60°F	32.6	47.9	44.1	48.3	50.3	51.2
Specific Gravity at 60°F	0.8623	0.7886	0.8058	0.7870	0.7783	0.7742
ASTM D-86 Distillation						
IBP, °F	135	108	174	126	165	162
5%	182	168	198	170	186	188
10%	216	188	210	1[illegible]	195	198
30%	289	220	234	218	219	216
50%	349	243	264	240	240	234
70%	394	274	300	276	270	260
90%	472	323	327	329	314	301
95%	544	356	336	379	345	318
EP, °F	576	372	352	382	376	361
% Recovered	98.5	97.2	99.0	98.0	99.0	
% Bottoms	1.5	2.8	1.0	2.0	1.0	
Carbon, wt-%		85.4	85.23	85.12	84.75	
Hydrogen, wt-%		13.7	12.59	12.90	13.53	

TABLE 1 (Cont.)

ANALYSES OF H-COAL LIQUID FOR THE BRECKINRIDGE PROJECT

Column Number	1	2	3	4	5	6
Liquid Description		Naphtha Cut of H-Coal Liquid		Naphtha Cut After Decantation and Filtering (Hydrotreater Feed)		
Analysis	As-Received H-Coal Liquid	Current Sample	"Earlier" Sample		Hydrotreater Product	Rerun Hydrotreater Product
UOP Number	70-2623	70-2623A	50-2019	70-2523	3794-61	70-2623D
Sulfur, ppm	3,120	2,510	2,260	2,510	0.8	0.4
Nitrogen, ppm	5,000	3,500	1,600	2,600	0.22	0.2
Oxygen, ppm	15,700	6,500	10,400	7,243	32.1	
Chlorides, ppm	3			145		
Phenols, wt-%	3.13	4.68	2.68			
Thiophenols, ppm	225	410	1,900			0.32
Metals by Emission, ppm						
Fe		24.0	0.34			
Ni		0.03	0.04			
V		0.02	0.04			
Pb		13.0	<0.05			
Cu		0.03	0.07			
Na		0.11	<0.05			
Mo		<0.03				
Bromine Number		15.9	21.3	21.4		
Diene Value		4.3		3.18		
Fia Test, LV%						
Saturates		75.6	67.7		85.5	
Olefins		5.7	7.5			
Aromatics		14.1	18.7		14.5	
Oxygenates		4.6	6.1			

TABLE 1 (Cont.)

ANALYSES OF H-COAL LIQUID FOR THE BRECKINRIDGE PROJECT

Column Number	1	2	3	4	5	6
Liquid Description		Naphtha Cut of H-Coal Liquid		Naphtha Cut After Decantation and Filtering (Hydrotreater Feed)		
Analysis	As-Received H-Coal Liquid	Current Sample	"Earlier" Sample		Hydrotreater Product	Rerun Hydrotreater Product
UOP Number	70-2623	70-2623A	50-2019	70-2623	3794-61	70-2623D
Octane Number						
Motor					64.4	65.8
Research					68.4	65.1
PONA Analysis						
Paraffins, vol-%					18	19.4
Naphthenes, vol-%					67	66
Aromatics, vol-%					15	14.6
Nitrogen Jet Gum				12.7		
M.S. Analysis						
(For Details, See Appendix A)						
Paraffins		20.06	16.61		20.75	21.45
Naphthenes		64.13	45.35		64.73	63.95
Monocycloparaffins		51.69	44.74		57.57	58.15
Bi, Dicycloparaffins		8.57	0.61		7.16	5.80
Tricycloparaffins		3.87	0.00		0.00	0.00
Aromatics		15.81	22.07		14.52	14.6
Olefins			15.97			

TABLE 2

Revised Hydrotreating Product Yield and Property Estimate

Basis: Rerun C_6 - 355°F H-Coal Naphtha

Charge	Wt-%	Vol-%	(SCFB) BPSD	Sp. Gr.
Raw Oil	100.00	100.00	20,000	0.7874
Hydrogen (Chemical)	0.97		(500)	
Products				
H_2S	0.28			
H_2O	0.90			
NH_3	0.40			
C_1	0.04			
C_2	0.14			
C_3	0.25	0.39		0.51
C_4	1.50	2.04		0.58
C_5	3.50	3.94		0.70
C_6+	93.96	94.85		0.78
Product Properties				
API	19.9			
P, wt-%	20			
N, wt-%	61			
A, wt-%	19			
Distillation, (D-86), °F				
IBP	110			
50%	240			
EP	355			
Sulfur, wt-ppm	0.5			
Total Nitrogen, wt-ppm	<1.0			

Breckinridge H-Coal Project - Naphtha Hydrotreater

TABLE 3(A)

Estimated Investment Requirements

Basis: April, 1981
U.S. Gulf Coast Erection to UOP Standards and Specifications Exclusive of Offsites
Catalyst Inventory Allowance Reflect Current Price FOB Point of Manufacture

Estimated Erected Cost	US$
Material and Labor	15,100,000
Design Engineering and Contractor Expenses	4,400,000
Total Estimated Erected Cost	19,500,000
Catalyst Inventory Allowance	2,472,000

SALES

UOP Process Division

TABLE 3(B)

ESTIMATED NORMAL UTILITY REQUIREMENTS

ITEM	LOAD BHP NORM.	ELEC. POWER KW	STEAM THOUSAND POUNDS PER HOUR 600 # SAT. °F	___ # ___ °F	___ # ___ °F		BFW	COND.	LOSS	EQUIP. DUTY 10⁶ BTU / HR	___ °F COOL. WATER °F RISE	GPM	FUEL 10⁶ BTU / HR
PUMPS	870	703											
RECYCLE GAS COMPR.	2424	1891											
AIR COOLING	260	213								26.94			
WATER COOLING										2.41	30	160	
STEAM HEATING			-14.5					+14.5		10.56			
FIRED HEATING										44.89			
WATER INJECTION								-8.8	8.8				-53.3
TOTALS		2807	-14.5					+5.7	8.8			160	-53.3

NOTES: GAS TO FUEL AND FUEL FIRED BASED ON NET HEATING VALUES.
ANNUALIZED AVG LOAD OF _____ % OF DESIGN LOAD ASSUMED FOR AIR COOLING.

DESIGN AIR TEMP. OF 85 °F ASSUMED.
AIR-WATER COOLING BREAK TEMP. = 120 °F.

LOCATION BRECKINRIDGE COUNTY, KY
UNIT PLANT 18 NAPHTHA HYDROTREATER
CAPACITY 20000 BBL/DAY (BPSD)
BY [illegible]
REV.
SHEET ___ OF ___
DATE 4.15.81

TABLE 4

H-Coal Platforming - Product Properties

Research Octane (clear)	103	105
Weight % Recovery	100.1	99.8
Product Yields		
H_2, SCFB	1,845	1,973
C_1, wt-%	0.34	0.43
C_2	0.63	0.87
C_3	0.85	1.32
C_4	0.96	1.42
C_5+, LV-%	87.0	84.7
API	37.9	36.3
D-86 Distillation		
IBP	136	130
50%	246	246
EP	374	414
Aromatics, wt-%		
Benzene		14.8
Toluene		25.4
Xylene		25.0
A_9+		19.1
Total		84.3

NOTE: See Table 1, Column 6 for Platformer feedstock properties.

TABLE 5A

Estimated Platforming Yields and Product Properties

Basis: Continuous Platforming Unit, 103 RON

	Wt-%	Vol-%	(SCFD) BPSD
Charge			
Hydrotreated Rerun H-Coal Naphtha	100.00	100.00	20,000
Products			
H_2	3.52		(1797)
C_1	0.28		
C_2	0.60		
C_3	0.85		
i-C_4	0.45	0.62	
n-C_4	0.50	0.66	
i-C_5	1.23	1.52	
n-C_5	1.16	1.42	
C_6+	91.41	84.02	
Total	100.00	88.25	
Product Properties	Debut. Bottoms		
API	37.9		
RVP	3.13		
RON-0	103.0		
MON-0	91.0		
ASTM D-86 Distillation			
IBP, °F	142		
10%	182		
30 %	210		
50%	238		
70%	270		
90%	311		
EP, °F	404		

TABLE 5B

Estimated Platforming Yields and Product Properties

Basis: Continuous Platforming Unit, 105 RON

	Wt-%	Vol-%	(SCFD) BPSD
Charge			
Hydrotreated Rerun H-Coal Naphtha	100.00	100.00	20,000
Products			
H_2	3.72		(1899)
C_1	0.42		
C_2	0.95		
C_3	1.30		
i-C_4	0.71	0.98	
n-C_4	0.79	1.05	
i-C_5	1.75	2.17	
n-C_5	1.40	1.72	
C_6+	88.96	86.71	
Total	100.00	86.62	
Product Properties			
API	34.9		
RVP	3.48		
RON-0	105.0		
MON-0	92.6		
ASTM D-86 Distillation			
IBP, °F	1.39		
10%	180		
30 %	210		
50%	239		
70%	270		
90%	311		
EP, °F	406		

SALES

UOP Process Division

ESTIMATED NORMAL UTILITY REQUIREMENTS

ITEM	LOAD BHP	ELEC. POWER	STEAM THOUSAND POUNDS PER HOUR							EQUIP. DUTY	___ °F COOL. WATER		FUEL
	NORM.	KW	600 #/750 °F	150 #/SAT °F	50 #/SAT °F		BFW	COND.	LOSS	10^6 BTU / HR	°F RISE	GPM	10^6 BTU / HR
PUMPS	257	215											
RECYCLE GAS COMP	2120	1654											
BOOSTER GAS COMP	3395	2648											
WATER COOLING										13.7	20	918	
OTHER COOLING, CONDENSORS	76	66								52.3			
FIRED HEATERS			91.2	-7.6			-96.0	+0.1	12.4	281.4			317.4
REGENERATOR		125			-0.1							35	
TOTAL			91.2	-7.6	-0.1		-96.0	+0.1	12.4			953	317.4

NOTES: GAS TO FUEL AND FUEL FIRED BASED ON NET HEATING VALUES.
ANNUALIZED AVG LOAD OF _____ % OF DESIGN LOAD ASSUMED FOR AIR COOLING.

DESIGN AIR TEMP. OF 80 °F ASSUMED.
AIR-WATER COOLING BREAK TEMP. = 120 °F.

LOCATION BRECKINRIDGE COUNTY, KY
UNIT PLANT 18, PLATFORMER
CAPACITY 20000 BPSD

BY CHRISTENSEN
SHEET ___ OF ___
DATE 4.14.81
REV. ___

TABLE 6(B)

105 RON CASE

UOP Process Division

SALES

ESTIMATED NORMAL UTILITY REQUIREMENTS

ITEM	LOAD BHP	ELEC. POWER	STEAM THOUSAND POUNDS PER HOUR							EQUIP. DUTY	___ °F COOL. WATER		FUEL
	NORM.	KW	600 # / 750 °F	150 # / SAT. °F	50 # / SAT. °F		BFW	COND.	LOSS	10^6 BTU / HR	°F RISE	GPM	10^6 BTU / HR
PUMPS	172	614											
RECYCLE GAS COMP.	2155	1681											
BOOSTER GAS COMP.	3654	2850											
WATER COOLING	–	–								14.1	30	938	
OTHER COOLING, CONDENSERS	82	70								52.0			
FIRED HEATERS	–	–	94.2	-7.8			-99.1			289.2			326
REGENERATOR		195			-0.1			+0.1	12.8			35	
TOTAL			94.2	-7.8	-0.1		-99.1	+0.1	12.8			973	326

NOTES: GAS TO FUEL AND FUEL FIRED BASED ON NET HEATING VALUES.
ANNUALIZED AVG LOAD OF _____ % OF DESIGN LOAD ASSUMED FOR AIR COOLING.

DESIGN AIR TEMP. OF _____ °F ASSUMED.
AIR-WATER COOLING BREAK TEMP. = _____ °F.

COMPANY BRECKINRIDGE H-COAL PROJECT
LOCATION BRECKINRIDGE COUNTY, KY
UNIT PLANT 18 PLATFORMER
CAPACITY 20000 BPSD

CHARGE (HYDROTREATED)
BY
SHEET OF
DATE 4-14-81
REV.

APPENDIX A

DETAILS OF GLC AND M.S. ANALYSES

Naphtha Cut of "Raw" H-Coal Liquid

Carbon Number Distribution by M.S., Vol-%

Carbon Number	Paraffins	Monocyclo Paraffins	Aromatics J=6	Aromatics J=8	Aromatics J=12
6	5.24	14.00			
7	5.40	16.07	4.81		
8	4.34	11.83	6.77	0.19	
9	2.78	7.59	2.38	0.06	
10	2.29	1.94	0.33	0.29	
11	0.01	0.26	0.71	0.26	0.01
12					
13					
Total	20.06	51.69	15.00	0.80	0.01

Cyclopentanes	15.68
Cyclohexanes	36.01
Total Monocycloparaffins	51.69
Bi, Dicycloparaffins	8.57
Tricycloparaffins	3.87
Total Naphthenes	64.13

Hydrotreated Naphtha

(Second Stage Product)

GLC, Wt-%

Iso-C_4	
n-C_4	0.14
i-C_5	0.39
n-C_5	1.56
2-MP	0.81
3-MP	0.55
2,2-DMB	0.0
2,3-DMB	0.08
n-C_6	2.35
C_7 P	4.57
C_8 P	4.32
C_9 P	2.26
C_{10} P	1.37
C_{11} P	0.57
C-C_5	1.16
MCP	3.24
C-C_6	9.84
C_7 N	18.27
C_8 N	14.76
C_9 N	12.58
C_{10} N	4.11
C_{11} N	0.97
Total P+N	83.9
Benzene	1.1
Toluene	4.6
C_8 Arom.	6.7
C_9+ Arom.	3.7
Total Arom.	16.1

MS Analysis, LV-%

Paraffins	20.75
Naphthenes	64.73
Monocycloparaffins	57.57
Bi, Dicycloparaffins	7.16
Tricycloparaffins	0.00
Aromatics	14.62
Alkylbenzenes	13.85
Indans, Tetralins	0.67
Naphthalenes	0.00

Carbon Number Distribution, LV-%

C.N.	Par.	MCP	J=6	J=8	J-12
6	5.34	16.50	1.61		
7	6.42	16.36	5.05		
8	5.16	13.78	5.24	0.01	
9	3.75	8.88	1.50	0.18	
10	0.08	2.04	0.36	0.32	0.0
11	0.0	0.01	0.06	0.14	0.0
12	0.0	0.0	0.02	0.02	0.0
13	0.0	0.0	0.01	0.0	0.0
Total	20.75	57.57	13.85	0.67	0.0

Cyclopentanes	18.79
Cyclohexanes	38.78

Rerun Hydrotreated H-Coal Naphtha

Carbon Number Distribution by M.S., Vol-%

Carbon Number	Paraffins	Monocyclo Paraffins	Aromatics J=6	Aromatics J=8	Aromatics J=12
6	4.2	15.80	1.10		
7	5.94	16.93	7.15		
8	4.63	14.14	3.50		
9	4.31	9.11	0.82	0.21	
10	2.37	2.17	1.61	0.16	
11			0.01	0.03	
12					0.0
13					0.0
Total	21.45	58.15	14.19	0.40	0.01

Cyclopentanes	19.06
Cyclohexanes	39.09
Total Monocycloparaffins	58.15
Bi, Dicycloparaffins	5.80
Tricycloparaffins	0.0
Total Naphthenes	63.95

UOP
Process Division
20 UOP Plaza—Algonquin & Mt. Prospect Roads • Des Plaines, Illinois 60016
Telephone 312-391-2000 • Telex 25-3285 • TWX 910-233-3501

April 30, 1981

	DISTRIBUTION
	ASFI & BECHTEL
X	BECHTEL ONLY
	CONTRACT CORRESP.
	GEN'L CORRESP.
	CONF. NOTES
	PROJ. SCHEDULE
	PROJ. PROG. REPORTS
	BASIC DATA
X	LKM, WRC, ARP

FN 10.2

Mr. J. R. Bruner
Project Manager
Bechtel Petroleum, Inc.
P. O. Box 2166
Houston, Texas 77001-2166

Job 14222 - Breckinridge Project
Deliverables Under Subagreement Between
Bechtel and UOP

Dear Jack:

This letter serves to correct inadvertent errors/omissions in the report on the pilot plant work done by UOP dated 23rd April, 1981.

1. Page 7, 3rd paragraph, 3rd to last line. Should read "4th quarter 1980 dollars" instead of 4th quarter 1981 dollars".

		Load BHP	Electric Power KW
2.	Table 6(A)		
	Booster Gas Compressor	3395	2648
3.	Table 6(B)		
	Booster Gas Compressor	3654	2850

Should you have any questions, please do not hesitate to let me know.

Sincerely,

Avinash Manudhane

Avinash Manudhane
Project Coordinator

RECEIVED
MAY 4 1981
J. R. BRUNER

pam

UOP Inc.

UOP
Process Division
20 UOP Plaza—Algonquin & Mt. Prospect Roads • Des Plaines, Illinois 60016
Telephone 312-391-2000 • Telex 25-3285 • TWX 910-233-3501

April 23, 1981

DISTRIBUTION	
	ASFI & BECHTEL
X	BECHTEL ONLY
	CONTRACT CORRESP.
	GEN'L CORRESP.
	CONF. NOTES
	PROJ. SCHEDULE
	PROJ. PROG. REPORTS
	BASIC DATA
X	LKM w/a WRC

Mr. J. R. Bruner
Project Manager
Bechtel Petroleum, Inc.
P. O. Box 2166
Houston, Texas 77001-2166

Subject: Job 14222 - Breckinridge Project Deliverables Under Subagreement Between Bechtel and UOP FN 10.2

Dear Mr. Bruner,

Enclosed please find two copies of a report on pilot plant work carried out by UOP under the above subagreement. The work included:

(i) Fractionation of the as-received coal-liquid to generate a naphtha cut

(ii) Hydrotreating of the naphtha

(iii) Catalytic reforming (Platforming) of the naphtha

The objectives of the pilot plant work were to confirm predicted product yields and catalyst stability that had earlier been used to estimate capital cost and utility requirements.

The report enclosed: (a) describes the processing sequence utilized, (b) provides analytical results characterizing the main product from each processing step, (c) comments on the significance of the pilot plant results and (d) summarizes revised product yield estimates and cost figures.

With this report, the submission of deliverables under the subagreement is completed. Should you have any questions, please do not hesitate to call me.

Sincerely

Avinash Manudhane

Avinash Manudhane
Project Coordinator

pam
Attachments

PROPERTIES OF MATERIAL
TO BE TESTED BY U. O. P.

MOORE (APC) TO KREUDING (UOP)
5/23/80

REF. 46

COPIES JBG
WHD 05.25.80

Ashland

Ashland Petroleum Company
DIVISION OF ASHLAND OIL INC.
P. O. BOX 391 • ASHLAND, KENTUCKY 41101 • (606) 739-4166

RESEARCH AND DEVELOPMENT DEPARTMENT

May 23, 1980

Mr. Arthur P. Kreuding
UOP Process Division
20 UOP Plaza
Des Plaines, Illinois 60016

Dear Art:

In accordance with our meeting of April 17, 1980, and subsequent telephone conversations, we have completed screening of drum materials selected for your use under Phase Zero of the Breckinridge Project. Attached are the measured properties of twelve drums of material produced from Kentucky #11 coal via the H-Coal process in the syncrude mode by Hydrocarbon Research, Incorporated, at their Trenton, NJ facility, during run number 130-89. These drums were selected from material produced after at least 20 days of operation.

Also appended, as Table II, are properties for nominal IBP-355°F (ASTM) naphthas produced by laboratory batch fractionation of samples from three of these drums. These properties are, in my judgement, both reasonably consistent between samples and within the range of expected results. Further, these data are remarkably similar to our data base for Illinois #6 coal products.

Based on these results, I have concluded that the drums selected are appropriate for your use, and that the naphtha to be processed will be an adequate representation of both Kentucky #11 and Illinois #6 coal products. We are prepared

RECEIVED

MAY 27 1980

SYNTHETIC OIL

to ship ten of these drums for your use; please notify me when shipment is desired. We will retain two of the selected drums at this location as spare material.

Please do not hesitate to contact me if I may be of further assistance, or if additional information is required.

Yours,

Howard F. Moore

HFM:lf

cc: H. N. Hicks

bcc: E. M. Hobbs
W. P. Hettinger, Jr.
C. D. Hoertz
D. K. Chapman
W. Lyons
D. A. Fabry

TABLE I

PROPERTIES OF SELECTED DRUMS

SAMPLE NUMBER	API GRAVITY, °API	BS&W, VOL%	TOTAL NITROGEN WT%	TOTAL PHENOLS, WT%
9-HC-129	31.5	None	0.65	6.89
9-HC-70	30.9	None	0.67	7.70
9-HC-91	31.5	None	0.67	7.84
9-HC-19	31.5	None	0.67	8.17
9-HC-26	31.6	None	0.65	7.37
9-HC-132	31.4	None	0.64	7.68
9-HC-133	31.2	None	0.68	7.70
9-HC-161	34.8	Trace	0.49	6.31
9-HC-134	36.0	None	0.45	5.24
9-HC-74	34.8	None	0.56	5.44
9-HC-131	36.2	None	0.53	5.80
9-HC-75	35.2	None	0.56	5.50

TABLE II

IBP-355°F (ASTM) Naphtha Properties

SOURCE DRUM NO.	9-HC-129	9-HC-133	9-HC-75
Yield, WT%	46.7	51.4	58.1
°API	43.7	43.1	45.6
FIA: Saturates	70.7	71.1	73.2
Olefins	6.7	6.0	5.5
Aromatics	22.6	22.9	23.3
Total Phenols, WT%	6.9	8.3	5.5
Total Nitrogen, WT%	0.29	0.25	0.20
Total Sulfur, WT%	0.27	0.33	0.25
ASTM D-86 Distillation, Vol%			
IBP	142	152	152
5	182	180	186
10	190	192	194
30	232	230	220
50	256	260	252
70	300	300	284
90	342	334	320
95	354	346	336
EP	366	360	350

H-Coal® Pilot Plant

TOPICAL REPORT T-8
COAL RUN NO. 6 WITH ILLINOIS COAL
IN SYNCRUDE MODE

ASFI

MAY 20, 1981

REF. 47

The memoranda and reports in Reference 47 are included only in the limited access version because they contain proprietary information.

SUPPORTING DATA FROM PDU RUN #5
AND OTHER PDU RUNS

HRI

JUNE 1981

REF. 48

The memoranda and reports in Reference 48 are included only in the limited access version because they contain proprietary information.

Miscellaneous

DESIGN DATA FOR PLANT 4
PRIMARY SEPARATION DECANTERS

HICKS TO DISTRIBUTION
(ASFI)
5/15/81

REF. 34

The memoranda and reports in Reference 34 are included only in the limited access version because they contain proprietary information.

INTEGRATED PILOT PLANT

PHASE I - FINAL REPORT

BY: HRI

NOVEMBER 1977

REF. 39

REPORT PREPARED FOR

HRI ENGINEERING DIVISION

H-COAL™ PROCESS DEVELOPMENT UNIT OPERATIONS USING ILLINOIS AND KENTUCKY COALS WITH ASSOCIATED STUDIES OF SOLIDS SEPARATION TECHNIQUES AND THE HYDROCLONE SYSTEM INCLUDING PILOT PLANT HYDROCLONE OPERATION

REPORT NO. 62-213-1

TABLE OF CONTENTS

	PAGE
PROGRAM NOTES	1
INTRODUCTION	5
PART I - PDU H-COAL OPERATIONs 1966-1981 AND PILOT PLANT PERFORMANCE DATA	7
Process Development Unit Description	8
PDU Schematic - Coal Handling System	10
PDU Flow Sheet - Overall System	17
Project H-Coal - 1966/1967	18
Run 130-57	
Coal Analysis	19
Operating Results	20
Joint Participation Program (1973-1974)	25
Run 130-60	26
Coal Analysis	27
Operating Results	28
Run 130-62	36
Coal Analysis	37
Operating Results	38
Run 130-63	43
Coal Analysis	44
Operating Results	45
Phase I - DOE/Participants Program	49
Demonstration Runs	49
Run 130-65	
Coal Analysis	50
Operating Results	51

TABLE OF CONTENTS (CONTINUED)

	PAGE
Run 130-69	
Coal Analysis	54
Operating Results	55
PDU Run 1	70
Operating Results	71
PDU Run 2	
Preliminary Run 130-76	83
Operating Results	84
Run 2 Final Operation	95
Analysis	96
Operating Results	97
PDU Run 3	103
Coal Analysis	104
Operating Results	105
PDU Run 4	111
Coal Analysis	112
Operating Results	113
Phase II - DOE/Participants Program	130
PDU Run 5	131
Data Correlation	132
Coal Analysis	133
Operating Results	134
PDU Run 7	154
Coal Analysis	155
Operating Results	156
PDU Run 8	162
Coal Analysis	163
Operating Results	166
PDU Run 9	227
Comparison of Results - PDU Runs 5 and 9	228
Coal Analysis	229
Operating Results	231

TABLE OF CONTENTS (CONTINUED)

PAGE

Pilot Plant Operating Performance..... 316
Flowsheet - Coal Liquefaction and Oil Recovery Sections..... 317
Operating Data - 45.5-Day Run..... 318

PART II - SOLIDS SEPARATION TECHNIQUES - PDU..... 322

PDU Solids Separation System - Background..... 323
Why Solids Separation is Necessary..... 323
Initial Investigation of Techniques..... 323
Concept of Solvent Precipitation..... 324

Solvent Precipitation System Operation..... 326
Exhibit S-1 - System Flow Diagram..... 329

Solvent Precipitation System Description..... 330
Overview..... 330
Sampling and Analysis..... 330
Exhibit S-2 - Samples and Analysis Requirements..... 331

Equipment and Test Methods..... 333
Batch Autoclave Separation..... 333
Continuous 30-Pounds-Per-Hour Separator..... 333
300-Pounds-Per-Hour Separator..... 336
Exhibit S-3 - Solvent Precipitation Column..... 338
Solvent Precipitation Equipment List..... 339

PART III - HYDROCLONES - PDU AND PILOT PLANT..... 354

Hydroclone Performance in the PDU System..... 355
Illinois Coal Operations - Syncrude Mode..... 355
Illinois Coal Operations - Dual Mode..... 356
Kentucky Coal Operations - Syncrude Mode..... 356
Wyodak Coal Operations - Syncrude Mode..... 356
Exhibit H-1 - Analysis and Ratios - Kentucky Coal..... 358
Exhibit H-2 - Hydroclone Efficiency - Wyodak Coal..... 359

TABLE OF CONTENTS (CONTINUED)

	PAGE
Hydroclone Test Loop	360
Description	360
Operation	360
Exhibit H-3 - Bump Pump - Test Loop	362
Exhibit H-4 - DOXIE Hydroclone	363
Exhibit H-5 - Test Results - New DOXIE	364
Exhibit H-6 - Test Results - Resurfaced DOXIE	365
Hydroclone System Configuration	366
Description	366
Development	366
Exhibit H-7 - Hydroclones in PDU System	368
Exhibit H-8 - Hydroclone System Test Results	369
Pilot Plant Hydroclone Performance	370
Run 5	370
Run 6	370
Exhibit H-9 - Hydroclone Performance	372
Exhibit H-10 - Hydroclone Performance	373
APPENDIX - PDU OPERATIONS - VARIOUS COAL TYPES	380

H-COAL™ PROGRAM NOTES

In 1961, a group of HRI scientists wondered what would happen if they used powdered coal and oil as feed in a hydrogenation reactor instead of conventional petroleum feedstock. This research curiosity, which started with a truckload of coal pulverized by a sledgehammer, has become a technological giant in the synthetic fuels industry. HRI's H-Coal™ Process is being used in a coal liquefaction Pilot Plant in Catlettsburg, Kentucky. More than 1,500 barrels a day of clean liquid product can emerge ready for upgrading to gasoline and other fuels in conventional refineries. The success of this venture assumes critical importance in view of the energy crunch facing the United States.

All of the experimental work to bring H-Coal to commercial reality has been performed at the HRI R & D Center in Lawrence Township, New Jersey. In the last eighteen years, a full range of coals has been evaluated in experimental equipment with capacities from a few pounds to tons of coal per day. Specialized hardware has been designed and tested, and much of it has been scaled up for use in the Pilot Plant and, ultimately, in commercial H-Coal facilities.

The versatility of H-Coal is indicated by the following list of tested coals:

1. Illinois No. 6
2. Kentucky
3. Wyodak Subbituminous
4. Black Mesa
5. Kaiparowits
6. Pittsburgh Seam
7. Utah D
8. Colorado
9. North Dakota Lignite
10. Texas Lignite
11. Big Horn
12. Australian (Gelliondale) Brown Coal
13. German Lignite-Type
14. United Kingdom Bituminous
15. High-Ash, Southern Hemisphere Coal

The ebullated bed reactor is an inherent component of several HRI processes including, of course, the H-Coal Process. The ebullated bed reactor system was patented by HRI in 1961. Feed and hydrogen are in intimate contact with catalyst particles kept in a state of constant, random motion. The catalyst bed expands but stays within the confines of the reactor. The expanded bed allows particulates such as ash and unreacted coal to pass freely through the reactor and avoids plugging problems associated with more conventional reactor designs. One of its most interesting features is that the catalyst can be added and withdrawn continuously, avoiding expensive down time to replace spent catalyst.

Ebullating-bed bench units have been used for much of the H-Coal experimentation. These units, having diameters of 1/2 to 1 inch, are used to evaluate new coals, new catalysts and to define the chemistry of the process.

The Process Development Unit, which has been used for H-Coal testing since 1966, has been enlarged and modified almost continuously to parallel the growth of the H-Coal project. The PDU reactor has a diameter of 8-1/2 inches and permits evaluation of the mechanical operability of the reactor and associated components.

As mentioned, equipment is designed, constructed and operated to meet particular demands of the experimental program. One example is a cold flow model of the Pilot Plant reactor. HRI built and operated this system to confirm the internal design of the pilot plant reactor. The model is full scale: twenty-four feet high with a five-foot diameter.

HRI has made economic studies correlative to the experimental studies almost since the inception of the program. These studies include economic comparisons between eastern and western U.S. coals, the impact of low pressure operation in the fuel oil mode, and maximum boiler fuel and distillate production.

Several bench-scale runs were chosen as the design basis for Pilot Plant operations. Three of the four base cases used Illinois No. 6 bituminous coal at low, intermediate and high space velocities and the fourth case used Wyodak subbituminous coal. The final design for the Pilot Plant is based on PDU Run 5 which replicated anticipated operations.

H-COAL BACKGROUND

H-Coal was invented by HRI in 1963 and development has been continuous since that time. Dynalectron Corporation encouraged this development with financial support totalling several millions of dollars. In 1965, advancement of the process was stimulated by a multi-million dollar contract from the Office of Coal Research (now DOE). Since then, in addition to DOE funding, the program has been funded by various industrial participants, including many leading oil companies and coal producers in the United States. In 1974 DOE and an industrial consortium committed themselves to the design, construction and operation of the 600 ton/day H-Coal Pilot Plant at Catlettsburg, Kentucky. This plant, which is now in operation, is an important step toward large-scale operations.

The H-Coal Process converts coal to liquid and gaseous products. The process is unique because it utilizes HRI's patented ebullated-bed reactor. Intimate contact between catalyst particles, hydrogen and the slurry-coal feed are achieved by this reactor to permit superior reaction conditions and process control. Because this process utilizes relatively low reactor pressure (2000-3000 psig) its investment and operating costs are minimized.

THE H-COAL DEVELOPMENT PROGRAM

The purpose of the recent H-Coal Development Program has been the demonstration of the H-Coal Process in the H-Coal Pilot Plant. In Phase I of this program, HRI confirmed key design features and completed the detailed engineering design of the Pilot Plant. The Pilot Plant was constructed during Phase II of this program. Concurrent with the construction, the HRI laboratory support program also provided additional confirmation of plant design as well as development of the technical management plan. The objective of the current Phase III Program is a two-year demonstration of the H-Coal Process on a Pilot-Plant scale. This demonstration utilizes the operating configurations designed into the plant, which encompass syncrude and boiler-fuel mode operations using three different coals. A laboratory program is being performed in conjunction with the Pilot Plant to support this Phase III objective.

ADVANTAGES OF THE H-COAL PROCESS

The H-Coal Process offers many advantages over other coal liquefaction technologies. High yields of low-sulfur distillate liquids have been produced from a wide variety of bituminous and subbituminous coals and lignites. Typically, 2.8 to 3.5 barrels of C_3/975°F liquids are produced per ton of dry coal feed to liquefaction. The presence of the catalyst in the H-Coal liquefaction reactor significantly improves the conversion of heavy coal liquids to distillate products. The H-Coal reactor combines coal liquefaction, solvent hydrogenation and product upgrading, thus reducing the number of processing steps compared to other coal liquefaction technologies. This simplified flow scheme reduces plant costs, increases process efficiency and improves plant service factors.

The key to the advantages of the H-Coal Process is the H-Coal reactor. The ebullated-bed reactor allows intimate contact between catalyst particles, hydrogen and the coal-oil slurry, achieving essentially isothermal reactor conditions, with low and constant reactor pressure differential. The ebullated bed reactor system has over 28-unit years of commercial operation in HRI's H-Oil petroleum-residuum, hydroconversion process. Other major advantages of the H-Coal reactor are:

- High liquid yields and qualities are achieved in the presence of a synthetic catalyst and are not dependent on the catalytic effect of coal ash.

- On-stream catalyst replacement controls deactivation, provides constant product quality, allows the possibility of on-stream catalyst regeneration, and provides for high-unit service factors.

- Operating conditions can be varied to meet flexible product slate requirements.

- Direct catalytic hydrogenation of coal offers the potential for use of different and improved catalysts in the future as product requirements change.

- The ebullated bed assures good temperature control throughout the reactor, using the energy of the reaction to heat the feed slurry to reaction temperatures.

INTRODUCTION

From a reading of the program notes, one can see that H-Coal development has been intense, that commercial feasibiity is established, and that commercial H-Coal plants can become a reality within this decade.

The development path followed for commercialization of H-Coal is similar to that used by HRI for scale-up of the commercial H-Oil™ residuum and heavy crude hydroconversion process. The H-Oil reactor system was successfully scaled-up from the bench, through the PDU, followed by a large pilot plant demonstration unit and finally to a commercial scale plant. The reactor diameters are shown below.

	H-Oil Reactor Diameter	H-Coal Reactor Diameter
Bench Unit	3/4"	3/4"
Development Unit	8-2/1"	6 & 8-1/2"
Pilot Plant	4'6"	5'
Commercial Plant	13'	10-13'

The H-Coal commercialization steps follow the same reactor scale-up criteria. The five-foot-diameter H-Coal reactor is currently in use at Catlettsburg, while commercial-scale reactors are being designed as part of the Breckinridge H-Coal commercial plant project. An H-Coal commercial plant would have several reactors in parallel, depending on the economy of scale desired by the operator and the availability of capital. In terms of the individual reactor train, the commercial-scale reactor would have about ten times the throughput as the Catlettsburg Pilot Plant with a diameter scale-up of two to three times.

The focus of this report is a discussion of H-Coal technology development in the HRI Process Development Unit. The discussion is limited to those operations which used either Illinois or Kentucky bituminous coals. For information purposes, we have appended a list of all significant PDU coal operations since 1966, which includes all of the coal types processed in the system.

The report centers on several subjects:

- Part 1 includes a mechanical description of the Process Development Unit with a process flow scheme. The PDU operations on Illinois and Kentucky coals are also included. Each run is described briefly, and the description is followed by the coal analysis, where available, and comprehensive tabulations of operating conditions and product yields. Pilot Plant data for the recent 45-day run are also included in this section.

- Part 2 is a discussion of HRI's program to develop an efficient solids separation technique.

- Part 3 focuses on HRI's development of a hydroclone system. A discussion of hydroclone operation in the Pilot Plant is also included.

PROCESS DEVELOPMENT UNIT

OPERATIONS 1966 THROUGH 1981

AND

PILOT PLANT PERFORMANCE DATA

PROCESS DEVELOPMENT UNIT

The H-Coal Process Development Unit uses the ebullated bed reactor system to convert coal to liquid fuels at pressures up to 3000 psig and temperatures to 865°F. Feed capacity is 3.5 tons per day.

Coal-oil slurry feed and make-up plus recycle hydrogen are fed at high pressures through preheaters then introduced to the ebullated bed reactor. Ebullation is maintained by internal recirculation of the reactor liquid. Ebullation of the reaction mass permits temperature control within a narrow range by removing exothermic heat as sensible heat to the coal-slurry feed stream. Unconverted coal and ash are removed with the liquid-gaseous reactor products while the larger, heavier catalyst pellets remain in suspension at a level established by density difference and internal flow rates. At constant gas velocity, density and feed rate, catalyst bed expansion is maintained by varying the speed of the ebullating recycle pump and control valve setting. The catalyst bed level is monitored by a gamma ray indicator. Spent catalyst is withdrawn and fresh catalyst added to the reactor at regular intervals during operations in order to maintain catalyst age.

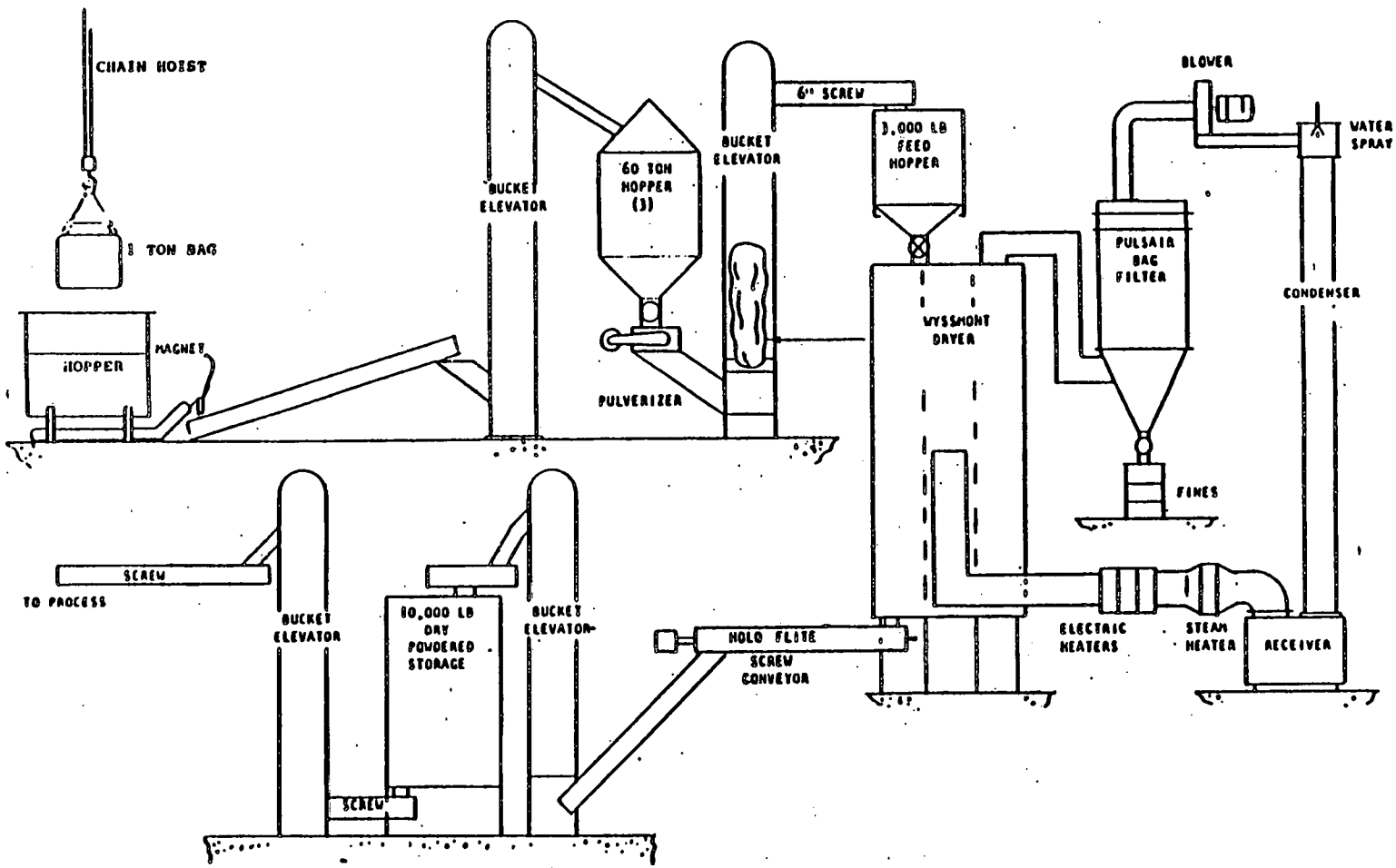
The coal-derived, liquid-gas-solid reactor effluent is removed overhead from the reactor. The gas, liquid and solid products are separated in another vessel. The reactor products are let down in pressure in a two-stage operation and cooled. The solids-free condensate is sent to atmospheric pressure fractionation. The non-condensible gaseous products are separated with the hydrogen-rich stream used for recycle. The remaining gaseous products are flared. The solids-containing liquid product is passed through a hydroclone separation system and the resulting hydroclone overflow stream, with a lower solids content, is recycled. The hydroclone underflow stream, which has a higher solids content, is used as vacuum column feed.

COAL HANDLING SYSTEM

Coal is received in railroad cars, drums or shipping containers, generally as lumps which are 1-1/2" or smaller.

The coal is tranferred through belt conveyors to a crusher and reduced to less than 1/2 inch at a rate of 5000 pounds per hour. The crushed coal is then sent, if necessary, to a dryer in order to reduce the surface moisture. A bucket elevator sends the coal to one of the three 60-ton-capacity storage hoppers. The coal is gravity fed from a storage hopper to a hammer mill which produces approximately 1300 pounds per hour of 95% -60 mesh coal powder. The powdered coal is kept in a 3000-pound storage hopper located above the rotary tray dryer. The powdered coal is fed from the storage hopper through a star feeder into the dryer.

In the dryer, the coal falls to the top tray of the eighteen tray unit. After one rotation the coal is wiped off to fall to the next tray. The dryer unit normally operates with a residence time of thirty-five minutes, a 95% nitrogen atmosphere and a temperature of 210-220°F. These conditions reduce the moisture content from 10% to 2% at a rate of 500 pounds of coal per hour. After its last pass in the dryer, the hot, dry coal falls into a cooler, which is a water-cooled screw conveyor. Under a nitrogen atmosphere, the dry, room-temperature coal is sent through a shaker screen to the 10,000-pound storage tank via two screw conveyors and a bucket elevator. The coal powder is transferred upon demand from this storage tank to the feed metering hopper located above the slurry mix tank. The next exhibit is a configuration of the coal handling system.



HYDROCARBON RESEARCH, INC.
A DIVISION OF DYNALECTRON CORPORATION

PDU COAL HANDLING SYSTEM
RUNS 130-91 and 92

DRAWN: A N R DATE: 18-80-70
ENGR: CW. DATE: C ! C
DWG. NO. BF-3064

FEED SLURRY PREPARATION

Pulverized coal is fed continuously from a weigh tank into the slurry mixing tank using a screw feeder. The coal is mixed with clean oil and hydroclone overflow using a mixer and recirculating pumps. These recirculating pumps are also used to maintain positive, high-velocity suction to the high pressure feed pumps. The clean oil is fed by penumatic pump to the slurry tank from the clean oil tank at a controlled volumetric rate. Inventory in the slurry mix tank is held constant by controlling the clean oil, hydroclone overflow and coal rates, and adjusting the high pressure feed pumps.

PREHEATERS

The coal-oil slurry is taken from the high pressure feed pumps and mixed with preheated, compressed make-up hydrogen. (Compression performed by either one or both of the fresh hydrogen compressors.) The slurry-hydrogen mixture is then sent to the fresh feed heater which is a dual, natural gas/fuel oil fired helical coil heater with semi-automatic combustion controls and automatic safeguards. From the fresh feed heater the slurry-hydrogen mixture is fed into the reactor through a side flange located below the bottom head. Scrubbed recycle gas is compressed by either the primary recycle gas compressor or the secondary recycle gas compressor. The recycle gas is then sent to the recycle gas heater which is the same kind of heater as the one used for fresh feed. From here the recycle gas is fed into the reactor through a side flange located below the bottom head and below the fresh feed inlet flange. The outlet temperatures of both heaters are manually controlled at the main panelboard. The recycle gas heater outlet temperature is controlled above reaction temperature and the fresh feed heater outlet temperature is controlled below the reaction temperature. These control points are used to help balance the hydrogenation exotherm.

REACTOR SECTION

The reactor is a pressure vessel with an internal diameter of about 8.5 inches. The vessel is 22 feet long from flange face to flange face.

CATALYST ADDITION AND WITHDRAWAL SYSTEMS

The reactor is equipped for catalyst addition and withdrawal. Catalyst is maintained in the reactor at constant activity by regular withdrawal of a portion of the catalyst and replacement by an equal amount of fresh catalyst.

The catalyst addition and withdrawal system has a number of special features. The balanced pressure design permits operation with almost no pressure drop across the block valves. This design evolved primarily to minimize valve wear; however, it also minimizes catalyst attrition during addition and withdrawal.

The system design which allows the catalyst to settle out through the withdrawal tube under almost no pressure drop requires that the time needed to withdraw a designated amount of catalyst be determined by trial and error. The reactor hydrodynamics, however, are such that the fine-quantity relationship cannot be exact. The procedure for catalyst addition is:

1. Withdrawn material is drained of oil and weighed.

2. An estimate is made of the spent catalyst in the withdrawn material and that amount of fresh catalyst is added to the reactor.

3. Catalyst content in the withdrawn material is determined analytically and a molybdenum balance is made. The actual amount of catalyst to be added is calculated.

4. Any discrepancy between the estimated amount of catalyst that was added to the reactor in Step 2 and the actual amount of catalyst to be added from Step 3 is accounted for in subsequent additions.

TWO-STAGE LETDOWN

Reactor effluent leaves the reactor through a dip tube and travels to the high pressure vapor-liquid separator. The level in the high pressure vapor-liquid separator may be sensed by two independent systems. The primary system utilizes a differential pressure sensor. (Both the high and low pressure legs are purged with recycle gas.) The secondary level sensing system uses a nuclear level indicator. Both systems may be used for level control.

The liquid stream from the high pressure vapor-liquid separator exits the bottom of the separator and passes through a one-half inch schedule 160 pipe to the first stage pressure letdown station. Here the liquid stream is let down from reactor pressure to approximately 1200 psi. The action of the first stage pressure letdown valves is controlled by the high pressure vapor-liquid separator level sensing system. The first stage letdown valves are angle body control valves with tungsten carbide trim. The mixed stream after the first stage pressure letdown enters the first stage pressure letdown vessel. Here the stream is separated into a liquid stream and a vapor stream. The vapor stream is let down in pressure from 1200 psi to about 50 psi. The internal pressure of the first stage pressure letdown vessel serves as the control setpoint for the vapor stream pressure letdown. The reduced pressure vapor stream is sent to the atmospheric flash vessel. The liquid stream from the first stage pressure letdown vessel is sent to the second stage pressure letdown station. Here the liquid stream is let down in pressure from 1200 psi to about 50 psi. The liquid level of the first stage pressure letdown vessel serves as the control setpoint for the second stage pressure letdown valves. The mixed stream from the second stage letdown is sent to the atmopsheric flash vessel.

The liquid and vapor streams from the first and second stage pressure letdown stations are combined and then separated into a vapor stream and a liquid stream in the atmospheric flash vessel.

The internal recycle oil flow is used to expand and control the ebullation of the catalyst bed within the reactor. The recycle oil flow is maintained by recycle pump. Recycle oil flow is controlled manually by adjusting the pump motor speed and the recycle oil control valve setting.

The catalyst bed is monitored by a gamma ray density system which has a gamma ray source, detector/transmitter and an amplifier/indicator. The source and detector/transmitter are mounted on a reactor traverse system. The traverse position along the length of the reaction is manually controlled at the main panel board. Both the position of the traverse and the density reading at that level are recorded. Suction for the recycle pump is taken through an internal recycle cup located above the expanded catalyst bed. The internal recycle oil flow is measured by a flow meter. The density of the recycle oil is monitored by a gamma ray nuclear density system with an output indicator located on the main panel board. Both recycle oil flow and recycle pump differential pressure are recorded on the main panel board. Flushing oil is pumped into the motor end of the recycle pump in order to keep the rotor bearing areas free of solids. Purge oil is also used to flush the recycle oil flow meter differential pressure taps.

Reaction temperatures are monitored by a ten-point internal thermocouple assembly terminating at critical distances along the reactor length. The reactor skin is wound with resistance wire heaters and then insulated to minimize heat loss. Heater controls are located opposite the main panel board in the control room.

LOW-PRESSURE VAPOR-LIQUID PRODUCT HANDLING

The vapor stream from the atmospheric flash vessel is cooled and partially condensed by a water cooler. This mixed stream is sent to the flashed liquid overhead product drum. The vapor stream from the flashed liquid overhead product drum is metered by the reactor liquid flash gas meter and sent to the flare. The liquid stream from the flashed liquid overhead product drum is pumped to the bottoms heater. The flow is metered. Flow is controlled by the flashed liquid overhead product drum liquid level control system. From the bottoms heater the liquid flows to the atmospheric still.

The liquid stream from the atmospheric flash vessel is sent to the hydroclone section where the material is pumped through the hydroclone preheater and sent to the hydroclone. Here the liquid stream is split into a relatively low ash hydroclone

overflow stream and a relatively high ash hydroclone underflow stream. The overflow stream is sent to the hydroclone overflow surge drum. From the drum the relatively low ash liquid is metered and recycled to the slurry mix tank. Level in the hydroclone overflow surge drum is maintained by liquid level control. The hydroclone underflow stream is sent to the hydroclone underflow surge drum and then to the vacuum still.

The liquid stream from the vacuum distillation tower is collected in drums and sent to storage. The vapor stream from the vacuum distillation tower is sent to the vacuum still condenser. The new liquid stream is sent to the vacuum still overhead receiver. This liquid stream is then pumped and metered to the clean oil tank. The vapor stream from the high pressure vapor-liquid separator exits at the top of the separator. Water is injected to prevent the formation of ammonium salts when the vapor stream cools. The vapor stream then passes into an extended-surface, hairpin heat exchanger which acts as a partial condenser. The mixed stream then enters the reactor overhead separator.

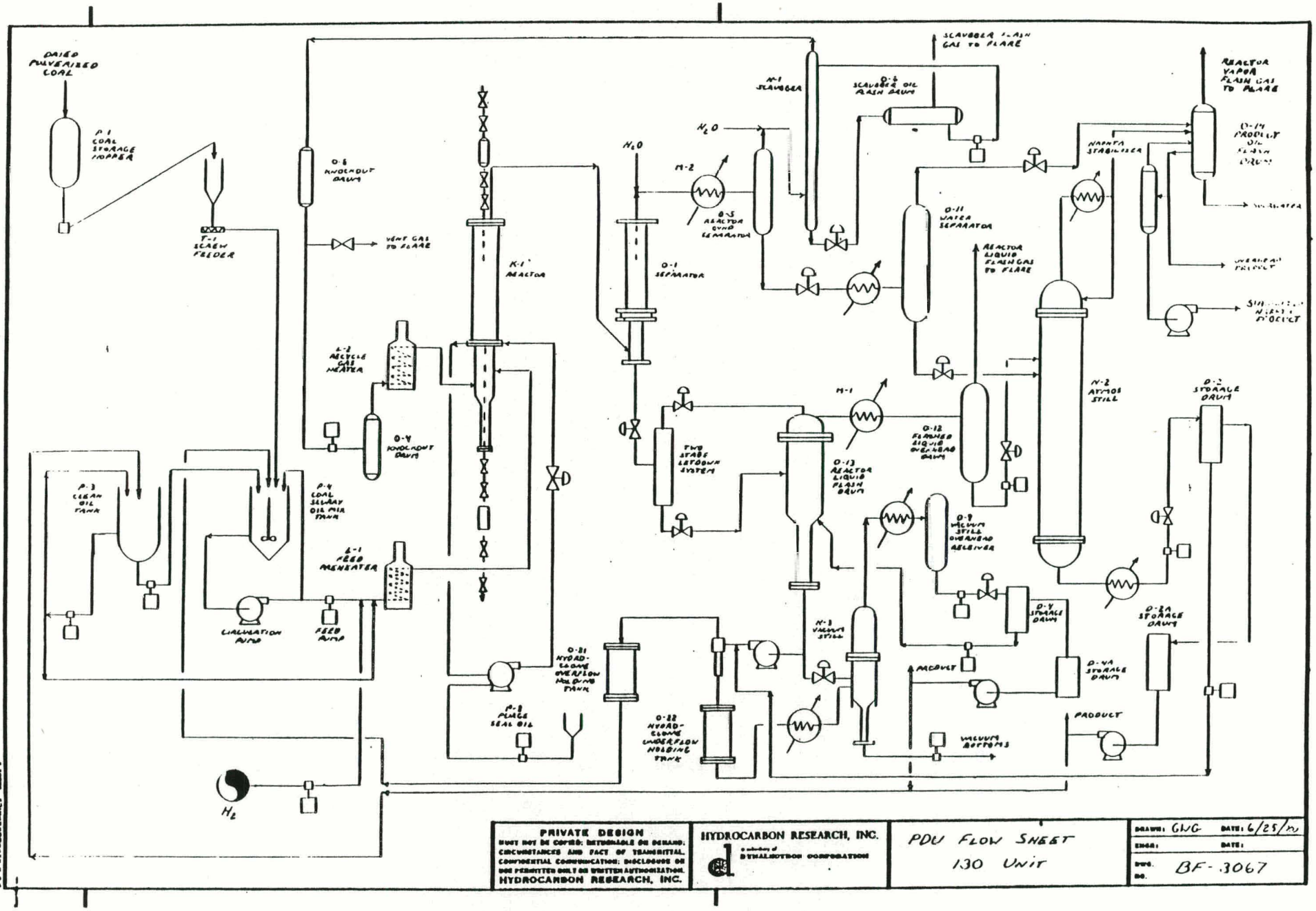
The vapor stream from the reactor overhead separator passes to the scrubber where it is scrubbed by a countercurrent No. 2 fuel oil stream. The scrubbed vapor stream is sent to the scrubber overhead knockout drum and then to the recycle gas compressor. The oil stream from the scrubber is sent to the scrubber oil flash drum. Any vapors that flash are metered by the scrubber flash gas meter. The liquid from the scrubber oil flash drum is recycled to the scrubber.

The liquid stream from the reactor overhead separator is sent to an extended-surface, hairpin heat exchanger for steam heating. The mixed stream exiting the heat exchanger then passes to the water separator.

The vapor stream from the water separator is sent to the product oil flash drum. The liquid stream from the water separator is sent to the atmospheric still preheaters and then to the atmospheric still where the distillate products are split into overhead and bottoms products. The bottoms product is cooled and pumped to the atmospheric bottoms storage drum. From storage, the atmospheric still bottoms are pumped and metered to the clean oil tank as recycle oil. Any atmospheric still bottoms in excess of recycle requirements are drummed and sent to field storage.

The overhead product from the atmospheric still is cooled and sent to the naphtha stabilizing column. The liquid stream (stabilized naphtha) is weighed and pumped to storage. The vapor stream is sent to the product oil flash drum.

In the product oil flash drum the entering streams separate into a vapor stream, an aqueous stream and a hydrocarbon stream. The vapor products are metered and sent to the flare. The aqueous phase is sent to the water holding drum. The material is weighed and then pumped to the sour water tank. The hydrocarbon stream is sent to the atmospheric still overhead holding drum, weighed and then pumped to storage.



PRIVATE DESIGN
MUST NOT BE COPIED; RETURNABLE ON DEMAND; CIRCUMSTANCES AND FACT OF TRANSMITTAL, CONFIDENTIAL COMMUNICATION; DISCLOSURE OR USE PERMITTED ONLY ON WRITTEN AUTHORIZATION.
HYDROCARBON RESEARCH, INC.

HYDROCARBON RESEARCH, INC.
a subsidiary of DYNALECTRON CORPORATION

PDU FLOW SHEET
130 UNIT

DRAWN: GWG DATE: 6/25/70
ENGR: DATE:
DWG. NO. BF-3067

PROJECT H-COAL - 1966/1967

The PDU operated on coal for the first time in 1966 under the sponsorship of the Office of Coal Research, Contract No. 14-01-001-477. The operations, five in all, were very successful providing solutions to mechanical problems which inevitably arise in new operating techniques, and in providing insight into the nature of coal liquefaction technology. The PDU program also enabled HRI to gain valuable scale-up experience, moving successfully from 25 lbs/day bench-scale units to the 3.5 tons/day Process Development Unit.

All the PDU operations used Illinois No. 6 coal and 5/64"-diameter cobalt molybdate catalyst. The data reported here are for Run 130-57, the final and most significant operation of the program. Operating results are given, as well as a summary of the principal operating and yield factors. A comparison is also provided of the normalized results with those of bench-scale operations with the River King Mine coal, both with filtered heavy slurry oil recycle and distillate slurry oil recycle.

The operation consisted of injecting dried Illinois No. 6 coal with recycled coal-derived distilled slurry oil and hydrogen into an ebullating catalyst bed at 2700 psig and 800-850°F. The gross H-Coal products were distilled continuously by atmospheric and vacuum distillation into net products and recycled slurry streams. Analyses of the feed coal are given. Cobalt molybdate hydrodesulfurization catalyst was used in these H-Coal operations.

The principal run objective was to demonstrate sustained H-Coal operation with satisfactory control of catalyst bed expansion, combined with proper operation of the distillation equipment to obtain enough recycled oil for feed coal slurry without requiring any extraneous oil to maintain the slurry oil inventory. This objective was achieved. Make-up oil was added only during startup procedures. No additional makeup oil was required until 166 hours of the run, and again at 272 hours of the run. Operation was then sustained on coal feed without oil additions until 348 hours.

COAL ANALYSES

RIVER KING MINE, ILLINOIS NO. 6 COAL

FOR PROCESS DEVELOPMENT UNIT H-COAL OPERATIONS

	Through 295 Hours			After 295 Hours	
	As Received	Ground, Dried		As Received	Ground, Dried
% Moisture	7.42	3.63		7.21	3.89
Proximate, Dry Basis					
% Ash	10.70	11.61		11.82	11.86
% Volatile Matter	39.29	38.66		37.84	37.49
% Fixed Carbon	50.01	49.73		50.34	50.65
	100.00	100.00		100.00	100.00
Ultimate, Dry Basis					
Carbon	70.90	70.46		69.40	70.35
Hydrogen	4.84	5.19		4.10	4.29
Nitrogen	1.52	1.42		1.38	1.27
Sulfur	3.55	3.55		3.63	3.89
Ash	10.70	11.61		11.82	11.86
Oxygen (By Difference)	8.49	7.77		9.67	8.35
	100.00	100.00		100.00	100.00
Size Analysis					
On 30 Mesh		0.00	0.00		0.00
30/100 Mesh		5.74	1.96		9.05
100/200 Mesh		16.09	10.00		16.13
200/325 Mesh		20.80	17.06		19.02
325/Pan		57.34	70.98		55.80
					100.00
Sulfur Forms, Dry					
Pyritic	1.24				
Sulfate	0.10				
Organic	2.06				
	3.40				
Mineral Analysis					
SiO_2	54.49				
Al_2O_3	18.20				
Fe_2O_3	16.70				
CaO	3.47				
SO_3	2.51				
K_2O	1.76				
MgO	1.07				
TiO_2	0.95				
Na_2O	0.34				
P_2O_5	0.12				
Undetermined	0.39				

H-COAL PROCESS DEVELOPMENT UNIT OPERATING RESULTS

RIVER KING MINE, ILLINOIS NO. 6 COAL

COBALT MOLYBDATE CATALYST - 5/64" DIAMETER EXTRUDATES

Hours of Operation Beginning/End	5-17	17-29	29-41	41-53	53-65	65-77	77-89	89-101	101-113	113-125	125-137
Catalyst Age, Lbs Coal/Lb Catalyst	4-16	16-32	32-51	51-72	72-92	92-113	113-129	129-143	143-165	165-181	181-202
Reactor Pressure, psig	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700
Reactor Temperature, °F	809	824	829	829	829	825	820	815	824	819	824
Dry Coal Rate											
Lbs/Hour	110	156	193	202	199	194	159	145	214	163	204
Lbs/Hour/Ft^3 Reactor	16.0	22.6	28.0	29.3	28.9	28.1	23.1	21.0	31.0	23.5	29.6
Feed Coal											
Moisture W %	5.6	6.2	5.9	5.7	5.8	6.6	6.2	6.3	6.0	4.5	6.9
Ash, W % (Dry Basis)	11.2	11.4	11.4	12.1	11.7	11.2	11.4	11.4	11.3	12.5	11.3
Hydrogen Reacted, W% of Dry Coal		5.4		5.0		5.0		5.9			4.5
Gross Product Properties											
Atmospheric Still Overhead, V % at 400°F	59	59	66	58	62	74	74	65	72	77	72
Slurry Oil (Recycled), V % at 650°F	76	76	78	86	84	87	88	88	88	89	87
Vacuum Bottoms Slurry,											
Ash, W %	17.2	19.0	22.7	22.4	23.4	23.1	22.1	21.7	24.2	24.5	22.7
Coke-Ash-Free, W %	10.0	9.6	10.9	12.0	12.4	12.1	13.1	12.4	15.0	15.4	19.2
Residuum Oil, 975°F, W %			24.6			29.5					
Distillate (975°F-), W %			41.8			35.3					
IBP, °F			600			605					
Gross Product Withdrawals, W % of Dry Coal											
C_1-C_3 Gases		7.0	(7.1)	7.1		7.4		6.6			6.3
CO_2 and CO		0.4	(0.4)	0.4		0.4		0.4			0.3
C_4-C_6 Gases		3.2	(3.5)	3.5		3.8		2.4			2.6
Collected 400°F EP Naphtha	27.6	23.6	21.1	20.7	20.7	20.0	24.6	23.7	19.8	22.4	20.0
400°F+ Distillates	(66.6)	(55.4)	31.8	(50.1)	(33.8)	29.6	(45.6)	(48.8)	(42.8)	(40.8)	(44.5)
Residuum Oil (975°F+)			12.0			12.6					
Unreacted Coal (Ash-Free)	6.3	5.1	5.3	5.9	6.6	5.2	7.7	6.6	6.9	8.7	8.9
Ash	10.9	10.1	11.0	11.1	12.4	9.9	13.0	11.5	11.2	13.8	10.5
Water (Net Chemical Appearance) Includes NH_3	6.7	10.8	8.7	7.8	9.0	10.4	9.7	10.2	7.7	13.0	7.7
H_2S Forced Sulfur Balance		4.0	3.0	3.1	3.0	3.1	2.9	3.1	2.8	2.5	3.0
Normalized Results											
Coal Conversion, % M.A.F. Coal (Solids by Ash Balance)	92.4	93.4	93.7	93.0	93.0	93.1	92.2	92.5	91.9	91.7	89.0
Net C_4+ Liquid Production W % of Dry Coal		63.9	(68.1)	67.3		66.2		68.6	67.4		67.1
Barrels/Ton Dry Coal				4.17		4.15					
Barrels/Ton M.A.F. Coal				4.72		4.63					

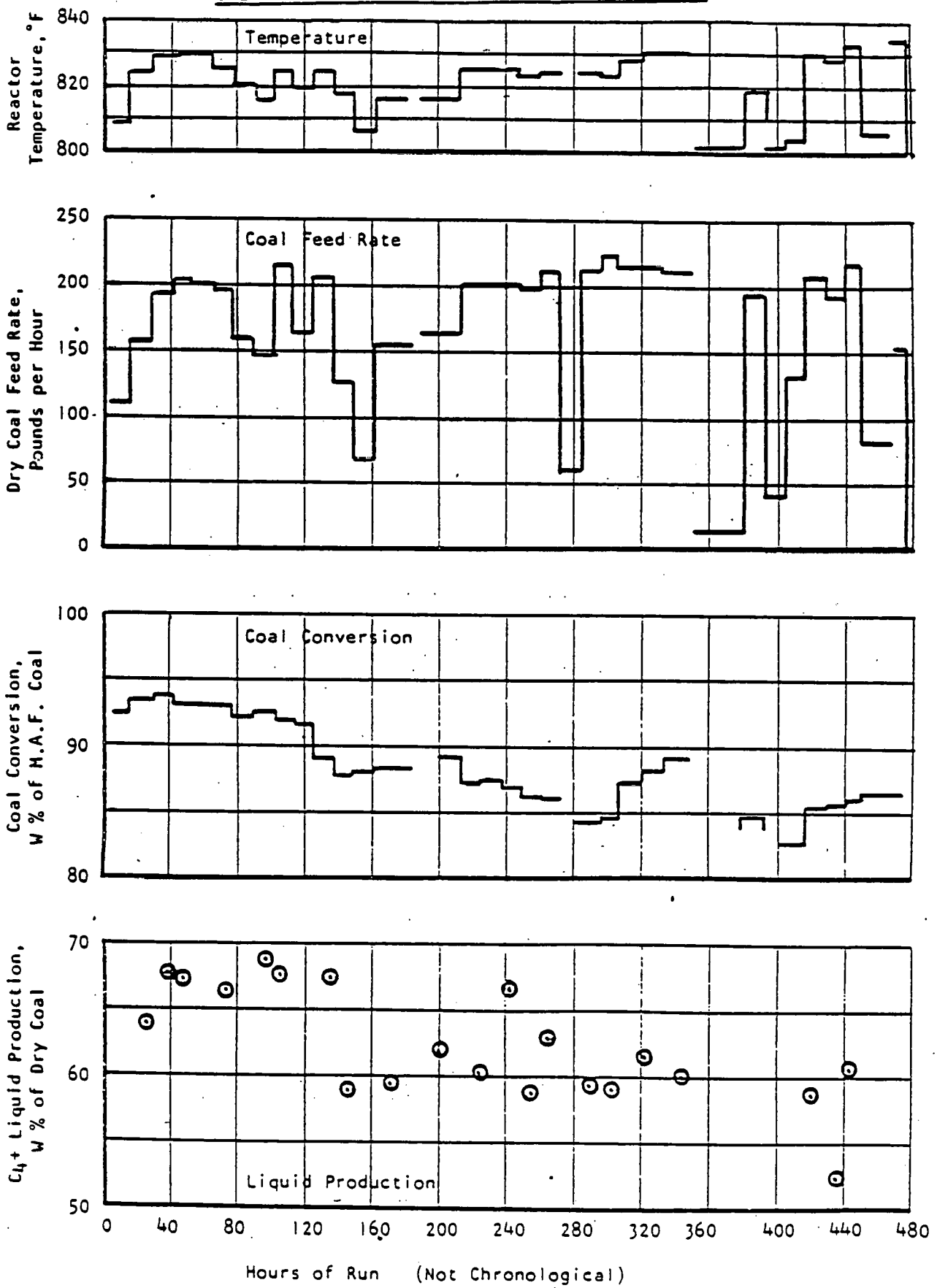
(continued)

Hours of Operation Beginning/End	137-149	149-161	161-185	188-212	212-236	236-248	248-260	260-270	270-283	283-295	295-307
Catalyst Age, Lbs Coal/Lb Catalyst	202-215	215-220	220-252	252-286	286-328	328-349	349-170	370-390	390-397	397-420	420-436
Reactor Pressure, psig	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700
Reactor Temperature, °F	817	806	816	816	825	825	823	824	790	824	823
Dry Coal Rate											
Lbs/Hour	126	68	156	163	197	197	195	210	57	210	224
Lbs/Hour/Ft^3 Reactor	18.3	9.9	22.6	23.6	28.6	28.6	28.3	30.5	8.3	30.5	32.5
Feed Coal											
Moisture, W %	5.7	6.3	5.1	5.8	5.9	6.0	6.1	6.0	....	5.8	5.3
Ash, W % (Dry Basis)	11.5	11.2	12.3	12.8	11.0	11.4	11.5	11.7	....	11.3	12.1
Hydrogen Reacted, W % of Dry Coal	5.1		4.9	4.7	4.7	4.5	4.4		....	4.1	4.3
Gross Product Properties											
Atmospheric Still Overhead, V % at 400°F	65	50	64	76	71	83	80	69	....	75	76
Slurry Oil (Recycled), V % at 650°F	90	88	81	86	81	90	84	90	....	84	85
Vacuum Bottoms Slurry,											
Ash, W %	19.7	19.9	21.6	25.6	21.5	18.0	19.3	21.9	....	19.3	21.4
Coke, Ash-Free, W %	18.5	18.2	19.2	21.0	21.0	18.0	20.5	23.1	....	23.0	24.7
Residuum Oil, 975°F, W %			22.7			26.0	24.5			....	
Distillate(975°F-), W %			36.5			38.0	35.7				
IBP, °F			610			550	550				
Gross Product Withdrawals, W % of Dry Coal											
C_1-C_3 Gases	7.2		6.9	5.8	7.5	5.8	6.0	5.5		8.1	7.6
CO_2 and CO	0.5		0.3	0.5	0.4	0.4	0.4	0.4		0.7	0.5
C_4-C_6 Gases	3.2		3.9	2.3	2.8	2.4	2.6	2.7		4.4	3.6
Collected 400°F EP Naphtha	21.4	30.5	19.2	18.8	20.6	20.3	21.4	17.6		13.9	18.7
400°F+ Distillate	(53.1)	(93.8)	32.2	(34.5)	22.9	32.1	27.0	(42.6)		(42.7)	(38.2)
Residuum Oil (975°F+)			12.7		15.9	14.5	14.5				
Unreacted Coal (Ash-Free)	12.1	10.0	10.7	8.9	11.2	10.0	12.1	12.1		14.2	14.0
Ash	12.9	15.3	12.1	10.8	11.5	10.0	11.5	11.5		11.9	12.2
Water (Net Chemical Appearance) Includes NH_3	9.8	13.8	9.7	7.4	10.2	9.3	9.4	8.9		9.6	8.7
H_2S, Forced Sulfur Balance	2.7		2.7	3.2	2.9	2.9	2.9	2.7		2.6	2.5
Normalized Results											
Coal Conversion, % M.A.F. Coal (Solids by Ash Balance)	87.7	88.0	88.3	89.2	87.2	86.9	86.1	86.1		84.4	84.7
Net C_4+ Liquid Production											
W % of Dry Coal	58.8		59.2	62.0	60.1	66.7	58.7	63.0		59.3	59.3
Barrels/Ton Dry Coal			3.65		3.67	4.23	3.59				
Barrels/Ton M.A.F. Coal			4.19		4.16	4.69	4.09				

(continued)

Hours of Operation Beginning/End	307-331-	331-348-	348-379-	379-391	391-403	403-415	415-427	427-439	439-445	445-469	469-473
Catalyst Age, Lbs Coal/Lb Catalyst	436-488	488-520	520-523	523-554	554-558	558-572	572-594	594-614	614-625	625-642	642-648
Reactor Pressure, psig	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700
Reactor Temperature, °F	828	830	797	818	783	804	830	828	833	806	834
Dry Coal Rate											
Lbs/Hour	218	212	14	192	41	131	206	191	212	81	151
Lbs/Hr/Ft3 Reactor	30.5	30.8	2.0	27.9	6.0	19.0	29.9	27.7	30.8	11.9	22.1
Feed Coal											
Moisture, W %	4.8	4.1	5.4	5.0	4.9	5.5	5.7	5.6	5.8	5.6	
Ash, W % (Dry Basis)	12.1	12.2	12.2	11.4	12.8	12.1	12.3	12.5	12.6	12.7	
Hydrogen Reacted, W % of Dry Coal	4.1	4.3					4.1	4.2	3.9		
Gross Product Properties											
Atmospheric Still Overhead, V % at 400°F	78	68	37	66	51	60	78	78	86		
Slurry Oil (Recycled), V % at 650°F	86	88		88		78	81	84	82		
Vacuum Bottoms Slurry,											
Ash, W %	23.5	24.2		16.7		15.2	19.6	22.9	24.2	18.6	
Coke, Ash-Free, W %	22.1	20.8		18.3		18.9	20.3	23.9	24.3	18.3	
Residuum Oil, 975°F+, W %	31.5	31.9									
Distillate, 975°F-, W %	22.9	23.0									
IBP, °F	670	645									
Gross Product Withdrawals, W % of Dry Coal											
C_1-C_3 Gases	7.0	9.6					8.1	9.2	8.6		
CO_2 and CO	0.4	0.3					0.1	0.9	0.2		
C_4-C_5 Gases	2.7	3.2					1.0	3.2	3.0		
Collected 400°F EP Naphtha	20.3	19.0		15.4		16.8	19.6	19.2	21.0		
400°F+ Distillate	24.9	23.9		(60.1)		(67.3)	(42.5)	(32.7)	(39.3)		
Residuum Oil (975°F+)	16.5	15.1									
Unreacted Coal (Ash-Free)	11.5	9.9		10.7		15.8	12.3	12.0	13.3		
Ash	12.3	11.4		9.8		12.7	11.8	11.6	13.2		
Water (Net Chemical Appearance) Includes NH_3	9.6	9.6		4.1		7.9	9.4	11.9	6.2		
H_2S, Forced Sulfur Balance	2.8	2.7		3.1		2.9	2.9	2.9	2.7		
Normalized Results											
Coal Conversion, % M.A.F. Coal (Solids by Ash Balance)	87.6	88.8		84.7		82.6	85.5	85.6	86.0	86.2	
Net C_4 Liquid Production W % of Dry Coal	61.6	60.5					58.3	52.4	60.8		
Barrels/Ton Dry Coal	3.70	3.67									
Barrels/Ton M.A.F. Coal	4.22	4.15									

OPERATING RESULTS - PROCESS DEVELOPMENT UNIT



PROCESS DEVELOPMENT UNIT 130 NORMALIZED PRODUCT DISTRIBUTION

RIVER KING MINE, ILLINOIS NO.6 COAL - COMPARISON WITH BENCH-SCALE RESULTS

Run	Process Development Unit				Bench-Scale Units		Conceptual Design*
					177-12	177-16	(Separate Report)
Hours on Stream	41-77	212-270	307-348	415-445	789-861	121-181	
Catalyst Age, Lbs Coal/Lb Catalyst	51-133	286-390	436-520	572-625	1800-1935	147-239	0-2000
Coal Feed, Lbs/Hour/Ft^3	28.7	28.5	30.6	29.5	31.2	31.1	28.0
Reactor Temperature, °F	828	824	829	830	853	842	850
C_1-C_3 Gases	7.5	6.3	8.3	8.8	10.5	7.8	9.0
C_4-400°F	24.9	23.2	22.3	22.8	18.8	13.5	16.4
400-650°F Mid-Distillate	14.8	9.7	11.4	( )	14.7	15.7	24.3
650-975°F Heavy Distillate	14.8	14.2	11.7	)34.5(	6.5	7.0	11.2
975°F+ Residuum Oil	13.0	15.2	15.6	( )	19.9	19.4	10.9
Unreacted Coal (M.A.F.)	5.8	11.6	10.6	12.8	11.1	14.4	9.5
Ash	10.9	11.4	11.7	12.4	11.2	11.7	11.6
$H_2O/NH_3/CO_2$	10.2	10.0	9.8	10.0	10.0	11.7	10.2
H_2S	3.1	2.8	2.8	2.8	2.2	2.8	2.2
Total (100+H_2 Reacted)	105.0	104.4	104.2	104.1	104.7	104.0	105.3
C_4+ Liquids, Net Production							
W % of Dry Coal	67.5	62.3	61.0	57.3	59.9	55.6	62.8
Barrels/Ton Dry Coal	4.19	3.83	3.69	(3.50)	3.61	3.23	3.80
Barrels/Ton M.A.F. Coal	4.70	4.33	4.18	(4.00)	4.08	3.68	4.30

*Conceptual Design yields based on bench-scale Run 72-168 and using filtered recycle slurry oil. Runs 177-12 and 177-17 used distillate recycle slurry oil.

JOINT PARTICIPATION PROGRAM
(1973-1974)

During this interim, in which H-Coal development was sponsored by an industrial consortium, HRI completed three successful PDU operations using Illinis No. 6 coal. The operating results of the three runs are given here.

RUN 130-60, ILLINOIS NO. 6 COAL

This run was conducted to form a more comprehensive basis for comparison between bench-scale and PDU operations on coal. The run lasted for 318 hours and provided more complete data vis-a-vis temperature/conversion relationships than any of the earlier PDU H-Coal studies. A coal analysis and operating results are included here.

COAL ANALYSIS

Run Number	130-60	130-60
Coal Source	River King	River King
Hours of Run	100-160	160-280
Grind Description	---------- Penn-Rillton/HR	
HRI Number	3429	3429
Moisture, W %	4.15	3.97
Proximate Analysis, Dry Basis		
Ash, W %	12.86	13.41
Volatile Matter, W %	39.51	38.82
Fixed Carbon, W %	47.63	47.77
Ultimate Analysis, Dry Basis		
Carbon, W %	69.20	68.88
Hydrogen, W %	4.99	4.90
Nitrogen, W %	0.95	1.02
Sulfur, W %	3.67	4.06
Ash, W %	12.86	13.41
Oxygen (Difference), W %	8.33	7.73
Screen Size (U.S.S.), W %		
+50	5.47	3.52
50/70	6.98	5.23
70/100	9.70	8.01
100/140	12.29	12.60
140/200	14.52	13.96
200/325	26.19	28.05
325/Pan	24.86	28.63
Btu		12,424
Mineral Analysis, W %		
Phosphorous Pentoxide, P_2O_5		0.24
Silica, SiO_2		47.38
Ferric Oxide, Fe_2O_3		19.62
Alumina, Al_2O_3		17.60
Titania, TiO_2		0.85
Lime, CaO		6.80
Magnesia, MgO		1.08
Sulfur Trioxide, SO_3		3.91
Potassium Oxide, K_2O		1.74
Sodium Oxide, Na_2O		0.43
Undetermined		0.35
Pyritic Sulfur, W %		1.62
Sulfate Sulfur, W %		0.05
Organic Sulfur, W %		2.27
Sulfur in Ash, W %	1.00	1.12

Coal Feed Schedule

Run	Hours
130-59	0-35
130-60	0-7
	7-82
	82-91
	91-347
130-62	0-169
	169-252
	252-262
	262-276
	276-286
	286-299
	299-301

RUN 130-60 - H-COAL OPERATIONS ON ILLINOIS NO.6 COAL

Catalyst - 110 Pounds HDS-2A, 1/16" Extrudates (HRI No.3397A, 33988, 3419)
Reactor Liquid Phase Depth - 19 Feet (7.5 cubic feet)

Period	1B	2A	2B	3	4	5	6A	6B	7	8
Hours of Run - Beginning	4	16	35	40	64	88	112	124	136	160
- End	16	28	40	64	88	112	124	136	160	184
Catalyst Age, Lbs Coal/Lb Catalyst										
- Beginning	6	24	42	51	96	143	195	222	248	298
- End	24	42	51	96	143	195	222	248	298	348
Coal Feed Rate, Lbs Dry Coal/ Hr/Ft³ Reactor Liquid Phase	20.4	20.0	24.0	26.6	28.0	30.5	31.8	30.7	29.3	29.5
Feed Coal										
HRI Number	3386	3429	3429	3429	3415	3429	3429	3429	3429	3429
Moisture, W %	4.03	3.99	4.12	3.86	3.68	4.14	4.14	4.14	4.24	3.95
Ash, % (Dry Basis)	12.46	12.54	12.39	12.05	11.76	12.49	12.42	12.42	12.29	13.21
Recycle Flows, Lbs/Lb Coal										
Atmospheric Still Bottoms	2.70	2.73	2.19	2.28	2.17	1.92	1.78	1.83	1.89	1.92
Vacuum Still Overhead	0.16	0.30	0.15	0.20	0.14	0.18	0.16	0.19	0.20	0.18
Hydroclone Overflow	0	0	0	0	0	0	0	0	0	0
Total	2.86	3.03	2.34	2.48	2.31	2.10	1.94	2.02	2.09	2.10
Temperatures, °F										
Coal Preheater Outlet	638	650	641	658	650	639	647	651	667	659
Reactor Liquid Phase Average	820	808	814	817	821	822	824	821	833	837
Vacuum Flash Zone	424	467	404	478	471	491	498	502	504	497
Pressure in Vacuum Flash, Torr	13	16	18	14		20	19	18	17	16
Pressure, psig										
Unit Back Pressure	2900	2890	2900	2900	2900	2900	2900	2900	2900	2900
Hydrogen Make-Up	2945	2955	2945	2940	2945	2950	2950	2950	2950	2950
Hydrogen Partial Pressure (Reactor Outlet)		1885	2160	1830	1675	1690	1685	1700	1580	1510
Recycle Gas, MSCF/Ton Coal	42.0	47.4	40.8	39.4	35.0	30.3	29.0	30.4	28.4	27.4
Vent Gas, MSCF/Ton Coal	3.80	4.11	2.50	2.76	1.90	2.10	2.09	2.26	2.31	2.30
Hydrogen Purity of Recycle Gas + Vent Gas, %		88.4	93.3	87.9	86.7	86.7	84.9	96.2	84.5	80.7
Vapor Phase Hydrogen, MSCF/Ton Coal (Reactor Outlet)			41.1	37.8	33.0	29.0	26.9	28.6	31.3	24.7
Make-Up Hydrogen + Recycle Hydrogen										
MSCF/Ton Coal		73.5	65.6	59.7	54.8	48.5	45.8	48.3	46.6	44.9
V % of Make-Up + Recycle Gas		93.0	96.0	92.6	92.2	92.3	91.3	92.0	91.4	89.5
Partial Pressure of Hydrogen, psig		2690	2785	2685	2675	2675	2650	2670	2650	2595
Hydrogen Consumption (Metered Gas Rates, Analysis)										
MSCF/Ton Dry Coal			22.2	20.6	20.7	18.6	18.2	19.0	19.6	19.8
W % of Dry Coal			5.8	5.4	5.4	4.9	4.8	5.0	5.2	5.2
Oil Additions										
Make-Up Anthracene Oil										
Lbs/Lb Dry Coal	0	0.23	0	0	0	0	0	0	0	0
Lbs/Hr/Ft³ Reactor	0	4.7	0	0	0	0	0	0	0	0
Flush Oil, Lbs/Lb Dry Coal	.019	.019	.017	.012	.011	.009	.009	.009	.009	.010

RUN 130-60 - H-COAL OPERATIONS ON ILLINOIS NO.6 COAL

Catalyst - 110 Pounds HDS-2A, 1/16" Extrudates (HRI No.3397A, 3398B, 3419)
Reactor Liquid Phase Depth - 19 Feet (7.5 Ft^3)

Period	9A	9B	10A	10B	11	12	13A	13B	14A	14B	15A	15B
Hours of Run - Beginning	184	196	208	220	232	256	280	292	304	316	328	340
- End	196	208	220	232	256	280	292	304	316	328	340	347
Catalyst Age, Lbs Coal/Lb Catalyst												
- Beginning	348	373	394	402	429	478	526	547	573	600	622	649
- End	373	394	402	429	478	526	547	573	600	622	649	665
Coal Feed Rate, Lbs Dry Coal/ Hr/Ft^3 Reactor Liquid Phase	29.0	24.6	9.7	31.4	31.7	28.0	25.4	30.7	31.8	25.4	31.7	32.6
Feed Coal												
HRI Number	3429	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Moisture, W %	3.65	3.63	3.40	4.32	4.22	4.22		4.06		3.87		4.16
Ash, % (Dry Basis)	13.07	13.08	13.26	13.21	12.37	13.14		12.71		13.22		13.10
Recycle Flows, Lbs/Lb Coal												
Atmospheric Still Bottoms	2.03	1.99	5.57	1.65	1.85	2.13	2.54	2.13	2.20	1.91	2.13	2.09
Vacuum Still Overhead	0.15	0.22	0.60	0.20	0.11	0.10	0.05	0.07	0.05	0.40	0.11	0.06
Hydroclone Overflow	0	0	0	0	0	0	0	0	0	0	0.05	0.20
Total	2.18	2.21	6.17	1.85	1.96	2.23	2.59	2.20	2.25	2.31	2.29	2.35
Temperatures, °F												
Coal Preheater Outlet	662	674	634	622	678	683	709	700	695	646	636	664
Reactor Liquid Phase Average	840	814	798	806	833	838	837	837	838	830	832	834
Vacuum Flash Zone	508	501	435	469	478	509	468	517	466	503	522	522
Pressure in Vacuum Flash, Torr	11	10	10	10	12	12	14	13	14	14	12	9
Pressure, psig												
Unit Back Pressure	2900	2900	2895	2900	2900	2900	2900	2900	2900	2900	2895	2900
Hydrogen Make-Up	2950	2950	2930	2940	2950	2950	2950	2945	2950	2940	2960	2955
Hydrogen Partial Pressure (Reactor Outlet)		1840			1440	1455	1575	1450	1315	1520	1600	
Recycle Gas, MSCF/Ton Coal	27.1	36.8	103.0	21.6	24.7	27.4	32.1	26.9	23.2	28.1	25.4	23.5
Vent Gas, MSCF/Ton Coal	1.96	3.66	8.50	2.41	2.18	2.47	2.63	1.89	2.02	2.33	1.82	1.55
Hydrogen Purity of Recycle Gas + Vent Gas, %		90.2			77.3	80.8	84.2	79.6	76.7	82.0	84.4	
Vapor Phase Hydrogen, MSCF/Ton Coal (Reactor Outlet)		37.4			21.5	25.1	30.0	23.8	20.4	25.8	23.4	
Make-Up Hydrogen + Recycle Hydrogen												
MSCF/Ton Coal		59.0			40.0	45.9	52.9	44.2	39.2	50.0	46.5	
V % of Make-Up + Recycle Gas		94.2			87.7	89.7	91.3	89.0	87.9	90.8	92.2	
Partial Pressure of Hydrogen, psig		2730			2545	2600	2650	2580	2550	2635	2675	
Hydrogen Consumption (Metered Gas Rates, Analysis)												
MSCF/Ton Dry Coal		20.0			17.6	19.8	21.9	19.6	18.2	21.5	20.7	
W % of Dry Coal		5.3			4.7	5.2	5.8	5.2	4.8	5.7	5.5	
Oil Additions												
Make-Up Anthracene Oil												
Lbs/Lb Dry Coal	0	0	2.35	0	0	0.04*	0	0	0	0.82	0.45	
Lbs/Hr/Ft^3 Reactor	0	0	22.8	0	0	1.1*	0	0	0	20.7	14.2	
Flush Oil, Lbs/Lb Dry Coal	.010	.011	.029	.009	.008	.010	.011	.009	.009	[illegible]	.008	[illegible]

*Slurry Oil from Period 10B

RUN 130-60 - OPERATING RESULTS

Period	1B	2A	2B	3	4	5	6A	6B	7	8
Collected Product Quantities, W % Dry Coal										
Atmospheric Still Overhead	22.3	21.4	34.9	18.8	20.6	21.1	16.9	22.8	34.8	30.3
Atmospheric Still Bottoms (1)	-0.4	21.1	-27.1	2.2	2.3	3.7	5.2	-2.5	-7.6	-4.4
Vacuum Still Overhead (1)	0.3	2.3	1.7	0.5	0.4	0.6	0.8	0	-0.5	-0.1
Vacuum Still Bottoms	53.8	60.5	81.2	52.3	47.5	49.8	47.9	53.0	44.2	48.5
0-13 to Filter (Product)				0.2	0.1			0.3	0.1	0.1
H_2O (2)	13.7	14.6	3.3	15.3	18.6	14.2	14.4	14.4	15.0	13.6
C_1-C_3			3.9	6.1	6.9	7.4	4.7	6.0	7.1	8.0
C_4-C_7			2.0	4.1	4.6	5.1	3.1	3.1	3.8	4.4
H_2S in Gases			0.6	2.4	2.9	2.6	1.7	2.0	1.9	2.1
CO_2 and CO			0.1	0.5	0.4	0.5	0.4	0.4	0.4	0.5
Total			100.6	102.4	104.3	105.0	95.1	99.5	99.2	103.0
Input Quantities, W % Dry Coal										
Dry Coal	100.0	----------	----------	----------	----------	----------	----------	----------	----------	----------
Moisture in Feed Coal	4.2	4.2	4.3	4.0	4.9	4.3	4.3	4.3	4.4	4.1
Oil Additions (Make-Up)	0	22.7	0	0	0	0	0	0	0	0
Hydrogen Reacted (Gas Analysis, Flow)			5.8	5.5	5.4	4.9	4.8	5.0	5.2	5.2
Flush Oil	1.9	1.9	1.7	1.2	1.1	0.9	0.9	0.9	0.9	1.0
Total Used for Normalization			111.8	110.7	111.5	109.8	110.1	110.3	110.5	110.4
Normalized Net Product Distribution, W % Dry Coal (3)										
CO, CO_2				0.6	0.4	0.5			0.5	0.5
C_1-C_3 Hydrocarbons in Gases				6.6	7.4	7.7			7.9	8.7
C_4-C_6 Hydrocarbons in Gases				4.4	4.9	5.4			4.2	4.7
IBP-400°F Naphtha				13.7	15.7	16.2			20.7	22.4
400-650°F Distillates				9.0	9.3	10.2			10.6	7.0
650-975°F Distillates				( )	( )	19.3			( )	13.6
975°F+ Residual Oil				(36.5)*	(31.6)				(26.5)	
Benzene-Soluble				( )	( )	12.6			( )	13.2
Benzene-Insoluble				0.0	1.0	0.2			1.3	1.9
Unreacted Ash-Free Coal				5.8	6.1	7.2			6.2	5.9
Ash				14.3	11.6	12.6			12.8	14.6
H_2O (Net)				10.9	13.1	9.4			10.7	9.0
NH_3 (Forced Nitrogen)				(0.8)	(0.8)	0.8			(0.8)	0.8
H_2S (Forced Sulfur)				(2.9)	(2.9)	2.9			(3.0)	3.0
Total (100 + Hydrogen Reacted)				105.5	105.4	104.9			105.2	105.3
Normalized Net C_4+ Liquid Recovery										
W % of Dry Coal										
Benzene-Soluble						63.7				60.9
Benzene-Insoluble						0.2				1.9
Barrels per Ton of Dry Coal						3.88				3.87
Barrels per Ton M.A.F. Coal						4.43				4.54
Barrels C_4 to 975°F- Distillate per Ton M.A.F. Coal						3.79				3.68

* Benzene-soluble oil in vacuum still bottoms + 650°F+ in atmospheric still bottoms plus vacuum still overhead

(1) Negative quantities of atmospheric still overhead + vacuum overhead are decreases of inventory of slurry oil holding tank

(2) Includes dissolved NH_3 + H_2S

(3) ASTM distillation cut points

RUN 130-60 - OPERATING RESULTS

Period	9A	9B	10A	10B	11	12	13A	13B	14A	14B	15A	15B
Collected Product Quantities, W % Dry Coal												
Atmospheric Still Overhead			-69.9*	-10.1*								
Atmospheric Still Bottoms (1)	25.8	62.6	69.5	29.6	28.1	34.4	34.0	23.7	22.1	54.3	23.8	25.1
Vacuum Still Overhead (1)	2.0	-39.6	211.0	-3.3	-7.2	-5.3	-12.8	-0.9	-15.2	14.6	44.1	1.2
Vacuum Still Bottoms	0.4	-4.0	22.8	0.0	-0.3	-0.1	-0.1	0.3	-0.2	3.4	2.5	0.3
H_2O Product (2)	45.8	57.8	78.4	70.8	53.1	50.5	52.9	51.9	53.7	68.3	53.9	60.6
C_1-C_3	13.6	13.0	23.9		13.4	15.5	12.4	15.1	15.7	15.3	14.5	13.8
C_4-C_7		6.3			10.0	10.9	9.8	8.1	8.7	9.6	6.8	
H_2S in Gases		4.4			4.8	6.1	5.6	5.2	4.5	5.7	4.0	
CO_2 and CO		2.8			2.2	2.7	3.0	2.9	3.1	3.2	2.7	
Total		0.8			0.9	0.7	1.0	1.0	0.7	0.8	0.7	
		104.1			105.0	115.4	105.8	107.3	93.1	175.2	153.0	
Input Quantities, W % Dry Coal												
Dry Coal	100.0	----------										
Moisture in Feed Coal	3.8	3.7	3.6	4.5	4.4	4.4	4.2	4.2	4.0	4.0	4.3	4.3
Oil Additions	0	0	235.4	0	0	4.0	0	0	0	82.0	44.8	0
Hydrogen Reacted (Gas Analyses, Flow)		5.3			4.7	5.2	5.8	5.2	4.8	5.7	5.5	
Flush Oil	1.0	1.1	2.9	0.9	0.8	1.0	1.1	0.9	0.9	1.1	0.8	0.8
Total Used for Normalization		110.2			109.9	114.7	111.1	110.3	109.7	192.8	155.4	
Normalized Net Product Distribution, W % Dry Coal (3)												
CO, CO_2					1.0	0.7		1.0		0.9	0.7	
C_1-C_3 Hydrocarbons in Gases					10.4	10.9		8.4		10.6	6.9	
C_4-C_6 Hydrocarbons in Gases					5.0	6.1		5.4		6.3	4.1	
IBP-400°F Naphtha					18.0	19.8		16.0		33.1	14.4	
400-650°F Distillates (Net)					4.4	6.6		7.8		3.0	26.7	
650-975°F Distillates (Net)					( )	11.6		( )		( )	( )	
975°F+ Residual Oil					(29.0)			(30.6)		(3.9)	(14.0)	
Benzene-Soluble					( )	11.9		( )		( )	( )	
Benzene-Insoluble					3.6	2.4		3.4		6.3	13.4	
Unreacted Ash-Free Coal					5.7	5.9		5.8		8.4		
Ash					15.5	15.9		13.0		16.9	12.3	
H_2O (Net)					8.5	9.9		10.2		11.5	9.6	
NH_3 Forced Nitrogen					(0.8)	0.76		(0.8)		(1.5)[4]	(1.3)[4]	
H_2S Forced Sulfur					(2.8)	2.8		(2.8)		(3.5)[4]	(3.1)[4]	
Total (100 + Hydrogen Reacted)					104.7	105.3		105.2		105.7	105.5	
Normalized Net C_4+ Liquid Recovery												
W % of Dry Coal												
Benzene-Soluble						56.0						
Benzene-Insoluble						2.4						
Barrels per Ton of Dry Coal						3.61						
Barrels per Ton M.A.F. Coal						4.30						
Barrels C_4 to 975°F- Distillate per Ton M.A.F. Coal						3.53						

* Atmospheric overhead from Period 9B added to atmospheric still

(1) Negative quantities of atmospheric overhead and vacuum overhead are decreases of inventory of slurry oil holding tank

(2) Includes dissolved NH_3 + H_2S

(3) ASTM distillation cut points

(4) Allows for complete desulfurization of make-up oil and 75% denitrogenation

RUN 130-60 - ANALYSES

Period	1B	2A	2B	3	4	5*	6A	6B	7	8
Atmospheric Still Overhead										
Gravity, °API	37.6	40.8	35.7	38.9	40.9	41.0	41.2	41.0	38.2	37.2
IBP, °F	166		172	170	154	150	140		158	138
EP, °F	512		532	546	542	538	520		582	550
V % @ 400°F	65		56	70	77	77	79		56	71
IBP-400°F Gravity, °API	44.3		40.3	45.7	45.7	44.4	44.9		42.5	43.6
400°F-EP Gravity, °API	26.6		25.5	25.7	26.4	25.2	27.0		26.1	26.4
Carbon, W %						87.28				88.04
Hydrogen, W %						13.14				12.09
Nitrogen, W %						0.082				0.144
Sulfur, W %						<0.02				<0.02
Phenols,										
V % Total						1.5				2.0
V % IBP-400°F						1.0				1.5
Atmospheric Still Bottoms										
Gravity, °API	17.3	17.8	15.8	18.3	19.4	19.1	19.2	19.0	18.5	17.7
IBP, °F	400		430	400	400	410	384		418	426
EP, °F						(830)				
V % @ 400°F	0		0	0	0	0			0	0
V % @ 650°F	88		89	89	88	85	88		84	82
IBP-650°F Gravity, °API	19.4		18.0	20.8	22.2	22.2	22.1		21.4	20.7
650°F+ Gravity, °API	4.5		4.5	5.3	5.6	5.6	5.0		3.9	2.8
Carbon, W %						87.61				88.35
Hydrogen, W %						10.54				10.45
Nitrogen, W %						0.13				0.19
Sulfur, W %						<0.02				<0.02
Vacuum Still Overhead										
Gravity, °API	12.1	12.3	11.4	12.4	13.7	13.2	13.5	12.8	12.8	12.2
IBP, °F	490		470	Water	460	(345)	450		466	460
EP, °F						(828)				
V % @ 650°F	78		73	82	68	(61.2)	66		64	65
IBP-650°F Gravity, °API	14.9		14.7	15.9	16.7	16.3	16.9		16.2	15.5
650°F+ Gravity, °API	5.2		3.9	7.1	7.8	7.7	8.0		6.6	5.9
Carbon, W %						89.13				88.50
Hydrogen, W %						9.86				9.75
Nitrogen, W %						0.19				0.19
Sulfur, W %						<0.02				<0.02
Water Product										
Nitrogen, W %						4.30				4.23
Sulfur, W %						4.12				3.93

* Period 5 Atmospheric Overhead Fractions

	Carbon	Hydrogen	Nitrogen	Sulfur
IBP-400°F	86.83	13.24	.074	0.02
400°F-EP	88.23	11.30	.077	0.02

Distillations - All ASTM D-86, except bracketed values, ASTM D-1160 (modified)

Period	9A	9B	10A	10B	11	12	13A	13B	14A	14B	15A	15B
Atmospheric Still Overhead												
Gravity, °API	38.3	33.7	31.3	31.3	34.8	34.6	35.8	36.5	38.6	32.4	34.2	34.8
IBP, °F		128		118	150	108		100		118	146	
EP, °F		558		608	560	566		540		554	594	
V % @ 400°F		55		50	64	61		68		58	58	
IBP-400°F Gravity, °API		41.3		41.1	41.8	42.5		42.3		39.5	42.9	
400°F-EP Gravity, °API		24.5		24.2	23.9	24.0		23.8		23.1	22.6	
Carbon, W %						87.76						
Hydrogen, W %						12.08						
Nitrogen, W %						0.11						
Sulfur, W %						<0.02						
Phenols												
V % Total						2.0						
V % IBP-400°F						2.0						
Atmospheric Still Bottoms												
Gravity, °API	17.4	16.8	16.8	13.6	15.3	16.4	17.5	18.0	18.3	13.5	12.1	11.8
IBP, °F		470		420	406	418		414		440	380	
EP, °F						(848)						
V % @ 400°F		0		0	0	0		0		0		
V % @ 650°F		82		84	88	86		86		84	85	
IBP-650°F Gravity, °API		18.9		16.8	17.8	18.6		20.8		16.8	15.0	
650°F+ Gravity, °API		4.9		1.5		1.3		2.8		-0.1	-1.2	
Carbon, W %						88.16						
Hydrogen, W %						10.20						
Nitrogen, W %						0.17						
Sulfur, W %						<0.02						
Vacuum Still Overhead												
Gravity, °API	11.8	11.6	11.7	5.7	8.6	10.3	11.6	12.2	12.7	10.0	3.9	2.3
IBP, °F		480		472	506	(411)		454		416	494	
EP, °F						(850)						
V % @ 650°F		65		58	60	(76.1)		76		71	50	
IBP-650°F Gravity, °API		14.6		9.4	11.9	13.5		15.4		14.8	8.5	
650°F+ Gravity, °API		5.7		0.5	4.1	4.3		4.2			-0.7	
Carbon, W %						89.44						
Hydrogen, W %						9.42						
Nitrogen, W %						0.26						
Sulfur, W %						<0.02						
Water Product												
Nitrogen, W %						3.57						
Sulfur, W %						2.99						

Distillations - All ASTM D-86 - except bracketed values from ASTM D-1160 (Modified)

Period	1B	2A	2B	3	4	5	6A	6B	7	8
Vacuum Still Bottoms										
W % of Flows from Vacuum Still				55.2	54.6	55.1	55.6	55.9	49.4	50.7
Benzene-Soluble, W %	62.61	68.78		64.63	63.08	62.05		58.60	58.64	56.88
Benzene-Insoluble, W %	12.34	14.96		10.29	14.01	14.04		16.04	15.49	15.05
Ash, W %	25.05	16.26		25.08	22.91	23.91		25.36	25.87	28.07
Unreacted Coal, W % (Estimated)				10.46	12.05	13.63		14.69	12.67	11.36
Benzene-Insoluble Residuum, W % (Estimated)				-0.17	1.96	0.41		1.35	2.82	3.69
Carbon, W %						67.71				63.06
Hydrogen, W %						5.39				5.01
Nitrogen, W %						0.62				0.64
Sulfur, W %						1.73				2.44
Oxygen, W % (By Difference)						0.64				0.78
Sulfur in Ash, W %						-				2.67
Pyridine-Soluble, W %	65.28	73.90		66.80	67.20	67.22		64.48	63.63	62.42
Pyridine-Insoluble, W % (Organic)	9.77	9.89		8.42	10.61	9.89		11.21	10.03	9.50
Benzene-Soluble Oil, °API										
IBP, °F						635				535
IBP-650°F, cc/100 Grams						1.0				3.1
650-975°F, cc/100 Grams						39.0				26.9
975°F+, W %						39.0				46.5
IBP-975°F, °API						1.7				-1.4
Carbon, W %						89.73				90.29
Hydrogen, W %						8.70				8.13
Nitrogen, W %						0.39				0.38
Sulfur, W %						<0.02				<0.02
Filter Cake										
W % of Feed to Vacuum Still										
Benzene-Soluble, W %			51.07	38.54	41.43	44.84		47.93	42.94	38.64
Benzene-Insoluble, W %			16.74	18.06	20.56	20.11		19.40	19.24	18.34
Ash, W %			32.19	43.40	38.01	35.05		32.67	37.82	43.02
Benzene-Insoluble Residuum, W %				-0.05	0.57	0.13		0.48	0.71	0.94
Unreacted Coal, W % (Estimated)				18.11	19.99	19.98		18.92	18.53	17.40
Pyridine-Soluble, W %			53.11	41.26	48.48	50.14		53.39	50.79	43.00
Pyridine-Insoluble, W % (Organic)			14.07	14.97	14.84	14.17		13.64	13.91	14.34
Sulfur, W %						5.00				
Filter Liquid From Feed to Vacuum Still										
Gravity, °API			6.0	6.2	6.2	4.4		4.4	4.7	6.0
IBP, °F			437	420	436	430		445	438	425
IBP-650°F, V %			59.5	63.0	56.0	42.0		48.0	53.0	57.0
650-975°F, V %			31.0	25.0	33.0	46.0		35.0	34.0	32.0
975°F+, W %			13.1	16.0	16.0	18.8		21.2	17.8	15.5
975°F+ Analyses										
Carbon, W %						88.96				88.17
Hydrogen, W %						6.99				6.17
Nitrogen, W %						1.18				1.32
Sulfur, W %			0.41	0.21	0.37	0.49		0.41	0.29	0.48
Ash, W %						0.00				0.00
Benzene-Insoluble, W %						7.33				10.82

Period	9A	9B	10A	10B	11	12	13A	13B	14A	14B	15A	15B
Vacuum Still Bottoms												
W % of Flows from Vacuum Still	50.4	50.0	41.0	56.0	54.0	48.5	58.7	58.0	70.7	48.9	60.5	67.2
Benzene-Soluble, W %		57.93		60.20	55.61	51.91		58.52		58.05	53.15	
Benzene-Insoluble, W %		19.83		18.82	16.47	16.35		17.10		19.46	24.48	
Ash, W %		22.24		20.98	27.92	31.74		24.38		22.49	22.41	
Unreacted Coal, W % (Estimated)		16.75		10.09	10.16	11.59		10.81		11.14		
Benzene-Insoluble Residuum, W % (Estimated)		3.08		8.75	6.31	4.76		6.29		8.33		
Carbon, W %						60.84						
Hydrogen, W %						4.57						
Nitrogen, W %						0.71						
Sulfur, W %						2.85						
Oxygen, W % (By Difference)						-0.71						
Pyridine-Soluble, W %		68.64		70.87	62.64	58.14		66.64		68.78	68.58	
Pyridine-Insoluble, W % (Organic)		8.91		8.32	9.82	10.81		9.06		8.74	8.94	
Benzene-Soluble Oil												
IBP, °F						625						
IBP-650°F, cc/100 Grams						1.8						
650-975°F, cc/100 Grams						47.0						
975°F+, W %						45.5						
IBP-975°F, °API						-3.1						
Carbon, W %						90.34						
Hydrogen, W %						7.94						
Nitrogen, W %						0.64						
Sulfur, W %						<0.02						
Filter Cake												
W % of Feed to Vacuum Still												
Benzene-Soluble, W %		42.79		37.88	35.44	38.17		41.75		36.14		
Benzene-Insoluble, W %		25.06		22.33	18.52	17.56		19.35		22.36		
Ash, W %		32.15		39.79	46.04	44.27		38.90		41.50		
Benzene-Insoluble Residuum, W %		0.85		3.17	1.77	1.39		2.11		1.81		
Unreacted Coal, W % (Estimated)		24.21		19.16	16.75	16.17		17.24		20.55		
Pyridine-Soluble, W %		50.67		45.20	36.07	39.53		45.38		42.27		
Pyridine-Insoluble, W % (Organic)		15.14		15.89	15.91	15.08		14.33		15.86		
Filter Liquid From Feed to Vacuum Still												
Gravity, °API		3.0		-3.9	2.5	4.1		5.9		-2.7		
IBP, °F		445		452	440	445		432		455		
IBP-650°F, V %		49.0		50.0	52.0	60.0		60.0		48.0		
650-975°F, V %		36.0		35.0	29.0	29.0		26.0		31.0		
975°F+, W %		20.5		22.1	22.7	15.3		17.5		26.4		
975°F+ Analyses												
Carbon, W %						89.51						
Hydrogen, W %						6.16						
Nitrogen, W %						1.22						
Sulfur, W %						0.57						
Ash, W %						0.03						
Benzene-Insoluble, W %						14.83						

RUN 130-62 - ILLINOIS NO. 6 COAL

This run was also a part of the comparison study mentioned above. It provided additional data relating to the temperature-sensitivity of conversion and desulfurization in H-Coal operations. The run also demonstrated the better product distribution attainable by using a residuum-containing stream (hydroclone overhead) as a part of the feed coal slurry oil. The coal analysis and operation results are included here.

COAL ANALYSIS

Run Number	130-62	130-62
Coal Source	River King	River King & Monterey
Hours of Run	5-133	169-301
Grind Description	----	--------
HRI Number	3429	3429/3395*
Moisture, W %	3.85	5.43
Proximate Analysis, Dry Basis		
Ash, W %	12.30	10.79
Volatile Matter, W %	40.90	41.32
Fixed Carbon, W %	46.80	47.89
Ultimate Analysis, Dry Basis		
Carbon, W %	69.13	69.24
Hydrogen, W %	5.17	5.15
Nitrogen, W %	1.12	1.12
Sulfur, W %	3.92	4.19
Ash, W %	12.30	10.79
Oxygen (Difference), W %	8.36	9.51
Screen Size (U.S.S.), W %		
+50	1.44	3.02
50/70	2.79	5.42
70/100	6.73	10.39
100/140	11.15	15.08
140/200	12.97	14.49
200/325	26.87	22.89
325/Pan	38.05	28.26
Btu		
Mineral Analysis, W %		
Phosphorous Pentoxide, P_2O_5		
Silica, SiO_2		
Ferric Oxide, Fe_2O_3		
Alumina, Al_2O_3		
Titania, TiO_2		
Lime, CaO		
Magnesia, MgO		
Sulfur Trioxide, SO_3		
Potassium Oxide, K_2O		
Sodium Oxide, Na_2O		
Undetermined		
Pyritic Sulfur, W %	1.63	1.23
Sulfate Sulfur, W %	0.05	0.20
Organic Sulfur, W %	2.12	2.80
Sulfur in Ash, W %	1.42	1.17

Coal Feed Schedule

Source	HRI No.
Monterey	3386
Monterey	3386
River King	3429
Monterey	3415
River King	3429
River King	3429
Monterey	3395
River King	3429
Monterey	3395
River King	3429
Monterey	3395
River King	3429

*About 75% Monterey Coal

RUN 130-62 - H-COAL OPERATIONS ON ILLINOIS NO.6 COAL (HRI 3394 AND 3429)

Catalyst - 100 Pounds HDS-2A, 1/16" Extrudates (HRI 3397A, 3397D and 3419)

Period	1B	2	3A	3B	4A	4B	5	6A	6B	7	8	9	10	11	12A	12B	13
Hours of Run - Beginning	5	13	37	49	61	73	85	109	121	183	157	181	205	229	253	265	277
- End	13	37	49	56	73	85	109	121	133	157*	181	205	229	253	265	277	301
Catalyst Age, Lbs Coal/Lb Catalyst																	
- Beginning	10	28	82	108	124	138	163	215	240	256	318	368	419	469	521	545	569
- End	28	82	108	124	138	163	215	240	266	318	368	419	469	521	545	569	620
Coal Feed Rate, Lbs Dry Coal/Hour/ Ft^3 Reactor Liquid Phase	32.7	31.5	31.0	30.8	16.6	29.2	30.5	29.3	29.9	30.1	28.9	28.9	29.3	29.5	28.9	27.6	29.5
Feed Coal																	
HRI Number	3429	----	----	----	----	----	----	----	----	----	3395	----	----	----	3395/3429	----	----
Moisture, W %	4.03	4.01	3.93			3.51	4.02	4.23	4.26	5.26	6.06	6.25	5.79	5.37	4.46	5.85	5.32
Ash, % (Dry Basis)	12.24	12.79	11.86			12.09	12.40	13.16	12.66	11.82	9.77	9.46	10.11	10.01	12.40	10.00	10.88
Recycle Flows, Lbs/Lb Coal																	
Atmospheric Still Bottoms	1.52	1.86	1.95	2.10	2.61	2.04	2.16	2.30	2.54	2.41	2.37	2.41	2.41	2.52	2.62	2.69	2.70
Vacuum Still Overhead	0.15	0.10	0.09	0.08	0.01	.004	.003	0.09	0.08	0.08	.002	.003	.004	.004	.004	.004	.004
Hydroclone Overflow	0.18	0.18	0.18	0.17	0.77	0.25	0.37	0.41	0.02	0.11	0.37	0.40	0.38	0.38	0.38	0.48	0.42
Total	1.85	2.14	2.12	2.35	3.39	2.29	2.53	2.80	2.64	2.59	2.74	2.81	2.79	2.90	3.00	3.18	3.12
Temperature, °F																	
Coal Preheater Outlet	585	609	654	665	647	684	681	689	692	685	690	691	698	713	724	722	733
Reactor Liquid Phase Average	806	823	828	831	805	830	832	829	830	829	829	829	829	829	835	838	842
Vacuum Flash Zone	508	509	499	502	-	512	487	498	450	448	424	445	465	475	390	386	470
Pressure in Vacuum Flash, Torr	9	10	13	13	-	10	13	14	13	13	15	14	17	14	16	12	14
Hydroclone			445	480	459	403	458	460	-	421	492	479	488	560	525	510	604
Pressure, psig																	
Unit Back Pressure	2805	2900	2900	2900	2900	2900	2900	2900	2900	2300	2900	2900	2900	2900	2900	2900	2900
Hydrogen Make-Up	2920	2940	2935	2925	2920	2925	2930	2935	2935	2330	2930	2935	2930	2940	2950	2940	2950
Hydrogen Partial Pressure (Reactor Outlet)		1745	1655			1775	1635	1510	1590	1475	1625	1555	1555	1480		1620	1415
Recycle Gas, MSCF/Ton Coal	22.1	27.2	31.3	30.0	50.2	30.8	26.0	26.1	26.0	25.2	26.0	25.6	25.3	24.8	25.1	26.4	23.1
Vent Gas, MSCF/Ton Coal	0.59	2.28	2.31	1.37	3.72	2.02	1.58	1.95	1.99	1.80	2.12	2.20	2.21	2.07	2.59	2.07	2.34
Hydrogen Purity of Recycle Gas + Vent, %		87.1	88.9			86.9	86.9	85.5	85.0	84.1	88.3	86.0	85.1	86.1		90.0	82.1
Vapor Phase Hydrogen, MSCF/Ton Coal (Reactor Outlet)		26.2	30.3			29.2	24.6	24.7	24.8	23.5	25.7	24.6	24.1	23.8		26.5	21.7
Make-Up Hydrogen + Recycle Hydrogen																	
MSCF/Ton Coal		48.9	59.3			48.3	45.1	48.3	47.0	44.1	49.1	47.2	46.2	45.2		49.2	43.7
V % of Make-Up + Recycle Gas		93.3	94.5			92.3	93.0	92.7	92.3	91.7	94.2	92.9	92.5	92.9		95.0	91.3
Hydrogen Partial Pressure, psig		2745	2775			2700	2725	2720	2710	2685	2760	2725	2710	2730		2795	2695
Hydrogen Consumption (Metered Gas Rates, Analyses)																	
MSCF/Ton Dry Coal		20.5	27.4			16.8	18.6	22.1	19.5	19.1	20.9	18.8	18.8	17.7		20.6	19.3
W % Dry Coal		5.4	7.2			4.4	4.9	5.9	5.2	5.1	5.5	5.3	5.0	4.7		5.5	5.1
Oil Additions																	
Make-Up Anthracene Oil, Lbs/Lb Dry Coal	0	.080	0	0	.904	0	0	0	0	0	0	0	0	0	0	.151	0
Lbs/Hr/Ft^3 Reactor	0	2.5	0	0	15.0	0	0	0	0	0	0	0	0	0	0	4.2	0
Flush Oil, Lbs/Lb Dry Coal	.009	.101	.009	.009	.016	.009	.010	.009	.009	009	.012	.011	.009	.009	.010	.010	.009

RUN 130-62 - OPERATING RESULTS

Period	1B	2	3A	3B	4A	4B	5	6A	6B	7	8	9	10	11	12A	12B	13
Collected Product Quantities																	
W % Dry Coal																	
Atmospheric Still Overhead	36.4	28.5	27.9	37.1	49.9	28.7	21.8	25.2	20.8	18.9	21.6	22.2	26.5	24.3	22.9	31.8	21.8
Atmospheric Still Bottoms (1)	-9.5	-1.7	-5.7	9.7	39.1	-10.2	5.3	-3.3	-7.8	4.9	-0.4	1.3	-0.7	-2.0	-18.2	11.8	0.2
Vacuum Still Overhead (1)	-0.7	0.1	0	0.7	0.1	0	1.3	1.7	-1.0	0.5	-	0.2	0.3	0.2	0.1	0.3	0.3
0-6 Drainings	-	-	-	0.9	-	1.3	-	-1.3	0.5	-0.2	1.8	1.8	-2.9	-0.6	-	-0.1	-
0-13 Drainings	0.4	0.1	-	-	-	0.3	0.1	0.4	0.3	2.0	0.1	0.2	0.2	0.2	0.1	0.3	0.2
Hydroclone Overhead	-1.2	-0.2	-0.6	0.7	11.6	-1.3	0.8	-0.6	-	0.2	-0.1	0.2	-0.1	-0.3	-2.6	2.1	0
Hydroclone Bottoms	-	-	-	-	-	-	-	0.1(4)	-	-	0.1	-	-	0.1	0.1	0.1	0.1
H_2O (2)	10.6	12.8	23.9	11.8	13.8	10.6	13.0	19.3	11.9	15.4	15.4	16.1	14.3	19.8	16.7	14.4	14.6
C_1-C_3		5.7	4.9			5.3	5.9	6.0	6.5	6.8	7.1	7.1	7.2	7.3		8.4	8.6
C_4-C_7		3.5	2.7			3.7	3.7	4.1	3.4	3.9	3.7	4.5	3.7	3.6		4.6	4.6
H_2S		1.7	1.2			1.1	2.2	2.2	1.8	2.5	1.4	2.8	2.6	2.2		2.0	2.0
CO_2 and CO		0.2	0.3			0.2	0.4	0.6	0.6	0.8	0.5	0.9	0.9	0.9		1.2	1.1
Total		101.0	94.2			78.9	94.6	99.6	101.7	102.6	98.7	109.7	101.3	108.5		129.1	101.4
Input Quantities, W % Dry Coal																	
Dry Coal	100.0	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Moisture in Feed Coal	4.2	4.2	4.1	3.8	3.9	3.7	4.2	4.4	4.4	5.5	6.5	6.6	6.1	5.7	4.7	6.2	5.6
Oil Additions	0	8.0	0	0	90.4	0	0	0	0	0	0	0	0	0	0	15.1	0
Hydrogen Reacted (Gas Analyses, Flow)		5.4	7.2			4.4	4.9	5.9	5.2	5.1	5.5	5.3	5.0	4.7		5.5	5.1
Flush Oil	0.9	1.0	0.9	0.9	1.6	0.9	1.0	0.9	0.9	0.9	1.2	1.1	0.9	0.9	1.0	1.0	0.9
Total Used for Normalization		118.6	112.2			109.0	110.1	111.2	110.5	111.5	113.2	113.0	112.0	111.3		127.8	111.6
Normal Net Product Distribution(3)																	
W % of Dry Coal																	
CO, CO_2		0.2					0.4		0.6	0.9	0.6	0.9	1.0	0.9		1.2	1.2
C_1-C_3 Hydrocarbons in Gases		6.6					6.8		7.0	7.4	8.1	7.3	8.0	7.5		8.3	9.4
C_4-C_6 Hydrocarbons in Gases		4.1					4.3		3.7	4.2	4.2	4.6	4.1	3.7		4.5	5.0
IBP-400°F Naphtha		19.5					16.2		15.5	15.5	20.3	18.8	18.6	15.4		20.4	16.9
400-650°F Distillates		8.2					16.0		-1.0	13.5	5.1	6.7	11.5	7.6		15.3	7.9
650-975°F Distillates		↑					↑		↑	16.5	↑	↑	16.6	↑		↑	14.6
975°F+ Residual Oil		32.2					28.0		44.8		36.1	33.8		29.4		24.8	
Benzene-Soluble		↓					↓		↓	13.0	↓	↓	12.6	↓		↓	13.2
Benzene-Insoluble (Non-Filterable)		0.7					2.7		2.2	0.9	6.8	2.2	3.3	4.4		3.8	4.3
Unreacted Coal		6.5					4.8		6.8	6.1		6.1	6.8	7.2		5.9	6.7
Ash		13.6					12.0		13.9	13.2	10.0	11.5	11.6	12.4		10.5	12.8
H_2O (Net)		9.6					9.7		7.7	9.9	10.5	9.6	7.2	12.7		6.9	9.2
NH_3 (Forced Nitrogen)		(1.0)					(0.9)		(0.9)	0.93	(0.7)	(0.6)	0.57	(0.6)		(0.7)	0.66
H_2S (Forced Sulfur)		(3.2)					(3.1)		3.1	3.1	(3.1)	(3.1)	3.1	(3.1)		(3.2)	3.2
Total (100 + Hydrogen Reacted)		105.4					104.9		105.2	105.1	105.5	105.3	105.0	104.7		105.5	105.1

1) Negative quantities of atmospheric still overhead and vacuum overhead + hydroclone overhead are decreases of inventory of slurry holding tank

2) Includes dissolved NH_3 + H_2S

3) ASTM distillation cut points

4) 0-5 sample

RUN 130-62 - ANALYSES

Period	1B	2	3A	3B	4A	4B	5	6A	6B	7	8	9	10	11	12A	12B	13
Atmospheric Still Overhead																	
Gravity, °API	24.5	34.6	35.3	35.8	29.8	33.3	36.6	38.0	38.1	39.5	40.2	41.1	37.6	37.4	37.9	37.0	38.9
IBP, °F	146	154		174		132	108		120	150	120	118	146	164		168	162
EP, °F	624	588		580		578	568		574	562	536	528	570	582		566	576
V % @ 400°F	37	62		63		54	67		72	75	80	79	70	65		66	73
IBP-400°F Gravity, °API	41.3	43.4		43.8		43.9	44.1		44.1	44.2	43.7	43.5	42.5	43.6		43.1	44.3
400°F-EP Gravity, °API	17.2	22.0		24.4		22.9	24.1		24.1	27.4	25.7	25.9	26.1	26.4		26.3	26.5
Carbon, W %										86.58			85.79				87.11
Hydrogen, W %										12.67			12.30				12.33
Nitrogen, W %										0.13			0.05				0.10
Sulfur, W %										0.02			0.02				0.02
Phenols, V % Total										2.0			3.0				3.0
V % IBP-400°F										2.0			2.0				2.0
Atmospheric Still Bottoms																	
Gravity, °API	10.1	14.0	16.6	17.3	13.5	15.8	17.8	18.6	19.6	20.7	20.2	20.2	20.4	20.3	20.6	19.2	19.8
IBP, °F	416	414		406		438	386		390	360	370	350	386	368		380	370
EP, °F										(850)			(820)				(850)
V % @ 400°F	-	-		-		-	1		2	7	6	7	3	5		3	5
V % @ 650°F	81	85		88		87	85		87	89	87	39	90	89		86	87
IBP-650°F Gravity, °API	12.8	17.7		19.0		17.7	21.2		22.6	23.3	22.6	23.6	22.3	23.1		22.4	23.1
650°F+ Gravity, °API	9.7	4.9		3.7		3.2	5.2		4.5		2.5	3.8	3.3	3.9		1.8	
Carbon, W %										88.41			88.33				88.84
Hydrogen, W %										10.74			10.77				10.85
Nitrogen, W %										0.24			0.17				0.02
Sulfur, W %										0.02			0.02				0.02
Vacuum Still Overhead																	
Gravity, °API	5.3	7.6	9.9	11.3				14.2		15.2	16.8	16.3	15.8	15.9	19.9	18.4	16.9
IBP, °F	476	526		490				400		440/(337)		410	370/(338)	426		386	420/(308)
EP, °F										(715)			(725)				(765)
V % @ 650°F	57	54		68				79		85	84	90	80	83		87	88
IBP-650°F Gravity, °API	8.5	11.4		13.8				17.0		17.5	18.2	19.7	18.1	18.1		20.8	17.8
650°F+ Gravity, °API	2.1	4.2		6.0							2.4	5.7	5.9	7.0		2.9	4.6
Carbon, W %										89.39			88.92				88.08
Hydrogen, W %										10.40			10.14				10.04
Nitrogen, W %										0.22			0.22				0.61
Sulfur, W %										0.02			0.02				0.02
Water																	
Gravity, °API										6.9			7.1				7.2
Nitrogen, W %										3.69			3.35				3.41
Sulfur, W %										2.58			3.05				2.72

istillations - All ASTM D-86 except bracketed values from ASTM D-1160 (Modified)

From distillation of filtered feed to vacuum still

RUN 130-62 - ANALYSES (CONTINUED)

Period	1B	2	3A	3B	4A	4B	5	6A	6B	7	8	9	10	11	12A	12B	13
Vacuum Still Bottoms																	
W % of Flows from Vacuum Still	66.1	62.9	58.0	57.8	70.4	94.6	75.7	79.6	73.4	66.7	55.2	60.8	60.9	62.8	64.1	60.9	60.4
Benzene-Soluble, W %	65.35	64.34		58.70		65.57	58.05		67.13	61.42	69.07	63.62	60.49	55.78		60.79	54.82
Benzene-Insoluble, W %	14.55	12.40		13.88		11.82	16.00		12.93	13.34	12.53	15.23	18.54	21.40		18.84	20.85
Ash, W %	20.10	23.26		27.42		22.61	25.95		19.94	25.24	18.40	21.15	20.97	22.82		20.37	24.33
Unreacted Coal, W % (Estimated)	13.49	11.24				10.43	10.28		9.75	11.64		11.17	12.41	13.29		11.39	12.75
Benzene-Insoluble Residuum, W % (Estimated)	1.06	1.16				1.39	5.72		3.18	1.70		4.06	6.13	8.11		7.45	8.10
Carbon, W %										65.42			68.80				67.97
Hydrogen, W %										5.48			5.50				5.26
Nitrogen, W %										0.58			1.14				1.06
Sulfur, W %										1.94			2.28				2.19
Sulfur in Ash, W %													1.81				1.55
Oxygen, W % (By Difference)										1.34			1.31				-0.81
Pyridine-Soluble, W %	69.86	67.24		62.30		68.08	63.08		72.15	65.74	75.28	71.41	71.48	68.97		69.43	64.58
Pyridine-Insoluble, W %	9.98	10.62		10.29		9.18	10.23		8.34	9.03	6.48	7.07	8.15	9.27		10.02	10.89
Benzene-Soluble Oil																	
IBP, °F										580			565				625
IBP-650°F, cc/100 Grams										9.2			10				1.8
650-975°F, cc/100 Grams										45.2			48				46.2
975°F+, W %										40.4			38.2				46.0
Filter Cake																	
W % of Feed to Vacuum Still	31.7	29.7				38.6	71.7	71.1	47.1	36.9		31.2	31.3	38.5		33.2	36.6
Benzene-Soluble, W %	43.78	39.44				43.53	38.19		38.17	38.07		38.65	40.09	36.27		36.63	34.96
Benzene-Insoluble, W %	22.82	19.98				18.17	20.19		21.04	19.85		22.03	23.52	25.08		24.36	23.91
Ash, W %	33.40	40.58				38.30	41.62		40.79	42.12		39.32	36.39	38.65		39.01	41.13
Benzene-Insoluble Residuum, W %	0.40	0.37				0.51	3.71		1.10	0.43		1.26	1.98	2.57		2.54	2.36
Unreacted Coal, W % (Estimated)	22.42	19.61				17.66	16.48		19.94	19.42		20.77	21.54	22.51		21.82	21.55
Pyridine-Soluble, W %	49.44	44.52				47.40	43.23		41.86	46.66		42.39	49.16	46.71		43.71	42.26
Pyridine-Insoluble, W % (Organic)	17.40	16.11				14.40	16.58		17.15	13.93		19.36	13.94	15.41		17.24	16.89
Filter Liquid From Feed to Vacuum Still																	
Gravity, °API	-0.6	2.6				3.7	-6.1	-8.0	-1.1	2.8		3.1	-0.1	-1.0		-0.5	-1.6
IBP, °F	470	454				435	465		458	445		443	430	438		432	425
IBP-650°F, V %	46	52				49	27		31	47		47	41	46		49	47
650-975°F, V %	34	37				36	41		41	30		29	33	25		26	24
975°F+, W %	24.1	17.5				19.1	37.6		33.2	27.5		28.1	32.1	35.5		29.6	35.8
Carbon, W %										88.75			88.65				89.15
Hydrogen, W %										8.85			8.44				8.33
Sulfur, W %										0.02			0.30				0.13
Nitrogen, W %										0.27			0.79				0.87

RUN 130-62 - ANALYSES (CONTINUED)

Period	1B	2	3A	3B	4A	4B	5	6A	6B	7	8	9	10	11	12A	12B	13
0-13 Bottoms (Charge to Hydroclone)																	
Ash, W %	9.18	11.55*	12.13	11.95	10.52	16.47	21.62	22.24	-	16.02	11.40*	12.40	11.56	14.10*	12.27	11.60	12.81*
Hydroclone Overhead																	
Ash, W %	7.10	8.53*	8.98	7.24	6.31	11.28	19.47	20.42	-	10.10	8.15*	8.21	7.86	10.40*	8.57	8.00	9.25*
Hydroclone Bottoms																	
Ash, W %	12.35	14.48*	16.96	16.05	12.35	20.62	24.12	24.00	-	23.05	15.65	13.99	13.33	16.25*	14.11	15.80	15.38*
Atmospheric Still Overhead																	
IBP-400°F																	
Carbon										86.10			85.25				87.16
Hydrogen										13.01			12.52				12.87
Sulfur										0.02			0.02				0.02
Nitrogen										0.03			0.04				0.13
400°F+																	
Carbon										87.66			88.09				88.18
Hydrogen										11.17			11.32				11.59
Sulfur										0.02			0.02				0.02
Nitrogen										0.10			0.10				0.14
Atmospheric Still Bottoms																	
IBP-650°F																	
Gravity, °API										23.2			22.3				23.1
Carbon										88.02			88.80				88.63
Hydrogen										11.30			11.09				10.91
Sulfur										0.02			0.02				0.02
Nitrogen										0.16			0.11				
650°F+																	
Gravity, °API										3.2			3.3				1.5
Carbon										90.10			89.25				89.54
Hydrogen										9.19			9.38				8.95
Sulfur										0.02			0.02				0.02
Nitrogen										0.59			0.44				-
Filtered Liquid**																	
IBP-650°F (650-975°F)																	
Gravity, °API									(0.9)	14.9		(2.3)	14.4				14.6
Carbon									(89.44)	89.03		(88.14)	87.75			(88.71)	90.21
Hydrogen									(8.70)	8.70		(8.75)	8.76			(8.13)	8.13
Sulfur									(<0.02)	0.02		(<0.02)	0.02			(0.11)	0.11
Nitrogen									(0.62)	0.62		(0.53)	0.59			(0.61)	0.61
975°F+																	
Gravity, °API										-9.7			-7.6				-9.2
Carbon										87.59			84.58				87.47
Hydrogen										5.49			6.32				6.32
Sulfur	0.53	0.30				0.27	0.92		0.51	0.63		0.73	1.02	0.88		0.83	0.79
Nitrogen										1.34			1.61				1.70
Vacuum Bottoms Benzene-Extracted Oil																	
IBP-975°F																	
Gravity, °API										2.0			5.4				-0.2
Carbon										90.80			88.33				89.76
Hydrogen										8.70			10.77				8.29
Sulfur										0.02			0.02				0.30
Nitrogen										0.55			0.17				0.68

THIS PAGE

WAS INTENTIONALLY

LEFT BLANK

RUN 130-63 - ILLINOIS NO. 6 COAL

This 385-hour run was completed in the Process Development Unit during the second quarter of 1973.

In Run 130-63, better control of the expansion of the catalyst bed in the reactor was attained by using a larger-diameter catalyst, 1/8" diameter, in place of the 1/16" diameter catalyst used in the earlier PDU runs. A coal analysis and the operating results are included here.

RUN 130-63 FEED COAL ANALYSIS

Coal Source	Monterey Coal Company	
Hours of Run	123-137	286-310
Grind Description	Penn Rillton	
HRI Number	3395	3386/3493
Moisture, W %	6.46	4.75
Proximate Analysis, Dry Basis		
Ash, W %	10.82	9.63
Volatile Matter, W %	40.92	42.23
Fixed Carbon, W %	48.26	48.14
Ultimate Analysis, Dry Basis		
Carbon, W %	70.18	69.92
Hydrogen, W %	5.06	5.57
Nitrogen, W %	1.27	1.18
Sulfur, W %	3.97	4.56
Ash, W %	10.82	9.63
Oxygen (Difference), W %	8.70	9.14
Screen Size (U.S.S.), W %		
+50	3.38	0.84
50/70	4.93	0.87
70/100	7.85	3.20
100/140	11.97	26.23
140/200	13.65	20.47
200/325	27.23	9.52
325/Pan	31.05	38.87
Sulfur in Ash, W %	0.96	1.39

Coal Feed Schedule

0-27 Hours	HRI No.3429 (River King Mine Coal)
20-173 Hours	32,700 Pounds HRI 3395, 1500 Pounds HRI 3493
173-214 Hours	HRI No.3493
214-310 Hours	12,900 Pounds HRI 3386, 10,700 Pounds HRI 3493
310-386 Hours	HRI No.3493

RUN 130-63 - H-COAL OPERATIONS ON ILLINOIS NO.6 COAL (HRI 3386, 3393, 3395)

CATALYST - AMERICAN CYANAMID HDS-2, 1/8" EXTRUDATES - 110 POUNDS (HRI 3473)

REACTOR LIQUID PHASE DEPTH - 19 FEET

Period	2A	2B	3A	3B	4	5A	5B	6A	6B	7	8A	8B
Hours of Run - Beginning	3	15	27	39	51	75	87	99	111	123	147	159
- End	15	27	39	51	75	87	99	111	123	147	159	171
Catalyst Age, Lbs Coal/Lb Catalyst												
- Beginning	6	28	53	79	104	154	180	206	230	255	308	329
- End	28	53	79	104	154	180	206	230	255	308	329	351
Coal Feed Rate, Lbs Dry Coal/Hour/ Ft^3 Reactor Liquid Phase	25.2	29.4	27.4	28.7	28.4	29.9	29.5	27.2	29.3	29.9	25.3	24.9
Feed Coal - W % Moisture	8.56	4.52	10.77	8.44	7.30	5.52	5.79	8.10	5.05	6.57	5.03	
- % Ash (Dry Basis)	12.18	12.84	11.49	10.56	9.79	10.07	9.54	10.37	9.36	10.47	9.49	
Recycle Flows, Lbs/Lb Coal									9			
Atmospheric Still Bottoms	1.85	1.67	2.12	1.98	1.99	1.96	2.04	2.03	2.27	2.11	2.11	2.48
Vacuum Still Overhead	0.11	0.17	0.20	0.13	0.10	0.07	0.07	0.08	0.01	0.004	0.23	0.005
Hydroclone Overflow	0	0.10	0.09	0.01	0.14	0.21	0.20	0.32	0.37	0.35	0.51	0.51
Total	1.96	1.94	2.41	2.12	2.23	2.24	2.31	2.43	2.65	2.46	2.85	2.99
Temperatures, °F												
Coal Preheater Outlet	608	616	645	658	635	661	671	651	662	691	696	704
Reactor Liquid Phase (Average)	816	823	823	826	825	827	830	830	831	835	828	818
Vacuum Flash Zone	496	495	487	473	474	503	503	503	503	512	465	483
Pressure in Vacuum Flash, Torr	18	13	14	18	10	20	15	18	17	17	17	13
Hydroclone	-	364	474	450	500	502	490	472	472	461	462	445
Pressure, psig												
Unit Back Pressure	2900	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Hydrogen Make-Up	2930	3005	2970	2935	2955	3030	2930	2940	2945	2955	2950	2945
Hydrogen Partial Pressure (Reactor Outlet)				1520	1480		1605		1580	1535		1480
Recycle Gas, MSCF/Ton Coal				22.7	23.1		24.1		24.3	22.5		28.5
Vent Gas, MSCF/Ton Coal				2.19	2.31		2.86		4.31	3.29		4.59
Hydrogen Purity of Recycle Gas + Vent, %				84.0	86.1		86.4		84.9	85.0		82.7
Vapor Phase Hydrogen, MSCF/Ton Coal (Reactor Outlet)				21.5	22.3		23.7		25.1	22.9		28.3
Make-Up Hydrogen + Recycle Hydrogen												
MSCF/Ton Coal				41.5	46.4		46.4		51.4	46.9		54.0
V % of Make-Up + Recycle Gas				91.9	93.5		93.4		93.3	93.3		91.6
Hydrogen Partial Pressure, psig				2695	2765		2735		2745	2755		2700
Hydrogen Consumption (Metered Gas Rates, Analyses)												
MSCF/Ton Dry Coal				19.4	23.0		21.8		24.9	23.2		23.1
W % Dry Coal				5.2	6.1		5.8		6.6	6.2		6.2
Oil Additions												
Make-Up Anthracene Oil,												
Lbs/Lb Dry Coal	.411	0	.186	.038	.163	0	.038	.388	0	0	.616	0
Lbs/Hr/Ft^3 Reactor	10.3	0	5.1	1.1	4.6	0	1.1	10.6	0	0	15.6	0
Flush Oil, Lbs/Lb Dry Coal	.015	.013	.014	.009	.009	.009	.008	.010	.009	.008	.010	.010

RUN 130-63 - OPERATING RESULTS

Period	2A	2B	3A	3B	4	5A	5B	6A	6B	7	8A	8B
Collected Product Quantities, W % Dry Coal												
Atmospheric Still Overhead	36.3	35.1	33.5	26.7	29.1	30.8	28.4	36.3	30.9	23.8	35.7	30.6
Atmospheric Still Bottoms(1)	-2.8	-23.1	27.4	-14.9	13.1	-9.5	3.2	22.8	-1.1	-5.2	13.4	-20.6
Vacuum Still Overhead(1)	0.1	-2.1	2.9	-0.8	0.9	-0.1	0.6	1.1	0.3	0.6	1.8	0.5
Vacuum Still Bottoms	85.8	65.3	69.5	61.1	64.4	50.3	51.4	58.8	55.7	54.6	62.0	64.8
H_2O(2)	15.8	20.5	18.5	16.4	24.3	19.4	15.3	22.3	16.7	16.2	14.5	23.4
C_1-C_3				5.3	4.7		4.4		7.3	7.7		10.2
C_4-C_7				2.9	2.5		2.5		4.1	4.2		5.7
H_2S				2.0	1.8		1.7		2.6	2.8		3.7
CO_2 and CO				0.7	0.5		0.5		0.7	0.8		0.9
Total				99.4	141.3		108.0		117.2	105.5		109.2
Input Quantities, W % Dry Coal												
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture in Feed Coal	9.4	4.7	12.0	9.2	7.9	5.8	6.1	8.8	5.3	7.1	5.3	5.3
Oil Additions	41.1	0	18.6	3.8	16.3	0	3.8	38.8	0	0	61.6	0
H_2 Reacted (Gas Analyses, Flow)				5.2	6.1		5.8		6.6	6.2		6.2
Flush Oil	1.5	1.3	1.4	0.9	0.9	0.9	0.8	1.0	0.9	0.8	1.0	0.8
Total Used for Normalization				119.1	131.2		116.5		112.8	114.1		112.5
Normalized Net Product Distribution(3), W % Dry Coal												
CO, CO_2				0.8	0.5		0.5		0.7	0.9*		0.9
C_1-C_3 Hydrocarbons in Gases				6.3	4.3		4.7		7.0	8.4		10.6
C_4-C_6 Hydrocarbons in Gases				3.5	2.3		2.7		3.9	4.6		5.9
IBP-400°F Naphtha				19.5	14.7		20.2		17.9	17.9		18.9
400-650°F Distillates										5.4		
650-975°F Distillates										14.9		
975°F+ Residual Oil				43.0	53.9		42.9		44.6			23.9
Benzene-Soluble										16.4		
Benzene-Insoluble				2.2	0.5		2.8		5.0	6.3		8.4
Unreacted Coal				6.7	6.1		8.6		5.4	7.8		6.3
Ash				10.2	6.5		10.4		8.7	11.0		9.4
H_2O (Net)				9.5	13.7		9.4		10.0	9.5		18.2
NH_3 (Forced Nitrogen)										0.29		
H_2S (Forced Sulfur)				(3.5)	(3.5)		(3.5)		(3.5)	2.8		(3.5)
Total (100 + H_2 Reacted)				105.2	106.1		105.8		106.6	106.2		106.2

(1) Negative quantities of atmospheric still overhead and vacuum overhead are decreases of inventory of slurry holding tank

(2) Includes dissolved NH_3 + H_2S

(3) ASTM distillation cut points unless indicated by an asterisk

RUN 130-63 - ANALYSES

Period	2A	2B	3A	3B	4	5A	5B	6A	6B	7	8A	8B
Atmospheric Still Overhead												
Gravity, °API	29.3	27.5	34.7	37.3	36.7	36.1	36.1	35.8	34.9	37.4	36.7	33.5
IBP, °F		148		162	152		154		160	168		162
EP, °F		585		570	576		588		580	568		658
V % @ 400°F		54		66	70		69		63	73		62
Gravity, °API - IBP-400°F		43.4		45.8	43.4		44.0		43.1	42.8		41.2
- 400°F-EP		20.7		24.1	23.4		24.0		23.7	25.2		22.7
Carbon, W %										87.07		
Hydrogen, W %										13.03		
Nitrogen, W %										0.08		
Sulfur, W %										<0.02		
Phenols, V % Total										2.5		
V % IBP-400°F										1.5		
Atmospheric Still Bottoms												
Gravity, °API	7.7	11.2		17.2	15.9	18.6	19.2	15.1	14.9	18.0	17.2	17.4
IBP, °F		455		350	416		396		398	376		400
EP, °F										(765)		
V % @ 400°F		0			0		1		0	2		0
V % @ 650°F		83		92	91		91		86	90		92
Gravity, °API - IBP-650°F		14.6		18.7	18.5		21.8		17.2	20.7		19.4
- 650°F+		1.0		2.4	2.5		8.7		0.7	1.6		-0.3
Carbon, W %										88.71		
Hydrogen, W %										10.51		
Nitrogen, W %										0.17		
Sulfur, W %										<0.02		
Vacuum Still Overhead												
Gravity, °API	9.1	10.1	9.3	9.1	8.8	12.1	12.7	12.7	5.7	14.6	16.2	10.6
IBP, °F		306		508	470		470		494	318		300
EP, °F										(760)		
V % @ 650°F		80		71	72		77		57	87		76
Gravity, °API - IBP-650°F		12.7		11.3	11.4		15.8		9.9	17.6		13.6
650°F+		1.6		4.0	3.1		5.7		0.6	4.0		1.4
Carbon, W %										88.25		
Hydrogen, W %										10.13		
Nitrogen, W %										0.20		
Sulfur, W %										<0.02		
Water												
Gravity, °API										8.0		
Nitrogen, W %										3.17		
Sulfur, W %										2.24		
Carbon, W %										2.10		
Vacuum Still Bottoms												
W % of Flows from Vacuum Still	65.9	52.7	51.1	52.2	55.8	51.1	51.6	52.8	57.1	47.3	39.3	42.7
Benzene-Soluble, W %		64.73		73.88	77.96		60.35		64.41	57.84		57.64
Benzene-Insoluble, W %		15.28		12.12	11.09		20.68		19.31	23.65		25.85
Ash, W %		19.99		14.00	10.95		18.97		16.28	18.51		16.51
Unreacted Coal, W % (Estimated)				9.12	10.21		15.58		10.03	13.04		11.05
Benzene-Insoluble Residuum, W % (Est)				3.00	0.88		5.10		9.28	10.61		14.80
Carbon, W %										68.31		
Hydrogen, W %										5.31		
Nitrogen, W %										1.04		
Sulfur, W %										2.23		
Oxygen, W % (By Difference)										4.60		
Pyridine-Soluble, W %		72.34		79.02	83.64		71.72		76.23	78.46		72.89
Pyridine-Insoluble, W % (Organic)		7.14		7.09	5.57		10.03		7.88	6.42		10.07
Benzene-Soluble Oil, °API										-5.9		
IBP, °F										570		
IBP-650°F, cc/100 grams										5.3		
650-975°F, cc/100 grams										48.5		
975°F+, W %										47.4		
Filter Cake												
W % of Feed to Vacuum Still				32.8	42.3		32.0		26.3	26.7		24.0
Benzene-Soluble, W %				37.19	47.01				37.27	35.66		31.57
Benzene-Insoluble, W %				25.19	25.70				25.45	27.90		28.90
Ash, W %				37.62	27.29				37.28	36.44		39.53
Benzene-Insoluble Residuum, W %				0.67	0.26		1.45		2.48	1.53		2.44
Unreacted Coal, W % (Estimated)				24.52	25.44		24.75		22.97	26.37		26.46
Pyridine-Soluble, W %				44.81	56.55				45.13	45.95		41.89
Pyridine-Insoluble, W %				18.11	13.70				17.63	18.05		20.55

RUN 130-63 - ANALYSES (CONTINUED)

Period	2A	2B	3A	3B	4	5A	5B	6A	6B	7	8A	8B
Filter Liquid from Feed to Vacuum Still												
Gravity, °API				-0.6	-5.0		1.5		-6.8	-1.3		-0.4
IBP, °F				472	453		442		450	432		449
IBP-650°F, V %				44	26		48		40	50		51
650-975°F, V %				31	40		33		31	26		29
975°F+, W %				30.6	41.1		24.4		36.6	30.0		26.4
Carbon, W %										88.31		
Hydrogen, W %										8.61		
Nitrogen, W %										0.66		
Sulfur, W %										0.49		
975°F+ Liquid												
Carbon, W %										83.90		
Hydrogen, W %										6.12		
Sulfur, W %				0.79	1.20		1.15		1.38	1.16		1.05
Nitrogen, W %										1.72		
Ash, W %										0.16		
Benzene-Insoluble, W %										27.18		
0-13 Bottoms (Charge to Hydroclone)												
Ash, W %	10.29				13.57		9.96	12.96	8.71	11.20	10.63	5.85
Hydroclone Overhead (Recycled)												
Ash, W %	5.49				10.52		6.75	10.03	5.63	7.45	6.08	4.76
Hydroclone Bottoms												
Ash, W %	9.58				13.12		10.26	11.94	10.42	12.40	9.62	6.94
Atmospheric Still Overhead												
IBP-400°F												
Carbon, W %										85.26		
Hydrogen, W %										12.15		
Sulfur, W %										<0.02		
Nitrogen, W %										0.06		
400°F+												
Carbon, W %										88.13		
Hydrogen, W %										11.20		
Sulfur, W %										<0.02		
Nitrogen, W %										0.11		
Atmospheric Still Bottoms												
IBP-650°F												
Carbon, W %										87.99		
Hydrogen, W %										11.12		
Sulfur, W %										<0.02		
Nitrogen, W %										0.11		
650°F+												
Carbon, W %										88.31		
Hydrogen, W %										8.88		
Sulfur, W %										<0.02		
Nitrogen, W %										0.40		
Filtered Liquid												
IBP-650°F												
Gravity, °API										13.9		
Carbon, W %										88.79		
Hydrogen, W %										10.25		
Sulfur, W %										<0.02		
Nitrogen, W %										0.14		
650-975°F												
Gravity, °API										0.3		
Carbon, W %										87.71		
Hydrogen, W %										8.05		
Sulfur, W %										0.10		
Nitrogen, W %										0.66		
Vacuum Bottoms, Benzene-Soluble Oil, IBP-975°F												
Gravity, °API										2.0		
Carbon, W %										88.49		
Hydrogen, W %										8.35		
Sulfur, W %										0.83		
Nitrogen, W %										0.61		

PHASE I - DOE/PARTICIPANTS PROGRAM

This program was conducted to confirm the Pilot Plant design basis using the three-ton-per-day PDU. The reactor gives flow patterns which more closely approximate the Pilot Plant than the bench unit, and the recycle streams can be continuously produced. Because the boiler fuel mode of operation had never been demonstrated on the PDU scale, this was the primary objective and required extensive unit modifications. Also, the continuous use of hydroclones to produce a residuum-containing recycle had not been demonstrated, so this also was an important objective. Prior work had indicated that residuum recycle aided conversion and this was included in the Pilot Plant design. Other run conditions were chosen to approach, as closely as possible, the Pilot Plant design.

DEMONSTRATION RUNS

Following extensive modifications and improvements to the PDU system, HRI conducted shakedown operations to demonstrate both the fuel oil mode and syncrude mode of operation. Both runs reported here used Illinois No. 6 coal and cobalt molybdate catalst. Run 130-65 operated in the fuel oil mode to produce low-sulfur fuel oil product, and Run 130-69 operated in the syncrude mode to demonstrate operation over a range of space velocities.

ANALYSES OF BURNING STAR MINE ILLINOIS NO. 6 COAL

USED IN RUN 130-65

		As Received	Dried For Unit 130
HRI Number		3663	3663
Moisture, W %		9.22	1.0-3.3
Proximate Dry Basis			
Ash, W %		11.77	11.45
Volatile Matter, W %		37.63	37.76
Fixed Carbon, W %		50.60	50.79
Ultimate Analysis, Dry Basis			
Carbon		70.81	71.61
Hydrogen		5.22	4.71
Nitrogen		1.19	1.42
Sulfur		3.54	3.34
Ash		11.77	11.45
Oxygen (Difference)		7.47	7.47
		100.00	100.00
Btu (Dry Basis)		12,522	
Sulfur Types			
Pyritic Sulfur		1.87	1.96
Sulfate Sulfur		0.13	0.07
Organic Sulfur		1.52	1.14
Total Sulfur		3.52	3.17
Mineral Analysis			
W % Ignited Bases			
Phosphorous Pentoxide,	P_2O_5	0.09	
Silica	SiO_2	47.94	
Ferric Oxide	Fe_2O_3	18.50	
Alumina	AL_2O_3	19.83	
Titania	TiO_2	0.91	
Lime	CaO	5.10	
Magnesia	MgO	1.02	
Sulfur Trioxide	SO_3	3.02	
Potassium Oxide	K_2O	2.14	
Sodium Oxide	Na_2O	0.53	
Undetermined		0.92	
		100.00	

RUN 130-65 H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO.6 COAL (HRI NO.366))

Catalyst - American Cyanamid HDS-1442A 1/16" Extrudates, HRI No.3556, 535 Pounds (Calcined Weight)
Reactor Liquid Phase Depth 19 Feet, Volume 3.7 Cubic Feet

Period	5A	5B	6A	6B	7A		8B	9	10	11A	11B
Time - Beginning											
Date	2/17	2/17	2/18	2/18	2/19		2/21	2/22	2/23	2/24	2/24
Time	1300	1400	0700	1900	0700		1900	0700	0700	0700	1500
End											
Date	2/17	2/18	2/18	2/19	2/19		2/22	2/23	2/24	2/24	2/24
Time	1900	0700	1900	0700	1600		0700	0700	0700	1500	2100
Catalyst Age, Lbs Coal/Lb Catalyst*											
Beginning	3	19	68	121	177		226	258	329	404	430
End	19	68	121	177	220		258	329	404	430	450
Coal Feed Rate, Lbs Coal/Hr/Ft^3	47.2	59.0	60.4	68.4	68.6		38.4	43.3	46.0	47.0	49.5
Feed Coal											
Moisture, W %			1.09	1.72			2.50	2.75	2.73	2.67	
Ash, % (Dry Basis)			11.67	11.67			11.29	11.29	11.28	10.82	
Recycle Flows, Lbs/Lb Coal											
Atmospheric Still Bottoms		2.23	2.02	1.84	1.93		3.02	3.30	3.34	2.98	
Vacuum Still Overhead	.696	.180	.105	.107	.152		.273	.077	.000	.000	.002
Temperatures, °F											
Coal Preheater Outlet	722	723	696	700	706		718	699	697	700	714
Reactor Liquid Phase Average	802	840	837	834	832		830	833	835	833	835
Vacuum Flash Zone	499	534	578	592	589		593	602	610	613	620
Pressure in Vacuum Flash, Torr			71	71	91		99	81	81	84	96
Pressure, Psig											
Unit Back Pressure	2690	2700	2700	2700	2695		2700	2700	2700	2700	2715
Hydrogen Make-up	2700	2745	2750	2750	2750		2700	2710	2720	2700	2700
Recycle Gas, MSCF/Ton Coal	19.4	22.7	23.1	21.6			15.0	16.1	19.9	19.3	21.6
Vent Gas, MSCF/Ton Coal	2.8	1.7	2.2	2.3	2.6		2.6	2.4	2.5	2.7	2.1
Hydrogen Purity of Recycle and Vent		87.2	90.8	89.7			92.1	91.0	92.3		
Vapor Phase Hydrogen, MSCF/Ton Coal											
Reactor Outlet		22.9		23.0				20.3	21.5		
Make-Up Hydrogen + Recycle Hydrogen, MSCF/Ton Coal		47.1	42.3	38.7			23.4	37.3	42.6		
V % of Make-Up + Recycle Gas		94.1	95.2	94.6			95.0	96.3	95.6		
Partial Pressure of Hydrogen, psi		2553	2585	2568			2578	2614	2621		
Hydrogen Consumption (Metered Gas Rates, Analyses)											
MSCF/Ton Dry Coal		21.1		13.4				12.1	15.2		
W % of Dry Coal		5.6		3.6				3.2	4.1		
Oil Additions											
Make-Up Hydrogenated Anthracene Oil											
Lbs/Lb Dry Coal			.203					.107			
Lbs/Hr/Ft^3			12.3					4.9			
Flush Oil, Lbs/Lb Coal	.022	.013	.014	.012	.013		.022	.019	.017	.016	.013

Interrupted coal feed to repair reactor liquid level control and clean out atmospheric still

*Dry coal and calcined catalyst weights

OPERATING RESULTS

Period	5A	5B	6A	6B	7A	8B	9	10	11A	11B
Collected Product Quantities, W % Coal										
Atmospheric Still Overhead	112.7	31.9	34.0	15.3	14.8	5.0	20.5	19.9	24.5	19.8
Atmospheric Still Bottoms*	-86.9	7.1	22.2	2.5	39.0	14.0	-4.0	2.1	-6.0	-3.7
Vacuum Still Overhead*					2.0		0.3	0.3	0.4	0.4
Vacuum Still Bottoms	70.3	36.6	60.1	49.4	45.1	78.7	71.6	66.9	68.1	63.4
Water** (with NH_3, H_2S Dissolved)	46.5	-0.8	3.4	11.7	12.2	11.9	14.3	15.0	6.9	6.8
C_1-C_3 Hydrocarbons		4.6		5.2		4.9	4.2	5.7	(5.7)	
C_4-C_6 Hydrocarbons		5.8		3.1		6.9	7.0	8.6	(8.6)	
H_2S (Gas Analyses)		2.2		2.1		2.3	2.1	2.4	(2.4)	
CO_2 and CO		0.6		0.6		0.6	0.6	0.5	(0.5)	
Total		88.0		89.9		96.3	116.6	121.4	(111.1)	
Input Flows, W % Coal										
Dry Coal		98.9		98.3		97.5	97.2	97.3	97.3	
Oil Additions		1.3		1.2		2.2	1.9	11.4	1.6	
Moisture in Feed Coal		1.1		1.7		2.5	2.8	2.7	2.7	
Hydrogen Reacted		5.6		3.6			3.2	4.1	(4.1)	
Total (Used for Normalization Basis)		106.9		104.8			105.1	116.5	105.7	
Normalized Net Product Distribution* W % Dry Coal**										
CO_2									0.5	
C_1-C_3 Hydrocarbons in Gases									5.6	
C_4-C_6 Hydrocarbons in Gases									8.5	
IBP-400°F Naphtha									11.9	
400-650°F Distillates									-1.2*****	
650-975°F Distillates									12.1******	
975°F+ Residual Oil - Benzene-Soluble									22.1	
Benzene-Insoluble									8.5	
Unreacted Coal (Non-Filterable)									13.2	
Ash									10.6	
Water (with NH_3, some H_2S)									10.0	
H_2S									2.3	
Total (100 + H_2 Reacted)									104.1	

* Negative quantities of A.S.B. and VSOH indicate decrease in inventory of slurry oil

** Collected quantities less H_2O additions to reactor outlet cooler

*** ASTM cut points no adjustment to TBP temperature

**** Net 400°F+ atmospheric still products less oil additions

***** Distillate in vacuum bottoms product

ANALYSES

Period	6A	6B	7A	8B	9	10	11A	11B
Atmospheric Still Overhead								
Gravity, °API	22.9	29.5	33.0	35.5	35.0	31.8	32.5	33.1
IBP, °F	212	182	185	216	194	203	218	197
EP, °F	608	556	547	570	54[illegible]	535	528	515
V % @ 400°F	33	55	67	62	67.5	60	62	70
Sulfur, W % (400°F+ Fraction)			0.04	0.05	0.04	0.04	0.05	
Atmospheric Still Bottoms								
Gravity, °API	0.4	1.0	-2.9/-4.5	9.7	11.9	12.9	13.3	14.0
IBP, °F		411		422	418	235	415	
EP, °F		875		650	730	745	735	
V % @ 400°F						4		
V % @ 650°F		65		84	86	85	87	
Residue @ End Point		20.5			2	2	2	
Ash, W %		3.7						
Sulfur, W %				0.02	0.05		0.06	
Vacuum Still Overhead								
Gravity, °API			8.2	5.0	5.0	5.3	5.6	5.3
IBP, °F						505	498	
EP, °F (Atmospheric Distillation)						650	650	
V % @ 650°F						46	53	
Sulfur, W %			0.06	0.05	0.08	0.07	0.05	
Vacuum Still Bottoms								
W % Benzene-Soluble		68.17	60.67	61.72	55.33	51.55		46.70
W % Benzene-Insoluble		16.73	22.32	23.24	29.06	32.53		37.60
W % Ash	16.11	15.10	17.01	15.04	15.61	15.92	16.72	15.64
W % Unreacted Coal, Estimated			13.85			19.79		
W % Benzene-Insoluble Residuum (Estimated)			8.47			12.74		
W % Distillate Oil			21.7			18.3		
W % Residual Oil			49.2			46.0		
W % Sulfur in Sample	1.53		1.90	1.81	1.93	1.95	2.05	2.05
W % Sulfur in Distillate Oil			0.18			0.23		
W % Sulfur in Residual Oil			0.81			1.19	1.11	
W % Sulfur in Total Oil (Calculated)			0.62			0.91		
Filter Cake								
W % of Feed to Filter			27.0*			34.3*	9.6**	
W % Benzene-Soluble			38.29			43.04	55.55	
W % Benzene-Insoluble			28.81			33.18	28.70	
W % Ash			32.90			23.78	15.75	
W % Benzene-Insoluble (Residuum (Estimated)			2.02			3.62		
W % Unreacted Coal (Estimated)			26.79			29.56		

* From filtration of one part vacuum bottoms plus one part vacuum overhead

** Sample from inlet line to 0-13 reactor liquid flash drum

ANALYSES OF COAL FEED TO RUN 130-69

Burning Star Mine, Illinois No. 6 Coal

Hours of Run	0-162	162-450	450-786	786-814	As Received
HRI Number	3663	3663	3689	3663/3689	3689
Moisture, W %					
As-Received	9.22		10.76		10.76
As Fed to Unit	2.29	2.48	2.41	2.29	
Proximate Analysis, W % Dry Basis					
Volatile Matter	38.68		38.01		37.72
Fixed Carbon	50.15		51.09		50.62
Ash	11.17		10.90		11.66
	100.00		100.00		100.00
Ultimate Analysis, W % Dry Basis					
Carbon	69.66	70.32	69.68	70.19	69.15
Hydrogen	4.86	5.10	5.18	4.87	5.12
Nitrogen	1.28	1.20	1.26	1.34	1.30
Sulfur	3.52	3.42	3.59	3.57	3.46
Ash	11.17	11.14	10.90	10.87	11.66
Oxygen (Difference)	9.51	8.82	9.39	9.19	9.31
	100.00	100.00	100.00	100.00	100.00
Iron, W %	1.43	1.28	1.53		
Sulfide Sulfur Equivalent to Iron	1.64	1.47	1.75		
Screen Size (U.S.S.)					
+50	3.69	3.67	5.34		
50/70	5.42	4.66	7.42		
70/100	10.62	8.55	11.85		
100/140	12.97	13.59	13.54		
140/200	12.97	15.53	12.19		
200/325	22.67	24.67	22.48		
325/Pan	31.66	29.33	27.18		
Sulfur Forms, W % Dry Coal					
Pyritic	1.65				1.71
Sulfate	0.18				0.16
Mineral Analysis of Ignited Sample					
Phosphorus Pentoxide	0.09				0.05
Silica	47.94				48.88
Ferric Oxide	18.50				17.91
Alumina	19.83				19.13
Titania	0.91				0.91
Lime	5.10				5.73
Magnesia	1.02				0.90
Sulfur Trioxide	3.02				3.22
Potassium Oxide	2.14				1.76
Sodium Oxide	0.53				0.53
Undetermined	0.92				0.96
	100.00				100.00
Heating Value, Btu (Dry Basis)	12,522		12,446		12,446
Hardgrove Grindability Index					52

RUN 130-69 - H-COAL OPERATIONS ON BURNING STAR MINE, ILLINOIS NO.6 COAL (HRI NO.3663)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates, HRI No.3558, 46.7 Pounds (Dry)

Reactor Liquid Phase Depth, 191 - Volume 3.7 Ft^3

Period	1B	2	3	4	5	6	7	8A	8B	9	10	11
Hours of Run - Beginning	6	18	42	66	90	114	138	162	180	186	210	234
End	18	42	66	90	114	138	162	180	186	210	234	258
Catalyst Age, Lbs Coal/Lb Catalyst - Beginning	13	38	90	146	201	259	317	376	385	397	450	508
End	38	90	146	201	259	317	376	385	397	450	508	564
Coal Feed Rate, Lbs Dry Coal/Hr/Ft^3 Reactor Liquid Phase	25.6	27.0	28.6	28.3	30.2	30.2	30.2		25.0	26.6	30.1	29.1
Feed Coal												
Moisture, W %	2.67	2.49	1.77	1.84	1.22	2.06	2.17		2.36	2.29	1.65	1.83
Ash, % (Dry Basis)	11.16	11.15	11.35	10.92	11.50	11.14	11.14		11.25	11.20	11.26	11.09
Recycle Flows, Lbs/Lb Coal												
Atmospheric Still Bottoms	2.77	2.83	2.43	2.15	1.80	1.51	1.51		2.36	2.22	1.54	1.60
Vacuum Still Overhead	0.59	0.40	0.48	0.55	0.61	0.65	0.69			0.54	0.57	0.62
Total	3.36	3.33	2.91	2.70	2.41	2.16	2.20		2.36	2.76	2.11	2.22
Temperatures, °F												
Coal Preheater Outlet	690	690	690	680	680	674	677		723	705	684	686
Reactor Liquid Phase Average	817	818	818	818	818	818	818		811	819	819	823
Vacuum Flash Zone	550	575	588	589	585	582	586		447	593	595	594
Pressure in Vacuum Flash, Torr	48	46	28	17.7	14	14	13			12.7	18.6	19.7
Pressure, psig												
Unit Back Pressure	2700	2700	2680	2720	2640	2635	2630		2700	2695	2680	2680
Hydrogen Make-Up	2785	2775	2755	2790	2730	2715	2710		2790	2765	2750	2750
Hydrogen Partial Pressure (Reactor Outlet)		1885	1945	2005	1895	1815	1835			2005	1995	1940
Recycle Gas, MSCF/Ton Coal		29.2	27.9	28.1	25.7	24.5	27.2			30.8	28.2	28.2
Vent Gas, MSCF/Ton Coal		3.6	3.9	4.7	3.7	3.7	3.4			3.7	3.7	4.4
Hydrogen Purity of Recycle + Vent Gas, %		94.4	94.5	94.4	94.3	90.5	91.8			94.6	93.2	92.3
Total Hydrogen, MSCF/Ton Coal (Reactor Outlet)		38.7	37.1	37.9	34.1	31.5	34.3			39.8	36.3	37.0
Make-Up Hydrogen + Recycle Hydrogen												
MSCF/Ton Coal		55.3	52.4	53.9	48.7	46.4	49.2			56.5	52.1	53.0
V % of Make-Up + Recycle Gas		97.1	97.1	97.2	97.1	95.2	95.7			97.2	96.4	96.1
Partial Pressure of Hydrogen, psig		2705	2675	2710	2650	2585	2590			2685	2650	2640
Hydrogen Consumption												
MSCF/To Dry Coal		17.0	15.6	16.3	14.8	15.2	15.2			17.1	16.0	16.3
W % Dry Coal		4.5	4.2	4.3	3.9	4.0	4.1			4.6	4.3	4.4
Oil Additions												
Make-Up Oil, Lbs/Lb Dry Coal	0	0	0	0	0	0	0		0	0	0	0.148
Lbs/Hr/Ft^3 Reactor	0	0	0	0	0	0	0		0	0	0	4.31
Vacuum Overhead Blend												
Flush Oil, Lbs/Lb Dry Coal	0.019	0.020	0.019	0.019	0.017	0.017	0.018		0.022	0.022	0.017	0.018
Venturi Oil, Lbs/Lb Dry Coal	0.048	0.007							0.045	0.020		

Off Conditions Due to Replacement of Reactor Liquid Letdown Valves

RUN 130-69 - OPERATING RESULTS

Period	1B	2	3	4	5	6	7	9	10	11
Collected Product Quantities, W % Dry Coal										
Atmospheric Still Overhead	15.9	29.6	33.2	24.0	23.8	28.2	25.8	27.6	26.3	28.2
Atmospheric Still Bottoms(1)	-2.3	-9.3	-3.6	2.1	2.2	1.5	-1.6	8.0	-2.3	3.6
Vacuum Still Overhead(1)	-0.1	-0.3	-0.1	1.3	1.5	1.1	-0.4	2.7	-0.2	2.1
Vacuum Still Bottoms	77.0	65.5	58.9	56.0	57.4	58.1	61.3	57.7	59.0	60.3
H_2O(2)	12.0	12.9	9.7	9.7	11.0	9.1	13.1	9.3	9.7	9.4
C_1-C_3		4.0	4.2	3.8	4.1	4.3	4.5	4.4	4.6	4.8
C_4-C_6		4.7	3.6	5.0	3.3	3.0	3.4	4.3	3.3	3.4
H_2S		1.9	1.6	1.7	1.8	2.1	1.7	1.9	1.7	1.6
CO_2 and CO		0.5	0.4	0.2	0.2	0.6	0.4	0.1	0.6	0.3
Total		109.5	107.9	103.8	105.3	108.0	108.2	116.0	102.7	113.7
Input Quantities, W % Dry Coal										
Dry Coal	100.0	----------	----------	----------	----------	----------	----------	----------	----------	----------
Moisture in Feed Coal	2.8	2.4	1.8	1.9	1.2	2.1	2.2	2.3	1.7	1.9
Oil Additions	0	0	0	0	0	0	0	0	0	14.8
Hydrogen Reacted (Hydrogen Orifice, Gas Analyses, Flow)		4.5	4.2	4.3	3.9	4.0	3.8	4.6	4.3	4.4
Flush Oil	1.9	2.0	1.9	1.9	1.7	1.7	1.8	2.1	1.7	1.8
Venturi Oil (Vacuum Overhead Blend)	4.8	0.7						2.0		
Total Used for Normalization Basis		109.6	107.9	108.1	106.8	107.8	108.1	111.0	107.7	122.9
Normal Net Product Distribution(3) W % of Dry Coal										
CO, CO_2	0	0.5	0.4	0.2	0.3	0.6	0.4	0.2	0.6	0.3
C_1-C_3 Hydrocarbons in Gases		4.0	4.2	4.0	4.1	4.3	4.5	4.1	4.8	5.2
C_4-C_6 Hydrocarbons in Gases		4.7	3.6	5.3	3.4	3.0	3.3	4.1	3.5	3.7
18P-400°F Naphtha		20.1	17.9	13.9	15.2	16.8	13.6	16.1	14.0	16.3
400-650°F Distillates		34.7	17.6	20.2	18.1	13.2	15.9	23.8	16.5	11.4
650-975°F Distillates						6.2				
975°F+ Residual Oil- Benzene-Soluble			24.2*	22.7*	22.0*	22.3	23.1*	18.5*	23.3*	23.9*
Benzene-Insoluble		3.1	2.8	4.3	5.1	2.6	5.6	4.6	7.6	7.7
Unconverted Coal		13.1	12.6	12.1	12.0	13.9	13.3	13.5	11.1	12.9
Ash		12.1	11.4	11.6	12.0	11.8	11.4	11.4	12.2	12.3
H_2O (Net)		10.4**	7.9**	8.2**	9.9**	6.2	10.8**	6.4**	8.5**	9.2**
NH_3 (Forced Nitrogen)		**	**	**	**	0.7	**	**	**	**
H_2S (Forced Sulfur)		1.9**	1.6**	1.8**	1.8**	2.4	1.7**	1.8**	1.8**	1.7**
Total (100 + Hydrogen Reacted)	104.5	104.2	104.3	103.9	104.0	103.8	104.6	104.3	104.4	

(1) Negative quantities of atmospheric still overhead are decreases of inventories of slurry oil holding tank

(2) Includes dissolved NH_3 + H_2S

(3) ASTM Distillation cut points

* Basis distillates in Period 6 benzene-soluble oil in vacuum bottoms product

** Water product contains some NH_3, H_2S

Period	1B	2	3	4	5	6	7	8B	9	10	11
Atmospheric Still Overhead											
Gravity, °API	38.2	34.1	31.5	32.3	33.3	33.0	32.0	32.7	33.6	32.5	32.2
IBP, °F	182	174	168	186	165	168	168	190	173	189	175
EP, °F	472	520	533	520	510	504	521	535	523	525	530
V % @ 400°F	84	70	56	58	65	62	55	69	64	53	56
Gravity, °API - IBP-400°F						39.3					
400°F+						24.2					
Carbon, W %						87.30					
Hydrogen, W %						12.04					
Nitrogen, W %						0.12					
Phenols, V % - Total						6.5					
IBP-400°F						4.5					
Atmospheric Still Bottoms											
Gravity, °API	15.7	16.5	16.4	17.0	17.4	17.4	17.0	18.4	18.1	17.6	16.8
IBP, °F	425	442	452	465	462	467	478	442	468	475	469
EP, °F	685	675	685	696	693	707	721	712	695	705	703
V % @ 650°F	93	95	94	93	93	92	90	93	92	92	94
Gravity, °API - IBP-650°F						18.7					
650°F+						6.4					
Carbon, W %						88.76					
Hydrogen, W %						10.45					
Nitrogen, W %						0.11					
Sulfur, W %	0.03	0.02	0.02	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.02
Vacuum Still Overhead											
Gravity, °API	9.5	9.4	9.5	9.3	9.4	10.2	10.2		10.4	10.5	9.8
IBP, °F	482	545	529	525	527	530	514		535	518	535
V % @ 650°F	75	58	52	44	45	45	44		50	50	44
Gravity, °API - IBP-650°F						14.2					
650°F+						7.0					
Carbon, W %						89.91					
Hydrogen, W %						9.53					
Nitrogen, W %						0.28					
Sulfur, W %	0.03	0.02	0.05	0.02	0.06	0.03	0.03		0.06	0.04	0.04
Water											
Carbon, W %						1.97					
Nitrogen, W %						2.67					
Sulfur, W %						2.35					
Vacuum Still Bottoms											
W % of Flows from Vacuum Still	55.4	60.9	54.1	49.4	47.5	46.5	46.1	99.8	50.6	49.8	48.5
Benzene-Soluble, W %	64.28	56.57	54.47	51.84	50.04	50.95	50.30	81.83	45.47	50.01	49.22
Benzene-Insoluble, W %	19.55	24.81	26.18	28.18	29.34	28.56	31.01	10.86	33.44	30.30	31.77
Ash, W %	16.17	18.62	19.35	19.98	20.62	20.49	18.49	7.31	21.09	19.69	19.01
Unreacted Coal, W % (Estimated)	16.23	20.06	21.38	20.76	20.65	23.99	21.68	7.65	24.89	17.98	19.91
Benzene-Insoluble Residuum, W % (Estimated)	3.32	4.75	4.80	7.42	8.69	4.57	9.13	3.21	8.55	12.32	11.86
Carbon, W %						69.12					
Hydrogen, W %						4.66					
Nitrogen, W %						1.18					
Sulfur, W %	1.68	1.71	2.06	2.07	2.18	2.18	2.15	0.88	2.05	2.12	2.25
Oxygen, W % (By Difference)						2.37					
Pyridine-Soluble, W %						67.04					
Pyridine-Insoluble, W % (Organic)						12.88					
THF-Soluble, W %						63.70					
THF-Insoluble, W %						15.81					
Benzene-Soluble Oil - IBP, °F						615					
IBP-650°F, W %						0.2					
650-975°F, W %						24.5					
975°F+, W %						75.3					

RUN 830-69 - ANALYSES (CONTINUED)

Period	1B	2	3	4	5	6	7	8B	9	10	11
Filter Cake											
W % of Feed to Vacuum Still		34.8	44.7	*	*	39.0	48.5		48.5	41.9	33.6
Benzene-Soluble, W %		42.43	47.39	43.84	53.96	50.49	58.38		52.91	40.32	36.24
Benzene-Insoluble, W %		29.33	28.06	30.56	24.24	25.01	26.88		25.10	33.42	32.00
Ash, W %		28.24	24.55	26.30	20.80	23.90	28.74		21.99	26.26	31.76
Benzene-Insoluble Residuum, W %		0.98	1.61	1.50	1.59	1.67	1.43		2.07	2.42	2.99
Unreacted Coal, W % (Estimated)		28.35	26.45	29.06	22.65	23.94	25.45		23.03	30.99	29.01
THF-Soluble, W %						60.36					
THF-Insoluble, W % (Organic)						17.31					
Carbon, W %						66.46					
Hydrogen, W %						5.60					
Sulfur, W %						1.81					
0-13 Bottoms (Feed to Vacuum Still)											
Ash, W %			11.44	10.64	12.40	11.33	10.76		8.55	11.33	10.93
Internal Recycle Slurry											
Ash, W %			5.63	6.18	6.17	5.54	6.09			6.61	6.39
Atmospheric Still Overhead											
400°F+											
Sulfur, W %	0.03	0.05	0.05	0.05	0.03	0.05	0.03	0.04	0.04	0.06	0.07
Vacuum Bottoms Benzene-Extracted Oil											
IBP-975°F											
Gravity, °API						-1.7					
Carbon, W %						88.69					
Hydrogen, W %						8.56					
Sulfur, W %						0.06					
Nitrogen, W %						0.66					
THF-Extracted Filter Cake											
Ash, W %						56.33					
Carbon, W %						34.07					
Hydrogen, W %						1.95					
Sulfur, W %						4.63					
Nitrogen, W %						0.67					

* Filtered one part vacuum overhead and two parts 0-13 bottoms (feed to vacuum still)

RUN 130-69 - CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS

Period	2	3	4	5	6	7	8A	9	10	11
Distillation of Filtrate from Filtration Operation										
Vacuum Distillation										
Final Vapor Temperature, °F	599	567	549	588	519	431		569	521	599
Pressure, Torr	0.6	1.4	3.0	1.2	1.0	2.0		0.4	2	0.8
Residue										
W % of Filtrate	22.5	26.5	19.0	14.7	20.1	19.9		16.2	27.6	28.4
W % of Vacuum Bottoms Slurry	24.3	27.1	42.9	32.9	26.4	23.5		16.5	32.2	38.9
Analysis										
Gravity, °API					-3.0					
Carbon, W %					87.73					
Hydrogen, W %					6.55					
Nitrogen, W %					1.16					
Sulfur, W %	0.62	0.78	0.71	0.83	0.80	0.72		0.94	0.91	0.95
Ash, W %	0.02	0.32	0.12	0.07	0.01	0.06				
Batch Distillation of Vacuum Bottoms Slurry Product										
Vacuum Distillation										
Final Vapor Temperature, °F	532	472	504	479	488	441	502	514	592	535
Pressure, Torr	1.0	4.2	2.4	4.2	6.4	6.4	9.2	6.5	2.8	1.0
Distillate, W % of Vacuum Bottoms Slurry	31.2	10.8	14.7	10.5	5.7	6.4	7.3	11.1	9.1	9.1
Analysis										
Gravity, °API	4.3	3.7	3.5	2.2	3.3	1.4	3.2	3.2	3.0	3.4
Carbon, W %					90.30					
Hydrogen, W %					8.46					
Nitrogen, W %					0.50					
Sulfur, W %	0.08	(0.12)	0.17	0.17	0.08	0.14	0.11	0.13	0.20	0.16
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product										
Constitution, W %										
Batch Still Distillate from Slurry Product	56.2	28.5	25.5	24.2	18.7	21.4		40.2	22.0	19.0
Batch Still Residue from Filtrate	43.8	71.5	74.5	75.8	82.2	78.6		59.8	78.0	81.0
Composition, W % (Calculated)										
Carbon					88.19					
Hydrogen					6.89					
Nitrogen					1.04					
Sulfur	0.32	0.59	0.57	0.67	0.67	0.60		0.61	0.75	0.80
Ash	0.01	0.23	0.09	0.05	0.01	0.05		0.02	0.12	0.15
Calculated Composition of 400°F+ Liquid Product										
Constitution, W %										
Atmospheric Still Overhead 400°F+	24.9	34.2	23.3	19.7	25.5	27.2		20.9	28.5	32.6
Atmospheric Bottoms Plus Vacuum Overhead Less Make-Up	-30.4	-12.5	3.6	4.4	2.0	-8.5		16.8	-9.0	-24.4
Vacuum Still Bottoms Solids-Free Oil	105.6	78.3	73.2	75.8	72.5	81.3		62.3	80.5	91.9
Composition										
Sulfur, W %	0.37	0.53	0.44	0.55	0.54	0.54		0.49	0.67	0.78

RUN 130-69 - H-COAL OPERATIONS ON BURNING STAR MINE, ILLINOIS NO.6 COAL (PERIOD 12-19, HRI NO.3663 - PERIOD 20-23, HRI NO.3689)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates, HRI No.3556, 46.7 Pounds (Dry)

Reactor Liquid Phase Depth, 191 - Volume 3.7 Ft^3

Period	12	13	14	15	16	17	18	19	20	21	22	23
Hours of Run - Beginning	258	282	306	330	354	378	402	426	450	474	498	522
End	282	306	330	354	378	402	426	450	474	498	522	546
Catalyst Age, Lbs Coal/Lb Catalyst - Beginning	564	620	676	734	793	851	913	986	1068	1149	1241	1335
End	620	676	734	793	851	913	986	1068	1149	1241	1335	1432
Coal Feed Rate, Lbs Dry Coal/Hr/Ft^3 Reactor Liquid Phase	28.9	28.8	29.7	30.4	30.2	31.9	37.6	39.8	42.0	47.5	48.6	49.6
Feed Coal												
Moisture, W %	1.77	2.07	2.11	1.64	1.89	1.60	2.34	2.26	2.59	1.64	1.88	2.37
Ash, % (Dry Basis)	10.97	10.74	11.16	11.18	10.62	10.96	11.29	11.09	10.71	10.61	10.62	10.77
Recycle Flows, Lbs/Lb Coal												
Atmospheric Still Bottoms	1.57	1.62	1.47	1.40	1.50	1.74	1.89	1.86	1.92	1.93	2.14	2.17
Vacuum Still Overhead	0.68	0.64	0.62	0.61	0.57	0.43	0.30	0.27	0.22	0.19	0.19	0.12
Total	2.25	2.26	2.09	2.01	2.07	2.17	2.19	2.13	2.14	2.12	2.33	2.29
Temperatures, °F												
Coal Preheater Outlet	691	695	697	693	697	700	708	717	721	725	719	726
Reactor Liquid Phase Average	827	811	833	838	838	838	837	838	838	838	837	840
Vacuum Flash Zone	594	597	584	598	600	599	603	603	606	614	620	590
Pressure In Vacuum Flash, Torr	14.9	13.4	13.5	14	12.8	12.4	12.0	12.2	12.6	12.8	13.5	14.2
Pressure, psig												
Unit Back Pressure	2690	2675	2700	2700	2700	2700	2695	2700	2700	2695	2700	2700
Hydrogen Make-Up	2780	2765	2785	2775	2785	2780	2765	2770	2780	2760	2710	2765
Hydrogen Partial Pressure (Reactor Outlet)	1920	1905	1885	1920	1875	1920	1365	1925	1955	1900	1890	1870
Recycle Gas, MSCF/Ton Coal	28.5	28.5	27.6	28.0	28.1	29.2	28.1	26.5	27.6	22.4	20.5	20.2
Vent Gas, MSCF/Ton Coal	3.8	3.8	3.6	3.6	3.7	3.4	3.0	2.9	2.6	2.4	2.4	2.5
Hydrogen Purity of Recycle + Vent Gas, %	92.7	92.8	91.2	91.8	92.2	93.7	93.8	94.4	95.0	93.9	95.1	94.0
Total Hydrogen, MSCF/Ton Coal (Reactor Outlet)	36.6	36.7	35.2	35.3	36.0	38.6	37.3	36.2	39.0	33.4	29.9	30.7
Make-Up Hydrogen + Recycle Hydrogen												
MSCF/Ton Coal	51.8	51.6	49.8	51.2	51.5	54.5	51.3	50.0	50.3	43.4	41.6	40.9
V % of Make-Up + Recycle Gas	96.1	95.9	95.3	95.7	95.9	96.7	96.7	97.1	97.4	97.0	97.7	97.1
Partial Pressure of Hydrogen, psig	2655	2650	2655	2655	2670	2690	2675	2690	2705	2675	2645	2685
Hydrogen Consumption - MSCF/Ton Dry Coal	15.5	15.1	14.9	16.2	15.8	16.2	14.3	14.1	11.6	10.2	11.9	10.5
W % Dry Coal	4.1	4.1	4.0	4.3	4.2	4.3	3.8	3.1	2.7	3.2	2.8	
Oil Additions												
Make-Up Oil, Lbs/Lb Dry Coal	0	0	0.164	0	0	0	0	0	0	0.037	0.076	0
Lbs/Hr/Ft^3 Reactor	0	0	4.86	0	0	0	0	0	0	1.76	3.69	0
Flush Oil, Lbs/Lb Dry Coal	0.019	0.019	0.018	0.018	0.017	0.016	0.014	0.014	0.013	0.011	0.011	0.011

RUN 130-69 - OPERATING RESULTS

Period	12	13	14	15	16	17	18	19	20	21	22	23
Collected Product Quantities, W % Dry Coal												
Atmospheric Still Overhead	27.9	28.9	32.3	29.2	26.8	24.4	20.8	22.3	21.6	19.9	18.0	18.0
Atmospheric Still Bottoms(1)	-1.7	-1.2	7.5	-2.0	1.5	0.8	-0.4	0.9	-1.9	-1.6	4.8	-4.7
Vacuum Still Overhead(1)	0.1	-0.1	3.5	-0.5	1.0	1.0	0.2	0.5	0.1	0.2	0.7	0.6
Vacuum Still Bottoms	57.3	57.7	57.2	54.5	54.5	59.1	63.2	61.2	62.2	64.3	70.2	70.8
O-S Liquid										2.8		
H_2O(2)	12.4	11.2	10.4	8.4	11.6	10.9	8.3	10.6	10.1	8.7	9.0	9.5
C_1-C_3	5.3	5.9	7.0	7.7	6.3	6.2	5.6	5.3	4.6	6.0	5.4	6.1
C_4-C_6	3.3	4.1	6.1	6.5	7.2	4.7	3.7	2.8	1.8	1.8	2.4	4.1
H_2S	1.4	1.7	1.7	2.0	2.0	2.2	1.9	1.8	1.5	2.1	2.2	2.2
CO_2 and CO	0.3	0.4	0.5	0.6	0.5	0.3	0.6	0.3	0.2	0.4	0.3	0.5
Total	106.3	108.6	126.2	106.4	111.4	109.6	103.9	105.7	100.2	104.6	113.0	107.1
Input Quantities, W % Dry Coal												
Dry Coal	100.0	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Moisture in Feed Coal	1.8	2.2	2.2	1.7	2.0	1.6	2.4	2.3	2.6	1.7	1.9	2.4
Oil Addition	0	0	16.4	0	0	0	0	0	0	3.7	7.6	0
Hydrogen Reacted (Gas Analyses, Flow)	4.1	4.1	4.0	5.4	4.2	4.3	3.8	3.8	3.1	2.7	3.2	2.8
Flush Oil	1.9	1.9	1.8	1.8	1.7	1.6	1.4	1.4	1.3	1.1	1.1	1.1
Total Used for Normalization	107.8	108.2	124.4	107.8	107.9	107.5	107.6	107.5	107.0	109.2	113.8	106.3
Normal H. Product Distribution(3)												
W % of Dry Coal												
CO, CO_2	0.3	0.3	0.5	0.5	0.5	0.3	0.6	0.3	0.3	0.5	0.3	0.5
C_1-C_3 Hydrocarbons in Gases	5.4	5.7	6.9	7.8	6.1	6.1	5.8	5.4	5.0	6.2	5.5	6.1
C_4-C_6 Hydrocarbons in Gases	3.4	4.3	6.0	6.6	6.9	4.6	3.8	2.8	1.9	1.9	2.5	4.1
IBP-400°F Naphtha	16.4	16.0	16.5	17.7	17.6	17.1	15.2	15.4	16.9	12.4	11.9	13.2
400-650°F Distillates	14.3	15.5	13.9	13.4	10.0	13.1	11.8	13.2	9.4	11.7	9.5	7.1
650-975°F Distillates					4.8							
975°F+ Residual Oil - Benzene-Soluble	21.8*	22.1*	21.4*	21.8*	21.1*	22.3*	23.8*	21.7*	23.5*	24.2*	25.5***	27.6***
Benzene-Insoluble	5.8	5.1	8.3	7.4	6.2	7.7	10.3	13.2	9.4	14.9	17.4	(14.2)
Unconverted Coal	12.4	12.5	9.3	9.6	9.0	11.2	12.4	10.2	14.8	10.2	9.7	(9.5)
Ash	12.1	11.6	11.5	11.4	10.7	10.7	12.0	11.2	12.3	11.0	11.6	(11.3)
H_2O (Net)	10.7**	9.0**	8.0**	6.9**	8.4	9.0**	6.2	8.5**	8.1**	7.5**	7.1**	6.9**
NH_3 (Forced Nitrogen)	*	**	**	**	0.8	**	**	**	**	**	**	**
H_2S (Forced Sulfur)	1.4**	1.8**	1.7**	2.0**	2.5	2.2**	2.0	1.9**	1.7**	2.2**	2.2**	2.2**
Total (100 + Hydrogen Reacted)	104.1	104.1	104.0	104.3	104.6	104.3	103.8	103.8	103.1	102.7	103.2	102.8

(1) Negative quantities of atmospheric still overhead and vacuum still overhead are decreases of inventory of slurry holding tank

(2) Includes dissolved NH_3 + H_2S

(3) ASTM Distillation cut points

*** Basis Period 26

* Basis Period 16 vacuum bottoms distillate content

** Water product contains some NH_3, H_2S

RUN 130-69 - ANALYSES

Period	12	13	14	15	16	17	18	19	20	21	22	23
Atmospheric Still Overhead												
Gravity, °API	32.9	33.7	33.3	33.5	36.1	36.0	35.3	35.0	34.2	32.0	34.5	35.1
IBP, °F	182	185	184	168	168	170	165	166	160	174	170	164
EP, °F	545	548	545	530	510	486	492	489	508	568	534	516
V % @ 400°F	60	58	54	62	64	73	73	70	75	61	68	76
Gravity, °API - IBP-400°F					40.3							
400°F-E.P.					24.3							
Carbon, W %					87.27							
Hydrogen, W %					11.96							
Nitrogen, W %/Sulfur, W %					0.12/0.09							
Phenols, V % - Total					5.0							
IBP-400°F					3.0							
Atmospheric Still Bottoms												
Gravity, °API	16.8	16.8	16.8	16.1	17.0	16.8	16.8	16.8	16.4	16.2	15.2	15.8
IBP, °F	457			476	468			448			415	
EP, °F	712			702	726			730				
V % @ 650°F	92			90	91			85			80	
Carbon, W %					88.32							
Hydrogen, W %					10.29							
Nitrogen, W %					0.09							
Sulfur, W %	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.07	0.07
Vacuum Still Overhead												
Gravity, °API	9.4	9.6	9.2	7.9	7.9	6.9	5.6	4.8	4.2	2.7	1.0	1.0
IBP, °F	529			532	(482)			536			540	
EP, °F					(955)							
V % @ 650°F	46			48	(39)			24			14	
Carbon, W %					90.07							
Hydrogen, W %					9.30							
Nitrogen, W %					0.25							
Sulfur, W %	0.06	0.04	0.10	0.06	0.11	0.13	0.13	0.17	0.20	0.25	0.23	0.27
Water												
Carbon, W %					2.12							
Nitrogen, W %					2.89							
Sulfur, W %					2.15							
Vacuum Still Bottoms												
W % of Flows from Vacuum Still	44.7	46.4	47.1	46.5	47.9	56.7	66.6	68.9	72.8	76.4	78.1	83.6
Benzene-Soluble, W %	47.78	48.92	48.31	50.28	51.04	49.00	46.60	44.16	44.10	46.00	45.39	49.76
Benzene-Insoluble, W %	31.42	30.76	31.33	29.09	28.75	32.51	35.01	37.58	36.41	37.51	38.33	34.03
Ash, W %	20.80	20.32	20.36	20.70	20.21	18.47	18.39	18.06	18.49	16.49	16.36	16.21
Unreacted Coal, W % (Estimated)	21.45	21.83	16.51	15.63	16.99	19.25	19.17	16.33	22.33	15.26	13.72	13.60
Benzene-Insoluble Residuum, W % (Estimated)	9.97	8.93	14.82	13.46	11.76	13.28	15.84	21.25	14.18	22.25	24.61	20.43
Carbon, W %					69.48							
Hydrogen, W %					5.12							
Nitrogen, W %					1.11							
Sulfur, W %	2.30	2.25	2.18	2.24	2.23	2.26	2.26	2.20	2.39	2.38	2.34	2.27
Oxygen, W % (By Difference)					1.85							
Pyridine-Soluble, W %					68.92							
Pyridine-Insoluble, W % (Inorganic)					10.97							
THF-Soluble, W %					65.68							
THF-Insoluble, W %					13.68							
Benzene-Soluble Oil - IBP, °F					725							
650-975°F, W %					21.4							
975°F+, W %					78.6							

RUN 130-69 - ANALYSES (CONTINUED)

Period	12	13	14	15	16	17	18	19	20	21	22	23
Filter Cake												
W % of Feed to Vacuum Still	29.8	32.7	46.6	29.4	31.0	28.8	35.9	*	*	*	*	*
Benzene-Soluble, W %	37.67	35.74	49.77	30.86	31.18	31.01	28.88	34.28	32.30	40.69	38.79	29.64
Benzene-Insoluble, W %	33.31	33.66	27.33	32.55	31.07	32.76	37.99	40.96	34.39	34.22	32.58	35.01
Ash, W %	29.02	30.60	22.90	36.59	37.75	36.23	33.13	24.76	33.31	25.09	28.63	35.35
Benzene-Insoluble Residuum, W %	2.91	2.18	2.72	2.88	2.56	2.30	3.46	1.13	4.27	4.05	6.09	5.36
Unreacted Coal, W % (Estimated)	30.40	31.56	24.61	29.67	28.51	30.46	34.53	39.83	30.12	30.17	26.49	29.65
Pyridine-Soluble, W %					46.62							
Pyridine-Insoluble, W %					18.37							
THF-Soluble, W %					42.18							
THF-Insoluble, W %					14.80							
Carbon, W %					48.69							
Hydrogen, W %					3.56							
Nitrogen, W %					0.62							
Sulfur, W %					3.20							
0-13 Bottoms (Feed to Vacuum Still)												
Ash, W %	9.67	9.75	9.60	10.08	11.02	10.45	11.72	13.38	13.58	9.01	12.89	13.03
Slurry Mixing Tank												
Ash, W %	3.42	2.81	3.28	3.54	3.64	3.37	3.74	3.71	3.63	3.40	2.90	3.27
Internal Recycle Slurry												
Ash, W %	6.42	7.07	6.84	8.00	9.05	9.01	7.83	8.98	8.38	8.24	7.91	7.34
Atmospheric Still Overhead												
400°F+ - Sulfur, W %	0.06	0.06	0.09	0.07	0.09	0.10	0.09	0.09	0.06	0.05	0.04	0.08
Vacuum Bottoms Benzene-Extracted Oil												
IBP-975°F												
Gravity, °API					-5.4							
Carbon, W %					89.35							
Hydrogen, W %					7.56							
Sulfur, W %					0.23							
Nitrogen, W %					0.70							
THF-Extracted Filter Cake												
Ash, W %					57.11							
Sulfur, W %					4.80							

* Filtered two parts 0-13 bottoms and one part vacuum overhead

RUN 130-69 - CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS

Period	12	13	14	15	16	17	18	19	20	21	22	23
Distillation of Filtrate from Filtration Operation												
Vacuum Distillation												
Final Vapor Temperature, °F	608	590	565	539	580	580	580	581	574	557	578	579
Pressure, Torr	0.6	2.0	1.4	1.8	2.2	2.0	2.2	1.8	1.2	1.2	1.6	1.2
Residue - W % of Filtrate	25.5	26.8	27.3	31.4	32.8	30.1	41.3	32.7	30.6	17.8	34.3	40.9
W % of Vacuum Bottoms Slurry	40.0	38.9	31.0	47.7	47.2	37.8	39.7	58.8	46.1	27.2	48.7	55.7
Analysis Carbon, W %					87.85							
Hydrogen, W %					6.67							
Nitrogen, W %					1.35							
Sulfur, W %	1.00	0.93	0.94	0.86	0.94	0.95	1.00	1.06	0.98	1.21	1.16	1.25
Ash, W %	1.01	0.20	0.07	0.05	0.05	0.96	0.03	0.65	0.15	0.79	0.08	0.75
Batch Distillation of Vacuum Bottoms Slurry Product												
Vacuum Distillation												
Final Vapor Temperature, °F	560	471	505	441	479	512	520	460	498	455	483	481
Pressure, Torr	2.0	2.4	3.0	2.4	9	2.2	5.0	4.3	3.0	11.0	3.4	8.6
Distillate, W % of Vacuum Bottoms Slurry	10.0	4.7	5.0	1.2	5.2	6.8	5.7	6.9	6.0	6.1	9.0	3.5
Analysis Gravity, °API	1.5	0.6	-1.9	4.4	-1.3	-1.2	-1.0	-2.0	-3.2	-1.7	-4.2	-4.0
Carbon, W %					88.02							
Hydrogen, W %					8.46							
Nitrogen, W %					0.59							
Sulfur, W %	0.39	0.19	0.39	0.21	0.31	0.23	0.25	0.42	0.39	0.28	0.56	0.56
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product												
Constitution, W %												
Batch Still Distillate from Slurry Product	20.0	10.8	13.9	2.5	9.9	15.2	12.6	10.5	11.5	18.3	15.6	5.9
Batch Still Residue from Filtrate	80.0	89.2	86.1	97.5	90.1	84.8	87.4	89.5	88.5	81.7	84.4	94.1
Composition, W % (Calculated)												
Carbon					87.87							
Hydrogen					6.85							
Nitrogen					1.27							
Sulfur	0.88	0.85	0.86	0.84	0.88	0.85	0.91	0.95	0.91	1.04	1.07	1.21
Ash	0.81	0.18	0.06	0.05	0.05	0.81	0.03	0.58	0.13	0.65	0.07	0.71
Calculated Composition of 400°F+ Liquid Product												
Constitution, W %												
Atmospheric Still Overhead, 400°F+	28.4	29.7	35.2	27.6	19.7	16.0	13.5	15.0	14.7	17.1	11.8	9.4
Atmospheric Bottoms Plus Vacuum Overhead Less Make-Up	-8.4	-7.5	-16.7	-10.1	1.9	0.2	-2.0	0.2	-7.6	-7.1	-6.1	-9.2
Vacuum Still Bottoms Solids-Free Oil	80.0	77.8	81.5	82.4	78.4	83.8	88.5	84.8	92.9	90.0	94.3	99.8
Composition, W %												
Sulfur	0.73	0.68	0.73	0.68	0.71	0.74	0.83	0.85	0.86	1.00	1.02	1.21

RUN 130-69 - H-COAL OPERATIONS ON BURNING STAR MINE, ILLINOIS NO.6 COAL (HRI NO.3689)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates, HRI No.3556, 46.7 Pounds (Dry)

Reactor Liquid Phase Depth, 191 - Volume 3.7 Ft^3

Period	24	25	26	27	28	29	30	31	32	33	34	34B/35A
Hours of Run - Beginning	546	570	594	618	642	666	690	714	738	762	786	798
End	570	594	618	642	666	690	713	738	762	786	798	814
Catalyst Age, Lbs Coal/Lb Catalyst - Beginning	1432	1524	1614	1709	1805	1903	2013	2128	2255	2390	2524	2589
End	1524	1614	1709	1805	1903	2013	2128	2255	2390	2524	2661	2685
Coal Feed Rate, Lbs Dry Coal/Hr/Ft^3 Reactor Liquid Phase	47.4	46.3	49.0	49.5	50.4	56.8	59.3	64.8	68.4	68.6	70.4	73.7
Feed Coal												
Moisture, W %	2.35	2.05	1.63	2.01	2.20	2.12	2.13	2.89	3.66	2.98	2.27	2.57
Ash, % (Dry Basis)	11.01	10.96	11.04	11.52	10.98	10.52	10.96	12.31	11.05	10.59	10.87	10.87
Recycle Flows, Lbs/Lb Coal												
Atmospheric Still Bottoms	2.27	2.39	2.27	2.34	2.28	1.97	2.08	2.17	2.10	2.12	2.03	1.93
Vacuum Still Overhead	0.08	0.14	0.12	0.12	0.13	0.18	0.07	0.04	0.03	0.02	0.004	
Total	2.35	2.53	2.39	2.46	2.41	2.15	2.15	2.21	2.13	2.14	2.03	1.93
Temperatures, °F												
Coal Preheater Outlet	733	735	738	742	741	719	727	738	736	741	746	745
Reactor Liquid Phase Average	842	845	847	847	847	848	848	849	848	848	846	845
Vacuum Flash Zone	585	617	609	602	602	582	542	579	585	567	579	573
Pressure in Vacuum Flash, Torr	13.0	13.1	13.2	12.7	12.9	12.7	13.4	43.1	94	63	24	28
Pressure, psig												
Unit Back Pressure	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2695
Hydrogen Make-Up	2765	2770	2775	2775	2780	2785	2775	2790	2790	2790	2790	2775
Hydrogen Partial Pressure (Reactor Outlet)	1835	1810	1810	1795	1765	1730	1720	1760	1640			
Recycle Gas, MSCF/Ton Coal	20.6	21.2	20.6	19.8	19.4	16.8	16.1	15.6	13.7	13.0	13.1	12.3
Vent Gas, MSCF/Ton Coal	2.7	2.6	2.3	2.1	2.2	1.7	1.6	1.8	1.6	2.0	1.6	1.5
Hydrogen Purity of Recycle + Vent Gas, %	93.3	93.7	92.9	93.3	92.8	93.1	93.0	93.8	93.0	93.2	93.3	93.5
Total Hydrogen, MSCF/Ton Coal (Reactor Outlet)	30.3	32.0	30.5	30.2	29.6	25.1	25.3	26.0	23.5	23.2	23.6	22.6
Make-Up Hydrogen + Recycle Hydrogen												
MSCF/Ton Coal	42.1	42.7	41.5	41.0	40.4	36.5	35.5	34.9	32.1	32.0	31.5	29.9
V % of Make-Up + Recycle Gas	96.8	97.0	96.6	96.9	96.7	96.9	96.9	97.3	97.1	97.3	97.3	97.4
Partial Pressure of Hydrogen, psig	2670	2685	2680	2690	2685	2700	2690	2715	2710	2720	2720	2700
Hydrogen Consumption - MSCF/Ton Dry Coal	12.1	11.0	11.2	11.0	11.1	11.5	10.4	9.2	9.0	9.1	8.1	7.5
W % Dry Coal	3.2	2.9	3.0	2.9	3.0	3.1	2.8	2.4	2.4	2.4	2.1	2.0
Oil Additions												
Make-Up Oil, Lbs/Lb Dry Coal	0.152	0.018	0	0.045	0.045**	0.302	0.123	0.050	0.084	0.073	0.100	0.094
Lbs/Hr/Ft^3 Reactor	7.22	0.84	0	2.25	2.25	17.1	7.26	3.27	5.74	5.01	7.00	6.56
Vacuum Overhead Blend												
Flush Oil, Lbs/Lb Dry Coal	0.011	0.011	0.011	0.010	0.010	0.009	0.009	0.008	0.008	0.008	0.008	0.007
Venturi Oil, Lbs/Lb Dry Coal								0.009	0.002	0.006	0.017	0.017

**Hydrogenated anthracene oil

RUN 130-69 - OPERATING RESULTS

Period	24	25	26	27	28	29	30	31	32	33	34	34B/35A
Collected Product Quantities, W % Dry Coal												
Atmospheric Still Overhead	19.3	18.6	17.5	17.4	18.6	14.7	17.9	14.9	14.8	14.1	14.7	12.9
Atmospheric Still Bottoms(1)	5.5	-4.4	-2.4	1.1	-0.5	16.9	-1.4	-3.8	1.7	-0.6	1.7	1.3
Vacuum Still Overhead(1)	0.6	0.2	0.2	0.4	0.3	1.9	1.0	0.6	0.8	0.3	0.2	
Vacuum Still Bottoms	78.6	66.5	68.0	70.1	70.2	74.7	80.8	77.9	79.7	79.6	84.4	82.2
0-5 Liquid						5.9						
H_2O(2)	9.3	9.9	8.2	8.6	8.5	9.1	8.2	7.3	8.9	7.3	8.8	6.9
C_1-C_3	4.7	5.6	5.3	5.3	6.1	5.9	5.6	5.6	5.1	5.9	5.3	5.0
C_4-C_6	5.3	5.7	6.5	5.7	6.9	7.8	6.9	5.6	6.1	5.9	5.7	4.2
H_2S	1.8	1.8	2.1	2.1	2.5	2.3	2.3	2.3	2.1	2.2	2.3	2.2
CO_2 and CO	0.8	0.8	0.9	0.8	0.9	1.0	1.0	1.2	1.6	1.3	1.2	1.2
Total	125.9	104.7	106.3	111.5	113.5	140.2	122.3	112.3	120.1	116.0	124.3	115.9
Input Quantities, W % Dry Coal												
Dry Coal	100.0	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Moisture in Feed Coal	2.4	2.1	1.7	2.1	2.3	2.2	2.1	3.0	3.8	3.1	2.3	2.6
Oil Addition	15.2	1.8	0	4.5	4.5	30.2	12.1	5.0	8.3	7.3	10.0	9.4
Hydrogen Reacted (Gas Analyses, Flow)	3.2	2.9	3.0	3.0	3.0	3.1	2.8	2.4	2.4	2.4	2.1	2.0
Flush Oil	1.1	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.7
Venturi Oil (Vacuum Overhead Blend)								0.9	0.2	0.6	1.7	1.7
Total Used for Normalization Basis	121.9	107.9	105.8	110.6	110.8	136.4	118.2	112.1	115.5	114.2	116.9	116.4
Normal Net Product Distribution(3)												
W % of Dry Coal												
CO, CO_2	0.7	0.8	0.9	0.8	0.9	1.0	1.0	1.2	1.5	1.3	1.2	1.2
C_1-C_3 Hydrocarbons in Gases	4.6	5.8	5.2	5.3	5.9	5.7	5.5	5.6	4.9	5.8	5.0	5.0
C_4-C_6 Hydrocarbons in Gases	5.1	5.8	8.2	5.7	6.7	7.6	6.7	5.6	5.9	5.8	5.3	4.3
IBP-400°F Naphtha	12.7	14.7	13.4	12.8	14.3	7.6	10.7	9.2	10.0	9.8	10.3	9.6
400-650°F Distillates	3.1	4.1	1.8	6.9	4.9	7.7	7.7	10.6	10.0	9.0	7.1	-0.6
650-975°F Distillates			5.3									8.5
975°F+ Residual Oil - Benzene-Soluble	29.4*	27.0*	26.2	26.3*	26.7*	31.9***	28.2***	27.4***	25.7***	26.8***	27.2***	28.6
Benzene-Insoluble	13.2	14.2	13.7	16.0	15.7	8.3	16.7	15.7	15.3	16.9	14.6	15.4
Unconverted Coal	13.5	9.2	8.7	9.4	8.5	12.8	7.9	8.7	11.2	9.9	12.7	13.4
Ash	12.6	11.2	11.2	11.2	11.0	11.6	10.6	11.5	11.2	10.8	10.7	11.2
H_2O (Net)	6.7***	8.1***	6.0	6.4***	6.0***	6.7***	5.7***	4.4***	4.7***	4.1***	6.0***	4.2
NH_3 (Forced Nitrogen)	***	***	0.36	***	***	***	***	***	***	***	***	0.13
H_2S (Forced Sulfur)	1.8***	1.9***	2.22	2.1***	2.4***	2.2***	2.2***	2.2***	2.0***	2.2***	2.2***	1.94
Total (100 + Hydrogen Reacted)	103.2	102.9	103.2	103.0	103.0	103.1	102.8	102.4	102.4	102.4	102.1	102.9

(1) Negative quantities of atmospheric still overhead and vacuum still overhead are decreases of inventory of slurry holding tank

(2) Includes dissolved NH_3 + H_2S

(3) ASTM Distillation cut points

*** Basis Period 34

*** Water product contains some NH_3, H_2S

* Basis Period 26 vacuum bottoms distillates

RUN 130-69 - ANALYSES

Period	24	25	26	27	28	29	30	31	32	33	34	34B/35A
Atmospheric Still Overhead												
Gravity, °API	35.3	36.4	36.7	36.5	35.8	30.1	32.8	33.3	34.6	34.0	32.8	33.1
IBP, °F	175	170	165	188	159	153	166	160	146	150	144	149
EP, °F	498	490	487	506	497	628	566	534	516	526	486	488
V % @ 400°F	70	78	80	76	80	55	64	64	75	72	76	75
Gravity, °API - IBP-400°F			39.2								36.9	
400°F-E.P.			24.7								20.4	
Carbon, W %			86.93								86.47	
Hydrogen, W %			12.23								11.36	
Nitrogen, W %/Sulfur, W %			0.06/0.11								0.12/0.16	
Phenols, V % Total			3.5									
V % IBP-400°F			3.0									
Atmospheric Still Bottoms												
Gravity, °API	15.8	16.2	16.4	15.9	15.4	10.9	12.0	12.6	13.2	13.0	12.5	12.4
IBP, °F			(373)								(335)	
EP, °F			(755)								(780)	
V % @ 650°F			85								86	
Gravity, °API - IBP-650°F											13.1	
650°F+											2.5	
Carbon, W %			89.20								89.34	
Hydrogen, W %			10.18								9.53	
Nitrogen, W %			0.17								0.26	
Sulfur, W %	0.06	0.08	0.11	0.09	0.14	0.13	0.12	0.12	0.12	0.08	0.14	0.15
Vacuum Still Overhead												
Gravity, °API	4.4	2.6	1.7	1.5	0.9	-1.0	0.9	1.7	3.4	4.8	4.9	4.9
IBP, °F			(396)		506		(480)					
EP, °F			(950)				(882)					
V % @ 650°F			29		35		(40)					
Gravity, °API - IBP-650°F			5.5									
650°F+			0.7									
Carbon, W %			89.03									
Hydrogen, W %			8.57									
Nitrogen, W %			0.31									
Sulfur, W %	0.24	0.31	0.25	0.25	0.32	0.21	0.26	0.26	0.23	0.19		0.24
Water												
Carbon, W %			1.85									
Nitrogen, W %			1.58								1.03	
Sulfur, W %			1.16								0.75	
Vacuum Still Bottoms												
W % of Flows from Vacuum Still	90.1	81.9	84.4	85.0	84.0	79.9	91.5	93.9	94.8	97.6	99.2	100.0
Benzene-Soluble, W %	48.44	49.37	49.48	47.30	48.73	55.02	54.87	53.48	50.82	52.02	52.16	52.16
Benzene-Insoluble, W %	35.04	34.24	33.72	36.54	35.29	28.95	31.47	31.68	34.55	34.21	34.40	34.40
Ash, W %	16.52	16.39	16.80	16.16	15.98	16.03	13.66	14.84	14.63	13.77	13.44	13.44
Unreacted Coal, W % (Estimated)	17.70	13.46	13.04	13.48	12.45	17.56	10.09	11.44	14.66	12.61		16.04
Benzene-Insoluble Residuum, W % (Estimated)	17.34	20.78	20.68	23.06	22.84	11.39	21.38	20.24	19.89	21.60		18.36
Carbon, W %			72.05								74.45	74.45
Hydrogen, W %			5.05								5.63	5.63
Nitrogen, W %			1.43								1.52	1.52
Sulfur, W %	2.19	2.28	2.24	2.32	2.39	2.24	2.04	2.25	2.22	2.09	2.05	2.09
Oxygen, W % (By Difference)			2.43									
THF-Soluble, W %			67.96									
THF-Insoluble, W % (Organic)			16.24									
Benzene-Soluble Oil - IBP, °F			810									585
IBP-650°F, W %			0.0									3.0
650-975°F, W %			20.2									31.2
975°F+, W %			79.8									65.8

RUN 130-69 - ANALYSES (CONTINUED)

Period	24	25	26	27	28	29	30	31	32	33	34	34B/35A
Filter Cake												
W % of Feed to Vacuum Still		*	*	*	*	*	19.8	*	*	*	*	**
Benzene-Soluble, W %		45.53	55.18	34.06	37.15	28.11	29.06	30.70	29.26	28.99	34.57	31.58
Benzene-Insoluble, W %		30.49	31.32	30.95	31.10	33.42	33.20	31.72	32.83	32.34	35.77	38.96
Ash, W %		23.98	33.50	34.99	31.75	38.47	37.74	37.58	37.91	33.67	34.57	29.46
Benzene-Insoluble Residuum, W %		4.79	3.80	3.80	4.61	3.46	6.39	3.96	3.60	3.61	4.11	3.81
Unreacted Coal, W % (Estimated)		25.70	27.52	27.15	26.49	29.96	26.81	27.76	29.23	33.73	31.67	35.15
THF-Soluble, W %			40.23									
THF-Insoluble, W % (Organic)			26.58									
Sulfur, W %			3.21									2.89
0-13 Bottoms (Feed to vacuum Still)												
Ash, W %	14.46	14.07	14.02	14.75	14.28	14.26	12.70	13.17	14.17	14.45	14.23	
Slurry Mixing Tank												
Ash, W %	3.04	3.12	3.22	3.13	3.13	3.03	3.27	3.61	3.60	3.48	3.28	3.78
Internal Recycle Slurry												
Ash, W %		7.80	5.41	9.98	7.50	8.76	7.70	7.16	7.92	8.75	7.14	
Atmospheric Still Overhead												
IBP-400°F												
Sulfur, W %			0.12									0.15
Nitrogen, W %			0.05									0.04
400°F+												
Sulfur, W %	0.11	0.09	0.10	0.14	0.18	0.14	0.12	0.11	0.13	0.11	0.05	0.08
Nitrogen, W %			0.13									0.20
Vacuum Overhead												
IBP-650°F												
Gravity, °API			5.5									
Sulfur, W %			0.09									
650°F+												
Gravity, °API			0.7									
Sulfur, W %			0.39									
Vacuum Bottoms Benzene-Extracted Oil												
IBP-975°F												
Gravity, °API			-7.2									-4.8
Sulfur, W %			0.76									0.60
Nitrogen, W %			0.77									0.61
975°F+												
Sulfur, W %			1.25									
THF-Extracted Filter Cake												
Ash, W %			55.53									

* Filtered one part 0-13 bottoms and one part vacuum overhead

** Filtered one part vacuum bottoms and one part vacuum overhead

RUN 130-69 - CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS

Period	24	25	26	27	28	29	30	31	32	33	34	34B/35A
Distillation of Filtrate from Filtration Operation												
Vacuum Distillation												
Final Vapor Temperature, °F	521		581	470	569	538	525	526	522	506	516	528
Pressure, Torr	1.4		2.2	1.6	2.6	1.4	1.8	2.8	2.0	3.1	1.6	2.2
Residue												
W % of Filtrate	34.0	**	28.7	Incomplete	32.6	31.5	54.6	32.3	34.5	36.9	35.7	33.9
W % of Vacuum Bottoms Slurry	44.2		54.3		59.8	64.5	47.9	57.0	59.8	59.9	58.7	53.5
Analysis												
Sulfur, W %			1.25	0.98	1.33	1.25	1.75	1.33	1.32	1.25	1.22	1.24
Nitrogen, W %												1.47
Ash, W %			1.07	1.35	2.41	0.90	7.77	0.66	0.35	0.48	0.40	0.54
Batch Distillation of Vacuum Bottoms Slurry Product												
Vacuum Distillation												
Final Vapor Temperature, °F		382	*	456	460			521	517	509	509	519
Pressure, Torr		12.6		3.0	4.3			2.2	1.4	0.3	0.4	0.4
Distillate, W % of Vacuum Bottoms Slurry		3.7	10.0	2.7	4.5			8.0	11.3	12.5	14.3	17.3
Analysis												
Gravity, °API		-0.5	-7.2	-4.8	-3.0			-6.0	-4.8	-5.1	-5.3	-3.6
Nitrogen, W %			0.77									0.76
Sulfur, W %		0.52	0.76	0.39	0.56			0.64	0.62	0.71	0.66	0.55
Calculated Composition of Solids-Free Oil In Vacuum Bottoms Slurry Product												
Constitution, W %												
Batch Still Distillate from Slurry Product					7.0			12.3	15.9	17.3	19.6	24.4
Batch Still Residue from Filtrate					93.0			87.7	84.1	82.7	80.4	75.6
Composition, W % (Calculated)												
Nitrogen			1.28									1.30
Sulfur			1.17		1.28			1.25	1.21	1.16	1.11	1.07
Ash					2.24			0.58	0.29	0.40	0.32	0.41
Calculated Composition of 400°F+ Liquid Product												
Constitution, W %												
Atmospheric Still Overhead 400°F+	13.2	9.9	7.7	8.9	8.3	14.0	12.6	10.4	7.1	7.8	7.2	6.8
Atmospheric Bottoms Plus Vacuum Overhead Less Make-Up	-22.8	-15.9	-6.9	-8.3	-12.1	-14.8	-25.7	-17.1	-13.5	-17.0	-21.7	-20.4
Vacuum Still Bottoms Solids-Free Oil	109.6	106.0	99.2	99.4	103.8	100.8	113.1	106.7	106.5	109.2	114.5	113.6
Composition, W %												
Sulfur, W %			1.16		1.24	1.17		1.27	1.20	1.19	1.19	1.14

* IBP-975°F from distillation of benzene-soluble oil

** Paper broke

PDU RUN 1 - ILLINOIS NO. 6 COAL - FUEL OIL MODE

The objective of this run was to demonstrate sustained fuel oil mode operation with residuum recycle from the hydroclone.

The unit fed coal continuously for a period of 534 hours to a catalyst age of 3060 lbs coal/lb catalyst. The hydroclone system was in operation from the start of the fourth day until shutdown. Hydroclone overflow recycle was initiated at about 0.9 lb/lb coal and held at that level for about 300 hours. It was brought up to about 1.2 lbs/lb for the last 200 hours. The 400°F$^+$ fuel oil product had a sulfur level of about 0.6 W % at the start of the run and this slowly increased to 1.0 W % as the catalyst deactivated. The target value of 0.7 W % was achieved at a catalyst age of about 1000 lbs coal/lb catalyst. Conversion held at the 91-92% level throughout. Total 400°F$^+$ fuel oil yield was relatively constant at about 55 W % of dry coal.

RUN-130-73 H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO.6 COAL (HRI 3721/3751)

CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDES (HRI No.3556), 45.1 POUNDS DRY

REACTOR LIQUID PHASE DEPTH - 19 FEET - VOLUME - 3.7 FT^3

Period	1	2A	2B	3	4A	4B	5	6	7	8	9	10
Hours of Run - Beginning	0	6	18	30	54	66	78	102	126	150	174	198
- End	6	18	30	54	66	78	102	126	150	174	198	223
Catalyst Age, lb Dry Coal/lb Catalyst												
Beginning	0	41	102	167	300	357	412	548	679	813	952	1090
End	41	102	167	300	357	412	548	679	813	952	1090	1236
Dry Coal Feed Rate, lbs/Hr/Ft^3												
Reactor Liquid Phase	47.2	59.7	64.1	66.0	69.4	68.7	69.0	66.4	68.3	70.7	69.9	71.4
lbs/Hr/Ft^3 Settled Catalyst	131.7	166.6	178.8	184.1	193.6	191.7	192.5	185.3	190.6	197.3	195.0	199.2
Feed Coal												
W % Moisture	3.17	4.48		2.24		2.57	2.55	3.26	3.95	3.76	3.50	2.56
% Ash (Dry Basis)	10.90	11.43		11.32		11.87	11.57	11.65	11.54	11.54	11.12	10.82
Recycle Flows, lbs/lb Solids												
Atmospheric Still Bottoms	1.49	1.48	1.98	1.91	1.93	1.82	1.35	1.33	1.11	1.12	1.12	1.07
Vacuum Still Overhead	0.33	0.20	0.20	0.17	0.13	0.06	0.01	0.01	0.02	0.06	0.01	0
Inventory Change	0	-0.12	0	-0.01	0.03	0.06	0.04	0.02	0	0.01	0.02	-0.02
Hydroclone Overflow (Oil)	0	0	0	0	0	0.45	0.77	0.81	0.86	0.80	0.82	0.87
Total	1.82	1.80	2.18	2.09	2.03	2.27	2.09	2.13	1.99	1.97	1.93	1.96
Temperatures, °F												
Coal Preheater Outlet	666	664	691	697	702	707	705	701	700	701	705	706
Reactor Liquid Phase Average	797	825	846	849	850	849	851	848	849	849	849	848
Vacuum Flash Zone	455	569	554	544	537	525	606	593	604	607	588	597
Pressure in Vac. Flash, Torr	18.2	16.9	16.3	16.2	16.2	25	12	12.3	11.6	10.6	10.0	10.0
Hydroclone	--	--	--	--	--	450	456	467	500	510	533	533
Pressure, psig												
Unit Back Pressure	2700	2700	2680	2700	2700	2700	2700	2700	2700	2695	2695	2700
Hydrogen Make-Up	2735	2735	2740	2750	2750	2750	2795	2800	2800	2800	2795	2800
Hydrogen Partial Pressure (Reactor Outlet)			1505	1670		1485	1425	1480	1560	1505	1480	1440
Recycle Gas, MSCF/Ton Dry Coal		13.6	11.5	9.9	9.4	9.5	8.6	8.8	9.0	9.2	8.7	8.5
Vent Gas, MSCF/Ton Dry Coal		1.55	1.56	1.71	1.65	1.44	1.49	1.08	1.75	1.65	1.86	1.42
H_2 Purity of Recycle Gas & Vent, %		94.5	93.0	91.8	92.8	92.2	92.2	91.4	91.8	90.0	91.8	91.0
Total H_2, MSCF/Ton Dry Coal (Reactor Outlet)		19.2	17.1	15.7	15.4	15.8	15.3	15.8	15.8	15.4	16.2	15.3
Make-Up H_2 + Recycle H_2												
MSCF/Ton Dry Coal		31.5	31.4	28.8	27.9	29.0	28.3	28.4	27.4	27.1	27.1	26.4
V % of Make-Up & Recycle Gas		97.7	97.5	97.3	97.6	97.5	97.7	97.4	97.4	96.7	97.4	97.2
H_2 Partial Pressure, psig		2670	2670	2675	2685	2680	2730	2725	2725	2705	2720	2720
H_2 Consumption												
MSCF/Ton Dry Coal		12.3	14.3	13.1	12.5	13.2	13.0	12.6	11.6	11.7	10.9	11.1
W % Dry Coal		3.3	3.8	3.5	3.3	3.5	3.5	3.4	3.1	3.1	2.9	3.0
Oil Additions												
Make-Up Oil, lbs/lb Dry coal	0	0	0	0	0	0	0	0	0	0	0	0
lb/Hr/Ft^3 Reactor	0	0	0	0	0	0	0	0	0	0	0	0
Flush Oil, lbs/lb/ Dry coal	0.005	0.004	0.003	0.003	0.003	0.004	0.003	0.003	0.003	0.003	0.003	0.003

RUN 130-73 - OPERATING RESULTS

Period	1	2A	2B	3	4A	4B	5	6	7	8	9	10
Collected Product Quantities, W % Dry Coal												
Atmospheric Still Overhead	0	6.8	13.8	15.1	13.7	13.9	12.8	18.1	12.9	16.8	14.8	14.8
Atmospheric Still Bottoms(1)	0.9	-10.4	0.7	-0.9	3.0	6.7	17.3	3.4	15.5	1.9	11.5	7.3
Vacuum Still Overhead(1)	0	-1.2	0.5	0.2	0.5	0.5	0.4	3.0	0.4	0.5	0.5	0.4
Vacuum Still Bottoms	84.4	72.5	67.8	67.0	67.4	62.3	53.9	59.9	57.7	65.9	60.9	60.8
H_2O(2)	-1.3	5.7	10.3	11.6	11.3	8.3	11.1	11.0	9.2	10.6	10.8	11.9
C_1-C_3		3.3	4.3	4.3	4.0	4.7	4.9	5.0	5.2	5.5	4.7	4.8
C_4-C_6		2.6	4.0	3.5	3.0	4.0	3.9	5.0	4.0	4.1	4.4	3.5
H_2S		1.4	1.5	1.4	1.5	1.9	1.6	1.6	1.9	1.9	1.6	1.6
CO_2 and CO		0.4	0.5	0.8	0.6	0.7	0.6	0.9	0.8	0.9	0.9	0.7
Total		81.1	103.4	103.0	105.0	103.0	106.5	107.9	107.6	108.1	110.1	105.8
Input Quantities, W % Dry Coal												
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture In Feed Coal	3.3	4.7	3.5	2.3	2.6	2.7	2.6	3.4	4.1	3.9	3.6	2.6
Make up Oil Additions	0	0	0	0	0	0	0	0	0	0	0	0
Flush Oil	0.5	0.4	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3
H_2Reacted (H_2 Gas Analysis Flow)		3.3	3.8	3.5	3.3	3.5	3.5	3.4	3.1	3.1	2.9	3.0
Total Used for Normalization		108.4	107.6	106.1	106.2	106.6	106.4	107.1	107.5	107.3	106.8	105.9
Coal Conversion (HHI Filtration)			90.6	90.9		89.0	91.5	91.0	91.3	89.6	90.9	90.6
Normalized Net Product Distribution(3)												
W % Dry Coal												
CO,CO_2			0.5	0.8	0.6	0.7	0.64	0.9	0.7	0.9	0.83	0.8
C_1-C_3 Hydrocarbons In Gases			4.5	4.4	4.0	4.8	4.95	4.9	5.1	5.5	4.60	4.7
C_4-C_6 Hydrocarbons In Gases			4.1	3.6	3.0	4.1	2.89	5.0	3.8	4.1	4.24	4.3
100-400°F Naphtha			10.5	12.1	11.1	11.6	12.12	13.9	10.2	12.7	10.48	11.0
400-650°F Distillates			4.4	2.3	5.5	9.0	13.98	8.6	13.7	5.6	12.02	11.9
650-975°F Distillates							9.29				9.30	
975°F + Residual Oil			40.8	35.8	36.2	34.7		30.9	30.4	31.4		30.6
Benzene Soluble							22.29				23.49	
Benzene Insoluble			8.6	10.8	10.8	7.4	7.16	9.9	10.0	13.3	10.31	11.9
Unconverted Coal			8.1	9.6	9.6	12.0	8.17	8.1	7.9	8.6	7.45	7.5
Ash			12.4	12.1	12.1	11.2	11.37	12.0	12.0	12.6	11.46	12.2
H_2O (Net)			8.1*	10.2*	8.8*	6.0*	7.94	7.5*	7.3*	6.6*	6.26	8.8*
NH_3 (Forced Nitrogen)			*	*	*	*	0.64	*	*	*	0.66	*
H_2S (Forced Sulfur)			1.6*	1.5	1.5*	1.9*	2.32	1.6*	1.9*	1.9*	2.40	1.6*
Total (100+H_2Reacted)			103.6	103.3	103.2	103.3	103.75**	103.3	103.0	103.2	103.50**	103.0

(1) Negative Quantities of Atmospheric Still Overhead and Vacuum Overhead are Decreases of Inventory of Slurry Oil Holding Tank.

(2) Includes Dissolved NH_3&H_2S

(3) ASTM Distillation Cut Points

* Water Product Contains NH_3, H_2S

** Hydrogen Consumption by Coal Feed and Product Hydrogen Analyses

Period	1	2A	2B	3	4A	4B	5	6	7	8	9	10
Atmospheric Still Overhead												
Gravity, °API			38.1	39.4	41.1	41.1	41.1	38.2	39.6	39.1	37.1	38.3
IBP, °F			152	158		155	140	141	151	162	139	164
EP, °F			540	548		492	516	521	505	508	527	520
V % @400°F			76	80		82	86	79	81	78	7[illegible]	77
Gravity, IBP-400°F °API							43.7				42.[illegible]	
400°F-EP, °API							23.1				23.9	
Carbon, W %							87.68				87.37	
Hydrogen, W %							12.48				12.38	
Nitrogen, W %							0.10				0.06	
Sulfur, W %							0.16				0.16	
Phenols, V % Total							2.0				5.0	
V % IBP-400°F							1.0				4.0	
Atmospheric Still Bottoms												
Gravity, °API	12.7	15.2	15.2	16.2	16.6	16.8	15.4	14.7	13.7	13.6	12.8	12.3
IBP, °F	420		405	396		396	380	402	396	415	406	420
EP, °F			735	720		710	818				925	
V % @ 400°F	-		-	<1		<1	8	-	<1	-	-	-
V % @ 650°F	86		90	90		89	82	80	76	73	76	70
Gravity, IBP-650°F, °API							17.6				16.1	
650°F+, °API							4.2				3.4	
Carbon, W %							88.65				88.80	
Hydrogen, W %							9.97				9.59	
Nitrogen, W %							0.35				0.31	
Sulfur, W %	<0.03		<0.03	<0.03		<0.03	<0.03	<0.03	<0.03	<0.03	0.01	<0.03
Vacuum Still Overhead												
Gravity, °API	5.7	6.3	5.1	6.5	6.9	10.2	7.0	7.5	6.5	7.0	6.3	6.4
IBP, °F	480		515	468		446	434	408	414	400	437	442
EP, °F							975					986**
V % @ 650°F	49		46	56		72	40	52	46	48	40	44
Gravity, IBP-650 °F, °API							14.8				13.4	
650°F+, °API							-0.6				-0.8	
Carbon, W %							89.62				88.90	
Hydrogen, W %							8.82				8.65	
Nitrogen, W %							0.65				0.57	
Sulfur, W %	<0.03	<0.03	<0.03	<0.03		0.01	0.08	0.06	<0.03	0.12	0.16	0.08
Water												
Nitrogen, W %							2.83				2.39	
Sulfur, W %							1.80				2.13	
Carbon, W %							1.17				1.22	
Phenols, W %							0.61				0.60	

* 3.5 W % Residue

** 1.5 W % Residue

RUN 130-73 - ANALYSES

Period	1	2A	2B	3	4A	4B	5	6	7	8	9	10
Vacuum Still Btms.												
W % of Flows from Vacuum Still		60.2	51.0	49.5	51.0	52.3	51.6	53.0	52.3	54.3	53.6	55.8
Benzene - Soluble, W %			58.13	52.48		52.44	51.46	48.89	47.01	47.03	50.72	46.54
Benzene-Insoluble, W %			24.04	29.85		30.14	27.86	30.65	31.70	33.57	29.95	33.34
Ash, W %			17.83	17.67		17.42	20.68	20.46	21.25	19.40	19.33	20.12
Unreacted Coal, % (Est.)			11.67	14.06		18.69	14.86	11.36	10.89	13.23	12.56	13.73
Benzene-Insoluble Residues, W %, (Est.)			12.37	15.79		11.45	13.00	19.29	20.81	20.34	17.39	19.61
Carbon, W %							68.49				69.58	
Hydrogen, W %							4.52				4.98	
Nitrogen, W %							1.23				1.17	
Sulfur, W %	8.23	2.00	2.08	2.06	2.36	2.07	2.41	2.27	2.21	2.10	2.06	2.14
Oxygen, W % (By Difference)							2.67				3.28	
ASTM Ash, W %	8.95	15.25	17.89	17.20/ 17.52	18.00	17.63	20.68/ 21.85	19.75/ 20.59	21.32/ 20.81	20.72/ 19.81	19.94/ 18.96	18.09/ 19.01
Coke/Ash Ratio (THF Extraction by Filtration)			0.684	0.692		0.885	0.658	0.661	0.639	0.686	0.682	0.745
Pyridine-Soluble, W %				73.49					68.36			
Pyridine-Insoluble, W % (Organic)				9.34					11.61			
Ash after Pyridine extraction				17.17					20.03			
Benzene Soluble Oil, IBP °F							755				755	
IBP-975°F, W %							21.2				21.9	
975°F+, W %							78.8				78.1	
Filter Cake												(10A)
W % of Feed to Vacuum Still				*	*							26.8
Benzene-Soluble, W %			41.98	40.45	44.41	43.37	35.78	32.21	31.89	30.76		30.06
Benzene-Insoluble, W %			25.01	29.49	27.19	31.00	28.76	27.23	26.29	30.92		29.86
Ash, W %			33.01	30.06	28.40	25.63	35.46	40.56	41.82	38.32		40.08
Benzene-Insoluble Residue, W %			3.40	3.92	4.59	3.50	3.28	4.71	4.86	4.79		3.82
Unreacted Coal, W % (Est.)			21.61	25.57	22.60	27.50	25.48	22.52	21.43	26.13		26.04
Carbon, W %							(28.71)**					(31.49)**
Hydrogen, W %							(1.41)					(1.70)
Nitrogen, W %							(0.77)					(0.39)
Sulfur, W %							3.16(5.09)				3.60	(5.31)
THF - Soluble, W %							39.82					34.28
Insoluble, W % (0)												25.00
Ash, W %												40.72
0-13 Bottoms												
Ash, W %	8.77		9.48									
Slurry Mixing Tank												
Ash, W %	3.76		3.11	3.71		4.40	5.95	5.68	6.31	5.81	5.82	5.93
Internal Recycle Oil (Flashed)												
Ash, W %			7.31	7.81		8.07	8.39	8.56	9.36	8.51	8.12	7.92

* Filtered a Blend of One Part Vacuum Overhead and One Part Vacuum Bottoms

** Analysis of Solids after THF Extraction

RUN 130-73 - ANALYSES

Period	1	2A	2B	3	4A	4B	5	6	7	8	9	10
Hydroclone Feed												
Ash, W %						9.47	9.93	10.61	9.82	10.85	9.10	8.67
Ash, W % Calculated *						9.59	9.16	9.08	9.28	8.72	8.80	8.59
Ash, W % Calculated **						8.45	9.26	8.72	8.78	8.84	8.55	8.50
Hydroclone Overflow												
Ash, W %						6.75	7.46	6.54	6.50	6.16	6.48	6.70
Hydroclone Underflow												
Ash, W %						10.90	10.76	11.38	12.01	10.78	10.92	10.53
Atmospheric Still Overhead												
IBP-400°F												
Sulfur, W %							0.09				0.18	
Nitrogen, W %							0.04				0.06	
400°F+												
Carbon, W %							88.66					
Hydrogen, W %							11.10					
Sulfur, W %			0.08	0.02		0.02	0.02	0.06	<0.03	<0.03	<0.03	0.02
Nitrogen, W %							0.19				0.18	
Atmospheric Still Bottoms												
IBP-650°F, Gravity, °API							17.6				16.1	
Sulfur, W %							<.03				.04	
650°F+, Gravity, ° API							4.2				3.4	
Sulfur, W %							0.15				0.14	
Vacuum Still Overhead												
IBP-650, Gravity, °API							14.8				13.4	
Sulfur, W %							0.10				<.03	
650°F-EP, Gravity, °API							-0.6				-0.8	
Sulfur, W %							0.21				0.26	
Vacuum Still Bottoms												
IBP-975°F, Gravity, °API							-7.9				-9.6	
Carbon, W %							89.10				87.98	
Hydrogen, W %							7.15				7.01	
Nitrogen, W %							1.17				0.99	
Sulfur, W %							0.30				0.58	
975°F+ Residuum Oil***												
Carbon, W %							86.32				86.21	
Hydrogen, W %							5.62				5.58	
Nitrogen, W %							1.61				1.41	
Sulfur, W %							1.02				1.00	
Ash, W %							0.34				0.67	

* Calculated from overflow and underflow analyses flows

** Calculated from overflow and vacuum still Bottoms analyses flows

*** Residuum Oil from filtrate obtained from vacuum still feed

RUN 130-73 - CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS

Period	1	2A	2B	3	4A	4B	5	6	7	8	9	10
Distillation of Filtrate From Filtration Operation												
Vacuum Distillation												
Pressure, Torr			2.0	1.8		2.0	1.8	2.0	3.8	3.2	4.0****	1.6
Final Vapor Temp., °F			539	499		522	520	521	549	550	561	552
Residue, W % Of Filtrate			32.0	27.7		31.3	35.0	38.0	47.4	43.3	48.6	43.3
Residue Analysis, W %												
Benzene-Soluble			68.73	60.26		63.84	58.53	60.06		65.72	69.36	64.65
Benzene-Insoluble, Organic			31.18	39.52		35.86	41.14	39.59		33.30	29.18	34.63
Sulfur			0.82	0.91		1.02	0.92	0.91	0.83	1.02	0.95	0.99
Ash			0.09	0.22		0.30	0.33	0.35	0.34	0.98	1.46	0.72
IBP-975°F							5.5				13.0	
975°F+							94.5				87.0	
Batch Distillation of Vacuum Bottoms Slurry Product												
Vacuum Distillation												
Final Vapor Temp., °F	536		489	543		520	541	524	531	539	527	530
Pressure, Torr.	0.8		2.6	2.2		2.2	2.5	2.2	1.7	2.6	3.7	1.4
Distillate, W %, Vacuum Bottoms Slurry	60.6		20.4	17.3		11.9	6.9	4.1	6.8	5.4	4.2	7.7
Analysis, Gravity, °API	5.1		-1.8	-1.4		-0.3	-4.0	-3.9	-5.0	-5.5	-5.5	-6.0
Sulfur, W %	0.03		0.09	0.13		0.15	0.19	0.25	0.19	0.27	0.22	0.33
Calculated Composition of Solids-Free Oil In Vacuum Bottoms Slurry Product												
Constitution, W %												
Batch Still Distillate From Slurry Product			28.9	25.3		18.6	16.9*	6.0	10.0	8.0	16.3*	11.6
Batch Still Residue From Filtrate			71.1	74.7		81.4	83.1**	94.0	90.0	92.0	83.7**	88.4
Composition, W % (Cal.)												
Carbon							86.78				86.50	
Hydrogen							5.88				5.81	
Nitrogen							1.54				1.34	
Sulfur			0.61	0.71		0.86	0.90	0.87	0.77	0.96	0.93	0.91
Ash			0.06	0.16		0.24	0.28	0.33	0.31	0.90	0.56	0.64
Calculated Composition of 400°F+ Liquid Product												
Constitution, W %												
Atmospheric Still Overhead 400°F+			6.8	6.7	5.2	5.5	3.6	8.2	4.7	7.9	7.0	7.0
Atmospheric Still Bottoms			1.3	-1.9	5.8	13.5	29.6	8.8	27.7	4.7	19.2	14.6
Vacuum Still Overhead***			0.4	-0.4	0.4	0.4	0.9	4.8	0.2	0.2	0.5	0.2
Vacuum Still Bottoms, Solids-Free Oil			91.5	95.6	88.7	80.6	65.9	78.2	67.4	87.2	73.3	78.2
Composition, W %												
Carbon							87.43				87.10	
Hydrogen							7.31				6.92	
Nitrogen							1.13				1.06	
Sulfur			0.56	0.68		0.70	0.60	0.69	0.53	0.84	0.69	0.71
Ash			0.06	0.15		0.19	0.18	0.26	0.21	0.78	0.41	0.50

* IBP-95°F From Distillation of Benzene Soluble Oil
** 975°F+ Residuum
*** Gross Collected Yield Less Flush Oil Make Up
**** Distillation of Filtrate From Filtration at 200 Hours (Period 10A)

RUN 130-73 - H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO.6 COAL (Pd 11-15 HRI 3721/3751,Pd 16 HRI 3724)

CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDES (HRI No.3556), 45.1 POUNDS DRY

REACTOR LIQUID PHASE DEPTH - 19 FEET - VOLUME - 3.7 FT^3

Period	11	12	13	14	15	16	17	18	19	20	21	22	23
Hours of Run - Beginning	223	247	271	295	319	343	367	391	415	439	463	487	511
End	247	271	295	319	343	367	391	415	439	463	487	511	535
Catalyst Age, lb Dry Coal/lb Catalyst													
Beginning	1236	1375	1514	1652	1790	1934	2078	2215	2356	2500	2640	2779	2920
End	1375	1514	1652	1790	1934	2078	2215	2356	2500	2640	2779	2920	3061
Dry Coal Feed Rate, lbs/Hr/Ft^3													
Reactor Liquid Phase	70.6	72.6	70.0	70.3	72.9	73.1	69.6	71.9	72.9	71.4	70.4	71.4	71.9
Lbs./Hr/Ft^3 Settled Catalyst	197.0	202.6	195.3	196.1	203.4	203.9	194.2	200.6	203.4	199.2	196.4	199.2	199.2
Feed Coal													
W % Moisture	3.58	2.67	2.76	3.11	3.25	2.53	2.32	3.25	2.24	2.66	1.73	2.04	2.98
% Ash (Dry Basis)	10.24	10.58	10.83	10.74	10.81	11.26	11.13	11.06	11.74	11.34	11.03	11.21	11.10
Recycle Flows, lbs/lb Solids													
Atmospheric Stl., Bottoms	1.02	1.09	1.08	1.04	0.98	0.89	0.94	0.92	0.91	0.85	0.81	0.79	0.73
Vacuum Still Overhead	0.02	0.08	0.01	0	0.05	0.11	0.24	0.10	0.07	0.10	0.14	0.12	0.23
Inventory Change	-0.03	0.02	0.01	-0.04	0.03	-0.01	0	0.01	0	-0.04	-0.03	-0.03	0.02
Hydroclone Overflow (Oil)	0.85	0.81	0.83	0.84	0.83	0.88	0.88	0.94	0.90	1.00	1.12	1.01	1.03
Total	1.92	1.96	1.91	1.92	1.83	1.89	2.06	1.95	1.88	1.99	2.10	1.95	1.97
Temperatures, °F													
Coal Preheater Outlet	703	706	706	709	708	710	711	714	715	717	725	728	733
Reactor Liquid Phase Avg.	848	849	848	848	848	849	849	848	848	848	849	849	849
Vacuum Flash Zone	592	607	619	609	613	618	607	618	615	616	619	615	617
Pressure in Vacuum Flash, Torr.	9.6	9.8	9.6	9.4	9.2	9.8	9.0	9.0	8.8	9.5	16.0	10.3	9.8
Hydroclone	533	547	535	541	515	549	550	535	543	524	511	534	537
Pressure, psig													
Unit Back Pressure	2685	2680	2700	2700	2665	2660	2660	2660	2655	2630	2620	2620	2600
Hydrogen Make-Up	2800	2800	2815	2800	2790	2800	2760	2745	2760	2735	2720	2715	2690
Hydrogen Partial Pressure (Reactor Outlet)	1525	1520	1605	1650	1575	1580	1530	1500	1500	1560	1560	1620	1550
Recycle Gas, MSCF/Ton Dry Coal	8.6	9.3	9.3	9.3	9.2	9.5	10.1	9.5	9.6	9.8	10.3	10.8	10.1
Vent Gas, MSCF/Ton Dry Coal	1.66	1.60	1.44	1.46	1.65	1.54	1.79	1.30	1.37	1.65	1.70	1.64	1.50
H_2 Purity of Recycle Gas & Vent, %	89.9	91.4	91.4	91.1	91.3	90.7	89.9	90.0	90.3	89.9	90.2	91.5	91.3
Total H_2, MSCF/Ton Dry Coal (Reactor Outlet)	16.3	16.5	18.2	18.1	17.6	17.1	17.5	16.4	16.2	17.3	18.3	18.1	17.8
Make-Up H_2 + Recycle H_2													
MSCF/Ton Dry Coal	26.6	26.7	27.2	27.0	26.3	25.7	26.9	25.4	25.8	26.4	27.5	27.1	26.8
V % Make-Up & Recycle Gas	96.9	97.1	97.1	97.0	97.1	96.7	96.4	96.4	96.5	96.4	96.5	96.7	96.8
Partial Pressure of H_2, psig	2710	2720	2735	2715	2705	2705	2660	2645	2660	2635	2625	2625	2605
H_2 Consumption													
MSCF/Ton Dry Coal	10.3	10.2	9.0	8.9	8.7	8.6	9.5	9.0	9.5	9.2	9.2	9.0	9.0
W % Dry Coal	2.8	2.7	2.4	2.4	2.3	2.3	2.5	2.4	2.5	2.4	2.5	2.4	2.4
Oil Additions													
Make-Up - Oil, lbs/lb Dry Coal	0	0	0	0	0	0	0	0	0	0	0	0	0
lb/Hr./Ft^3 Reactor	0	0	0	0	0	0	0	0	0	0	0	0	0
Flush Oil, lbs/lb Dry Coal	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003

RUN 130-73 - OPERATING RESULTS

riod	11	12	13	14	15	16	17	18	19	20	21	22	23
llected Product Quantities													
% Dry Coal													
Atmospheric Still Overhead	15.1	16.8	15.2	13.9	14.2	14.7	16.4	13.3	15.6	19.4	14.2	14.7	13.9
Atmospheric Still Bottoms(1)	5.4	3.7	9.4	4.3	3.2	4.5	0.7	5.3	2.4	-3.5	-2.5	-2.2	4.0
Vacuum Still Overhead(1)	0.4	0.6	-2.9	1.5	2.8	0.4	0.6	0.5	0.5	1.6	2.3	4.8	0.9
Vacuum Still Bottoms	64.4	63.8	61.8	64.4	66.6	64.6	68.3	64.2	65.1	65.5	72.5	66.7	68.1
H_2O (2)	9.9	10.8	9.9	10.9	10.2	8.9	10.2	10.5	8.5	10.0	10.0	8.8	8.6
C_1-C_3	5.1	4.9	5.5	5.0	4.7	4.7	5.2	4.9	4.8	4.7	4.4	4.5	4.8
C_4-C_6	4.8	3.7	3.3	2.7	3.8	2.8	2.9	4.7	4.1	4.3	2.5	3.5	4.9
H_2S In Gases	1.7	1.7	1.7	1.5	1.4	1.3	1.3	1.6	1.3	1.5	1.5	1.6	1.7
CO_2 & CO	0.9	0.8	0.9	0.8	0.9	0.7	0.6	1.0	1.0	1.0	0.9	1.0	1.0
Total	107.7	106.1	104.1	105.0	107.8	102.6	106.2	106.0	103.3	104.5	105.8	103.4	107.9
put Quantities, W % Dry Coal													
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture In Feed Coal	3.7	2.8	2.8	3.2	3.4	2.6	2.4	3.3	2.3	2.7	1.5	2.1	3.1
Make-Up Oil Additions	0	0	0	0	0	0	0	0	0	0	0	0	0
Flush Oil	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
H_2 Reacted (H_2 Gas Analysis Flow)	2.8	2.7	2.4	2.4	2.3	2.3	2.5	2.4	2.5	2.4	2.5	2.4	2.4
Total Used for Normalization	106.8	105.8	105.5	105.9	106.0	105.2	105.2	106.0	105.1	105.4	104.3	104.8	105.8
ial Conversion (by THF Filtration)	90.2	90.1	90.2	90.7	89.3	89.0	89.5	89.9	89.5	89.6	88.1	87.3	87.3
rmalized Net Product Distribution,(3)													
% Dry Coal													
CO, CO_2	0.9	0.8	0.9	0.8	0.9	0.67	0.6	1.0	1.1	1.0	0.9	1.0	0.95
C_1-C_3 Hydrocarbons In Gases	5.0	4.9	5.6	5.1	4.6	4.81	5.1	4.9	4.8	4.7	4.3	4.6	4.70
C_4-C_6 Hydrocarbons In Gases	4.8	3.7	2.9	2.7	3.7	2.91	3.0	4.7	4.2	4.3	3.4	3.6	3.91
IBP-400°F Naphtha	10.8	11.6	10.7	10.2	10.2	11.42	12.4	9.9	12.3	9.4	9.8	10.2	8.39
400-650°F Distillates	8.5	7.1	9.5	7.2	7.0	7.42	4.4	7.6	5.5	8.5	3.1	5.1	7.66
650-975°F Distillates	↑	↑	↑	↑	↑	7.68	↑	↑	↑	↑	↑	↑	7.67
975°F+Residual Oil	30.8	32.4	29.1	32.3	33.6		35.2	32.5	33.3	28.7	32.8	32.4	
Benzene Soluble	↓	↓	↓	↓	↓	22.75	↓	↓	↓	↓	↓	↓	24.64
Benzene Insoluble	15.2	13.6	15.7	14.6	15.1	17.96	13.3	13.4	14.9	18.1	16.4	18.3	16.11
Unconverted Coal	7.6	7.5	7.5	8.5	7.9	7.46	7.8	7.9	7.2	7.3	9.6	7.8	8.54
Ash	11.4	11.4	11.6	11.8	11.4	11.50	11.7	11.9	11.8	11.5	12.7	11.1	11.63
H_2O (Net)	6.0*	8.1*	7.2*	7.8*	6.7*	6.09	7.7*	7.2*	6.3*	7.3*	8.0*	6.9*	5.18
NH_3 (Forced Nitrogen)	*	*	*	*	*	(0.46)	*	*	*	*	*	*	(0.49)
H_2S (Forced Sulfur)	4.7*	1.7*	1.7*	1.5*	1.4*	(2.01)	1.3*	1.5*	1.3*	1.5*	1.5*	1.6*	(1.95)
Total (100+H_2 Reacted)	102.7	102.7	102.4	102.5	102.5	103.16**	102.5	102.5	102.7	102.3	102.5	102.5	102.82**

(1) Negative Quantities of Atmospheric Still Overhead and Vacuum Overhead are decreases of Inventory of Slurry Oil Holding Tank

(2) Includes Dissolved NH_3 & H_2S

(3) ASTM Distillation Cut Points

* Water Product Contains NH_3, H_2S

** Hydrogen Consumption by Coal Feed Product Hydrogen Analyses.

RUN 130-73 - ANALYSES

Period	11	12	13	14	15	16	17	18	19	20	21	22	23
Atmospheric Still Overhead													
Gravity, °API	37.1	37.7	35.5	37.0	38.8	37.5	37.2	37.8	36.4	28.5/** 32.6	34.3	35.2	34.6
IBP, °F	146	140	146	140	146	130	143	138	148	198/ 150	144	140	130
EP, °F	525	538	633	556	522	508	534	534	518		630	586	544
V % @ 400°F	75	74	71	75	75	78	78	76	79	46/64	71	71	69
V % @ 650°F	--	--	---	--	--	--	--	--	--	85/96	--	--	--
Gravity, IBP-400°F °API						43.2							41.2
400°F-EP, °API						23.1							21.1
Carbon, W %						87.75							87.61
Hydrogen, W %						13.50							11.99
Nitrogen, W %						0.13							0.12
Sulfur, W %						0.28							0.24
Phenols, V % Total						5.0							6.5
V % IBP-400°F						4.5							5.0
Atmospheric Still Bottoms													
Gravity, °API	12.6	12.2	12.1	12.1	12.5	12.1	12.1	11.9	11.2	11.7	12.3	12.0	11.5
IBP, °F	414	420	410	418	418	422	420	418	406	428	422	402	404
EP, °F						(876)							(952)
V % @ 400°F	—	--	--	--	--	--	--	--	--	--	--	--	--
V % @ 650°F	73	73	62	73	75	76	80	79	76	74	76	79	75
Gravity, IBP-650°F, °API						15.1							14.4
650°F+, °API						3.0							2.6
Carbon, W %						88.84							87:75
Hydrogen, W %						9.67							9.09
Nitrogen, W %						0.33							0.30
Sulfur, W %	0.06	0.09	0.09	0.06	0.08	0.14	0.15	0.03	0.09	0.13	0.17	0.17	0.21
Vacuum Still Overhead													
Gravity, °API	6.6	6.7	4.1	2.8	4.4	5.0	5.7	3.8	4.3	4.0	7.5	6.0	6.3
IBP, °F	436	424	448	494	438	454	428	434	454	438	428	416	404
EP, °F						(975)*							(1010)
V % @ 650°F	47	48	37	27	42	40	51	40	41	43	59	49	55
Gravity, IBP-650°F °API						13.0							13.2
650°F+ °API						-0.4							-0.8
Carbon, W %						88.01							87.54
Hydrogen, W %						8.38							8.50
Nitrogen, W %						0.55							0.51
Sulfur, W %	0.14	0.15	0.16	0.21	0.26	0.26	0.16	0.25	0.22	0.22	0.24	0.28	0.35
Water													
Nitrogen, W %						1.97							1.40
Sulfur, W %						1.70							1.25
Carbon, W %						1.44							1.19
Phenols, W %						0.79							0.65

* 2.0 W % Residue

** Leaking valve by passed atmospheric still feed to atmospheric still overhead accumulator
12.3 W % yield of 28.5 °API product, 7.1 W % of 32.6° product

RUN 130-73 - ANALYSES

Period	11	12	13	14	15	16	17	18	19	20	21	22	23
Vacuum Still Bottoms													
W % of Flows from Vacuum Still	55.8	52.5	57.0	58.0	54.4	52.0	46.4	51.4	54.0	58.5	52.0	50.1	47.8
Benzene - Soluble, W %	45.97	49.05	44.01	46.29	47.65	44.20	51.58	48.51	48.96	43.84	45.79	45.02	46.19
Benzene - Insoluble, W %	36.04	33.03	37.28	35.57	35.02	38.42	31.18	33.02	33.31	38.65	36.46	38.49	36.55
Ash, W %	17.99	17.92	18.71	18.14	17.33	17.38	17.24	18.47	17.73	17.51	17.75	16.49	17.26
Unreacted Coal, W % (Est.)	12.03	11.78	12.00	13.13	11.96	11.28	11.54	12.24	10.84	11.16	13.44	11.48	12.67
Benzene-Insoluble Residues, W % (Est.)	24.01	21.25	25.28	22.44	23.06	27.14	19.64	20.78	22.47	27.49	23.02	27.01	23.88
Carbon, W %						70.87							71.53
Hydrogen, W %						4.62							4.37
Nitrogen, W %						1.30							1.26
Sulfur, W %	2.24	2.35	2.41	2.33	2.40	2.38	2.42	2.50	2.38	2.44	2.47	2.49	2.45
Oxygen, W % (By Difference)						3.45							
ASTM Ash, W %	18.53/ 17.90	18.00/ 17.68	18.20/ 18.87	17.74/ 17.21	17.41/ 17.09	18.33/ 17.57	17.32/ 17.17	17.56/ 17.53	17.77/ 17.31	17.28/ 17.32	17.42/ 17.20	17.42/ 17.15	16.81/ 16.62
Coke/Ash Ratio (THF Extraction by filtration)	0.762	0.783	0.757	0.754	0.841	0.856	0.797	0.794	0.826	0.813	0.854	0.985	0.996
Pyridine-Soluble, W %		72.71											74.22
Pyridine-Insoluble, W % (Organic)		9.91											9.14
Ash, W %		17.38											16.64
Benzene Soluble Oil, IBP °F						785							755
IBP-975°F, W %						22.2							20.9
975°F+, W %						77.8							79.1
Filter Cake													
W % of Feed to Vacuum Still	25.4	24.1	24.1*	23.8	23.4	24.5	21.1	23.9	23.4	24.2	19.7	22.5	19.9
Benzene-Soluble, W %	28.53	31.54	30.25	26.44	32.73	29.38	30.36	26.48	28.07	26.24	22.22	24.65	28.72
Benzene-Insoluble, W %	31.93	30.03	31.16	33.74	30.86	31.18	30.39	31.88	30.24	31.87	35.63	33.65	32.71
Ash, W %	39.54	38.43	38.59	39.82	36.41	39.44	39.55	41.94	41.69	41.89	42.15	41.70	38.57
Benzene-Insoluble, Residue, W %	5.49	4.83	6.40	4.91	5.74	5.59	3.62	3.79	4.78	5.17	3.71	4.63	4.39
Unreacted Coal, W % (Est.)	26.44	25.20	24.76	28.83	25.12	25.59	26.47	27.79	25.46	26.70	31.92	29.02	28.32
Carbon, W %													(30.91)
Hydrogen, W %													(1.52)
Nitrogen, W %													(0.39)
Sulfur, W %						4.00(5.80)**						4.09	(5.74)**
THF - Soluble, W %						37.19							35.35
Insoluble, W % (o)						24.41							24.47
Ash, W %						38.40							40.10
Slurry Mixing Tank													
Ash, W %	5.91	5.41	6.09	5.65	5.60	5.56	5.08	5.71	5.93	5.88	5.38	5.47	5.24
Internal Recycle Oil (Flashed)													
Ash, W %	8.29		7.85		8.14	7.84							

* Filtration at 297 Hours (Period 14A)

** Analysis of Solids after THF Extraction.

RUN 130-73 - ANALYSES

Period	11	12	13	14	15	16	17	18	19	20	21	22	23
Hydroclone Feed													
Ash, W %	8.46	7.93	8.90	8.62	8.58	8.10	7.46	7.86	8.20	7.98	7.36	7.44	6.82
Ash, W % (Calculated)*	8.30	7.77	8.87	8.53	8.12	8.00	6.96	8.10	8.06	7.64	7.08	7.06	6.63
Ash, W % (Calculated)**	8.35	7.68	8.76	8.41	7.82	7.74	6.61	7.43	7.88	7.36	6.97	6.87	6.36
Hydroclone Overflow													
Ash, W %	6.40	5.62	6.91	6.60	6.02	5.98	4.65	5.76	6.22	5.82	4.95	4.98	4.51
Hydroclone Underflow													
Ash, W %	10.08	9.53	10.77	10.38	9.92	9.82	8.61	9.01	9.83	9.48	9.23	9.05	8.50
Atmospheric Still Overhead													
IBP-400°F													
Sulfur, W %						0.16							0.19
Nitrogen, W %						0.12							0.08
400°F+													
Carbon, W %													87.42
Hydrogen, W %													10.29
Sulfur, W %	<0.03	<0.03	0.02	0.10	0.10	0.14	0.16	0.15	0.20	0.20	0.17	0.16	0.19
Nitrogen, W %[1]						0.27							0.17
Atmospheric Still Bottoms													
IBP-650°F, Gravity, °API						15.1							14.4
Sulfur, W %						0.16							0.14
650°F+, Gravity, °API						3.0							2.6
Sulfur, W %						0.35							0.36
Vacuum Still Overhead													
IBP-650°F, Gravity, °API						13.0							13.2
Sulfur, W %						0.14							0.20
650°F+, Gravity, °API						-0.4							-0.8
Sulfur, W %						0.33							0.46
Vacuum Still Bottoms													
IBP-975°F													
Gravity, °API						-9.2							-10.1
Carbon, W %						87.45							86.27
Hydrogen, W %						6.92							6.83
Nitrogen, W %						1.01							1.11
Sulfur, W %						0.75							0.96
975°F+ Residuum Oil***													
Carbon, W %						85.95							87.63
Hydrogen, W %						5.36							5.04
Nitrogen, W %						1.72							1.42
Sulfur, W %						1.09							1.05
Ash, W %						0.51							0.30

* Calculated from Overflow and Bottoms analysis, flows.

** Calculated from Overflow and Vacuum Still Bottoms analysis, flows.

*** Residuum Oil from filtrate obtained from Vacuum Still feed.

RUN 130-73 - CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS

Period	11	12	13	14	15	16	17	18	19	20	21	22	23
Distillation of Filtrate on Filtration Operation													
Vacuum Distillation													
Final Vapor Temp., °F	550	550	560		555	558	557	519	530	530	519	520	529
Pressure, Torr	1.2	1.1	1.8		1.6	1.0	0.8	1.4	1.7	1.6	1.6	1.6	1.6
Residue, W % of Filtrate	41.8	41.4	41.4		44.4	43.1	38.5	46.1	42.3	45.3	34.5	40.2	38.3
Analysis of Residue, W %													
Benzene - Soluble	59.91	64.12			55.27	57.34	59.79	57.85	59.67	60.18	51.45	60.62	57.66
Benzene - Insoluble Organic	39.72	35.86			44.34	42.42	39.96	41.33	39.85	39.59	48.48	39.32	42.28
Sulfur	1.00	1.05	1.10		1.03	1.01	1.08	1.06	1.00	0.97	1.17	1.19	1.11
Ash	0.37	0.02	0.18		0.39	0.24	0.25	0.82	0.48	0.23	0.07	0.06	0.06
18P-975°F						6.2							5.6
975°F+						93.8							94.4
tch Distillation of Vacuum Bottoms Slurry Product													
Vacuum Distillation													
Final Vapor Temp. °F	536	521	551	480	470	422	473	589	508	511	509	520	501
Pressure, Torr	1.5	1.4	1.0	2.4	2.4	2.3	2.0	1.4	1.2	1.2	2.3	1.6	2.6
Distillate, W %, Vacuum Bottoms Slurry	7.7	6.0	6.6	7.3	6.1	6.2	6.8	5.5	6.3	4.5	5.3	3.3	2.6
Analysis, Gravity, °API	-7.0	-6.8	-8.4	-7.8	-8.8	-8.1	-6.7	-9.2	-8.0	-9.3	-7.1	-7.7	-7.7
Sulfur	0.43	0.45	0.49	0.57	0.60	0.64	0.60	0.65	0.60	0.63	0.71	0.67	0.68
Calculated Composition of Solids-ee Oil in Vacuum Bottoms Slurry oduct													
Constitution, W %													
Batch Still Distillate from Slurry Product	11.0	8.5	9.5	10.6	8.6	13.8*	9.5	7.3	8.8	6.3	7.7	4.6	13.8*
Batch Still Residue from Filtrate	89.0	91.5	90.5	89.4	91.4	86.2**	90.5	92.1	91.2	93.7	92.3	95.4	86.2**
Composition, W % (Cal.)													
Carbon						86.16							87.44
Hydrogen						5.58							5.29
Nitrogen						1.62							1.38
Sulfur	0.94	0.99	1.04		0.99	1.04	1.03	1.03	0.97	0.95	1.13	1.17	1.07
Ash	0.33	0.02	0.16		0.36	0.44	0.23	0.76	0.44	0.22	0.06	0.06	0.26
Composition of 400°F+ Liquid oduct													
Constitution, W %													
Atmospheric Still Overhead 400°F	7.4	8.5	8.8	6.9	6.9	6.3	6.8	6.4	6.6	18.1	8.2	8.3	7.4
Atmospheric Still Bottoms	11.6	6.2	18.7	8.0	5.1	8.8	1.3	9.6	4.4	-5.3	-5.8	-4.2	7.1
Vacuum Still Overhead***	-0.2	0.6	-6.6	2.8	5.1	0.2	0.4	0.6	0.9	2.0	4.1	8.7	1.1
Vacuum Still Bottoms Solids-Free Oil	81.2	84.7	79.1	82.3	82.9	84.7	91.5	83.5	88.1	85.2	93.4	87.1	84.5
Composition, W %													
Carbon						85.56							87.55
Hydrogen						6.29							5.97
Nitrogen						1.42							1.32
Sulfur	0.77	0.85	0.83		0.84	0.90	0.96	0.87	0.87	0.85	1.07	1.05	0.94
Ash	0.27	0.02	0.13		0.30	0.37	0.21	0.63	0.39	0.19	0.05	0.05	0.22

* 18P-975°F from Distillation of Benzene Soluble Oil

** 975°F+ Residue.

*** Gross collected yield less flush oil makeup

PRELIMINARY OPERATIONS - ILLINOIS NO. 6 COAL - FUEL OIL MODE

Immediately prior to PDU 2 (130-77) a 20-day run was conducted which demonstrated stable operation at the highest gas velocities used to that time. Velocities of 0.11 fps were maintained through much of the run. After initiating residuum recycle via the hydroclone and fine tuning the controllers on the internal recycle pump and recycle gas compressor, a velocity of 0.13 fps was achieved. The experience gained in this run led to the decision to reposition the net product take-off and to the selection of conditions for Run 130-77, the successful PDU 2. The run provided useful data at intermediate operating conditions.

The experience of Run 130-76 led to the higher gas rate, higher coal rate, higher reactor temperature and the increased proportion of hydroclone overhead in the recycle stream which also contributed to the success of Coal feed inspections were the same as that for the coal used in PDU Run 2.

RUN 130-76 - H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO.6 COAL (HRI 3767)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates (HRI 3556), 45.2 Pounds Dry

Reactor Liquid Phase Depth - 19 Feet, Volume 3.7 Ft^3

Period	1A	1B	2A	2B	3A	4B	5A	5B	6A	7B	8A	8B
Date (End of Period), 1976	2/10	2/11	2/11	2/12	2/12	2/16	2/16	2/17	2/17	2/21	2/21	2/22
Hours of Run - Beginning	3	15	27	39	51	60	69	81	93	101	112	124
End	15	27	39	51	60	69	81	93	100	112	124	136
Catalyst Age, Lbs Dry Coal/Lb Catalyst												
Beginning	10	69	127	188	250	296	336	398	361	501	552	611
End	69	127	188	250	296	336	398	461	395	552	611	672
Coal Feed Rate, Lbs Dry Coal/Hour/ Ft^3 Reactor Liquid Phase	60.2	59.5	61.2	63.4	63.3	49.8	63.1	63.9	60.7	55.9	60.8	62.0
Feed Coal												
W % Moisture	6.15	2.50	1.95	2.20	0.68	2.62		2.28		1.55		2.03
% Ash (Dry Basis)	11.80	11.07	11.33	11.06	11.06	11.49		11.77		11.84		11.30
Recycle Flows, Lbs/Lb Dry Coal												
Atmospheric Still Bottoms	2.25	3.42	3.38	3.20	3.26	1.75	2.67	2.69	2.84	2.23	3.41	3.68
Vacuum Still Overhead	0.61	0.44	0.44	0.48	0.47	0.83	0.39	0.41	0.38	0.54	0.32	0.29
Inventory Change	0.04	0.09	0.02	0.08	0.01	0.32	0.03	0.09	-0.07	0.07	0.02	0.01
Hydroclone Overflow	-	-	-	-	-	-	-	-	-	-	-	-
Total [a]	2.88	3.83	3.86	3.66	3.78	2.33	3.09	3.07	3.29	2.77	3.77	4.01
Temperatures, °F												
Coal Preheater Outlet	726	737	739	738	735	706	707	700	718	706	707	719
Reactor Liquid Phase, Average	818	822	822	824	822	812	825	824	820	820	823	821
Separator, Average	799	800	804	803	805	783	800	800	784	734	778	786
Vacuum Flash Zone	531	546	545	551	553	472	546	546	555	516	540	526
Pressure in Vacuum Flash, Torr	23	15.6	15.3	14.5	14.5	18.4	18.7	18.4	12.7	13.6	12.9	11.4
Hydroclone	-	-	-	-	-	-	-	-	-	-	-	-
Pressure, psig												
Unit Back Pressure	2500	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Hydrogen Make-Up	2500	----------	----------	----------	----------	----------	----------	----------	----------	2480	2500	2500
Hydrogen Partial Pressure (Reactor Outlet)												1560
Recycle Gas, MSCF/Ton Dry Coal		14.9	21.9	29.6	31.1	20.7	27.7	28.2	15.8	16.0		15.5
Vent Gas, MSCF/Ton Dry Coal		2.4	2.0	1.9	2.0	2.2	1.7	1.8	1.8	1.7		1.8
Hydrogen Purity of Recycle Gas + Vent, %		93.3	92.3	92.0	91.3	88.8	90.7	90.6	90.3	90.1		(92.0)
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)		19.9	25.1	31.7	32.8	22.4	29.3	29.9	18.9	18.9		19.9
Make-Up + Recycle Hydrogen												
MSCF/Ton Dry Coal		31.8	36.9	43.4	46.3	34.2	40.5	41.2	30.9	28.1		30.5
V % of Make-Up + Recycle Gas		97.0	95.6	94.9	94.5	93.7	94.0	94.0	95.3	94.7		96.1
Hydrogen Partial Pressure, psig		2425	2390	2370	2360	2340	2350	2345	2380	2345		2400
Hydrogen Consumption												
MSCF/Ton Dry Coal		11.9	11.9	11.7	13.5	11.8	11.2	11.3	12.0	9.2		10.6
W % Dry Coal		3.2	3.2	3.1	3.6	3.2	3.0	3.0	3.2	2.4		2.8
Oil Additions												
Make-Up Oil, Lbs/Lb Dry Coal	0.060	0.063	0.059	0.059	0.056	0.067	0.060	0.058	0	0.071	0.060	0.055
Lbs/Hr/Ft^3	3.6	3.8	3.6	3.7	3.6	3.3	3.8	3.7	0	3.8	3.7	3.4
Flush Oil, Lbs/Lb Dry Coal	0.003	0.004	0.003	0.003	0.003	0.004	0.003	0.003	0.003	0.004	0.003	0.003

[a] Total to reactor, includes make-up oil

Period	1A	1B	2A	2B	3A	4B	5A	5B	6A	7B	8A	8B
OPERATING RESULTS												
Collected Product Quantities												
W % Dry Coal												
Atmospheric Still Overhead	11.5	12.7	14.2	13.7	14.3	6.3	3.6	12.3	11.8	7.6	12.0	9.7
Atmospheric Still Bottoms(1)	3.1	9.1	2.4	7.4	1.0	22.4	3.5	8.0	-6.0	6.3	2.3	1.9
Vacuum Still Overhead(1)	1.1	1.6	0.5	1.5	0.4	11.0	0.7	1.6	-0.6	1.8	0.5	0.5
Vacuum Still Bottoms	69.4	73.5	72.8	74.0	72.4	70.5	72.9	74.9	83.8	68.4	76.9	63.6
H_2O(2)	8.1	13.1	7.1	8.1	7.9	4.8	11.9	9.5	6.6	4.4	10.9	7.6
C_1-C_3		2.7	2.4	2.0	2.1	1.9	2.1	2.0	1.9	1.9		2.8
C_4-C_6		1.9	2.5	1.9	1.7	0.8	2.1	1.6	1.8	1.7		3.4
H_2S		0.6	1.2	1.0	0.9	0.7	1.0	0.9	0.8	0.8		1.6
CO_2 and CO		0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3		0.6
Total		115.7	103.5	110.0	101.1	118.9	90.1	111.4	100.4	93.2		91.7
Input Quantities, W % Dry Coal												
Dry Coal	100.0	----------										
Moisture in Feed Coal	6.6	2.5	3.0	2.3	0.7	2.7	2.3	2.3	2.3	1.6	2.1	2.1
Make-Up Oil Additions	6.0	5.3	5.9	5.9	5.6	6.7	6.0	5.8	0	6.7	6.0	5.5
Flush Oil	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.3
Hydrogen Reacted		3.2	3.2	3.1	3.6	3.2	3.0	3.0	3.2	2.4		2.8
Total Used for Normalization		112.4	111.4	111.6	110.2	113.0	111.6	111.4	105.8	111.1		110.7
Normalized Net Product Distribution												
W % Dry Coal												
CO, CO_2		0.35		0.39		0.29		0.29		0.40		
C_1-C_3		2.50		2.22		1.63		1.36		2.28		
C_4-C_6		1.39		1.35		0.72		1.62		2.00		
IBP-400°F Naphtha		8.49		9.20		4.36		3.76		6.62		
400-650°F Distillate		13.95		15.25		41.0		12.97		12.79		
650-975°F Distillate												
975°F+ Residual Oil - Benzene-Soluble		29.16		28.39		26.34		33.67		37.92		
Benzene - Non-Filterable		10.55		13.39		5.62		9.43		8.92		
Unconverted Coal		12.73		12.97		9.49		13.30		14.39		
Ash		10.88		11.05		3.58		11.64		11.52		
H_2O (Net)												
NH_3 (Forced Nitrogen)		3.29		5.90		1.60		7.45		3.67		
H_2S (Forced Sulfur)		2.26		2.09		2.52		1.35		1.94		
Total (100 + Hydrogen Reacted)		103.16		103.11		103.09		102.44		102.42		
ANALYSES												
Atmospheric Still Overhead												
Gravity, °API	36.7	36.5	35.7	35.0	35.3	36.5		37.8	37.7	39.3		37.4
IBP, °F		174		146	148	142		126	160	160		142
EP, °F		542		562	523	512		532	520	528		530
V % @ 400°F		73		69	69	74		74	76	76		77
Atmospheric Still Bottoms												
Gravity, °API	16.9	15.8	16.8	16.3	15.2	16.0	15.4	15.7	15.1	16.9	16.6	16.5
IBP, °F		356		392	432	365		375	360	*		390
EP, °F		724		714	732	695		709	690	692		722
V % @ 400°F		4		2		6		6	3	3		2
V % @ 650°F		91		89	87	93		91	88	85		90
Sulfur, W %		<0.03		<0.03	<0.03	<0.03		<0.03	<0.03	<0.03		<0.03
Vacuum Still Overhead												
Gravity, °API	9.0	6.4	6.0	5.7	5.2	7.6	4.2	3.9	3.9	7.7	5.6	5.2
IBP, °F		503		514		430		510	500	502		506
V % @ 650°F		42		37		60		40	37	58		39
Sulfur, W %		0.05		0.05		0.03		0.04	0.05	0.03		0.04
0-12 Liquid, Gravity, °API		16.3		15.4		15.7		15.4		16.8		15.7
0-5 Liquid, Gravity, °API	17.8	18.5	18.3	18.0	16.9	16.7	17.6	17.9	17.9	19.1	18.9	18.6
Vacuum Still Bottoms												
W % of Flows from Vacuum Still	45.3	51.9	52.0	51.0	51.1	53.9	54.2	53.5	58.1	46.1	57.9	54.9
Benzene-Soluble, W %		52.03		49.69		61.62		53.47		56.86		50.23
Benzene-Insoluble, W %		32.69		35.45		24.17		30.77		28.38		35.51
Ash, W %		5.28		14.36		14.21		15.76		14.26		14.26
Unreacted Coal, W % (Estimated)		17.28		17.44		15.18		13.00		17.32		18.46
Benzene-Insoluble Residuum, W % (Estimated)		14.51		18.01		3.95		12.77		11.06		17.3
Sulfur, W %	1.99	2.03	2.31	2.17	2.16	1.91	2.11	2.15	2.19	2.16	2.24	2.21
ASTM Ash, W %	15.25	15.32	15.52	15.43	16.31	14.40	16.31	15.54	15.31	15.04	15.56	14.69

(1) Negative Quantities of Atmospheric Still Overhead and Vacuum Overhead Represent Decrease in Inventory of Slurry Oil Drum

(2) Includes Dissolved NH_3 and H_2S

* Trace of Water in Sample

Period	1A	1B	2A	2B	3A	4B	5A	5B	6A	7B	8A	8B
ANALYSES (CONTINUED)												
Filter Cake												
W % of Feed to Vacuum Still		30.9		31.1		24.3		26.4		28.9		28.5
Benzene-Soluble, W %	24.07	38.54		37.45		34.26		16.49		19.37		37.90
Benzene-Insoluble, W %	37.86	34.95		35.88		34.59		45.22		45.33		37.16
Ash, W %	37.17	26.51		26.67		31.15		38.29		35.29		24.94
Benzene-Insoluble Residuum, W %		3.93		4.58		1.32		1.48		1.22		4.88
Unreacted Coal, W % (Estimated)		31.02		31.30		33.27		43.74		44.11		32.28
Ash, W %												
0-13 Bottoms	4.49	8.05		8.09		7.34		9.22		9.60		8.16
Slurry Mixing Tank	1.86	2.19		2.22		2.51		2.42		1.72		1.94
Internal Recycle Oil (Flashed)			5.77		7.45		6.88		6.93			
Atmospheric Still Overhead												
400°F+ - Sulfur, W %		0.03		0.02	0.03	0.03		0.03	0.08	0.07		0.04
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS												
Distillation of Filtrate from Filtration Operation												
Vacuum Distillation												
Final Vapor Temperature, °F		545		550		551		544		523		537
Pressure, Torr		1.0		0.8		0.4		1.7		1.1		2.2
Residue, W % of Filtrate		33.0		32.0		25.5		35.8		35.6		40.0
Benzene-Insoluble, W %	14.0	32.11		30.11		27.40		37.75		37.96		30.54
Sulfur, W %		1.12		1.14		0.98		1.14		1.08		1.26
Ash, W %	0.01	0.07		0.22		0.05		0.13		0.06		0.06
Batch Distillation of Vacuum Bottoms Slurry Product												
Vacuum Distillation												
Final Vapor Temperature, °F		489		485		454		374		458		488
Pressure, Torr		2.5		2.9		5.8		5.4		8.0		4.0
Distillate, W % Vacuum Bottoms Slurry		11.6		11.4		19.9		8.8		11.9		10.1
Gravity, °API		-1.2		-1.6		0.1		-1.9		-0.8		-1.5
Sulfur, W %		0.65		0.21		0.14		0.19		0.22		0.31
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product												
Constitution, W %												
Batch Still Distillate from Slurry Product		16.6		15.8		26.5		11.9		14.6		15.0
Batch Still Residue from Filtrate		83.4		84.2		73.5		88.1		85.4		85.0
Composition, W % (Calculated)												
Sulfur, W %		1.04		0.98		0.76		1.03		0.95		1.12
Ash, W %		0.06		0.19		0.04		0.12		0.05		0.05
Calculated Composition of 400°F+ Liquid Product												
Constitution, W %												
Atmospheric Still Overhead, 400°F+		7.2		7.9		2.3		6.0		3.9		5.9
Atmospheric Still Bottoms		15.6		12.9		25.7		14.6		12.3		4.3
Vacuum Still Overhead*		-15.6		-8.1		12.0		-7.9		-8.2		-12.9
Vacuum Still Bottoms Oil		88.7		87.3		60.0		87.3		92.0		102.7
Composition												
Sulfur, W %		0.93		0.87		0.47		0.90		0.88		1.15
Ash, W %		0.05		0.17		0.02		0.10		0.04		0.05

* Less Make-Up Oil

RUN 130-76 - H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO.6 COAL (HRI 3767)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates (HRI 3556), 45.2 Pounds Dry

Reactor Liquid Phase Depth - 19 Feet, Volume 3.7 Ft^3

Period	9A	9B	10	11	12A	12B	13A	13B	14	15	16	17
Date (End of Period), 1976	2/22	2/23	2/24	2/25	2/25	2/26	2/26	2/27	2/28	2/29	3/1	3/2
Hours of Run - Beginning	136	148	160	184	208	215	219	231	243	267	291	315
End	148	160	184	208	215	219	231	243	267	291	315	339
Catalyst Age, Lbs Dry Coal/Lb Catalyst												
Beginning	672	732	791	910	1023	1059	1075	1135	1197	1319	1441	1562
End	732	791	910	1023	1059	1075	1135	1197	1319	1441	1562	1687
Coal Feed Rate, Lbs Dry Coal/Hour/ Ft^3 Reactor Liquid Phase	61.1	60.1	60.7	58.6	61.7	50.0	61.2	62.4	62.1	62.1	61.7	63.2
Feed Coal												
W % Moisture		1.83	1.82	1.86		1.69	1.28	1.57	1.65	1.96	1.79	1.73
% Ash (Dry Basis)		11.39	11.37	10.97		11.21	11.27	10.80	11.06	11.55	11.74	11.49
Recycle Flows, Lbs/Lb Dry Coal												
Atmospheric Still Bottoms	3.43	3.16	3.13	2.92	2.89	1.61	2.55	3.18	2.85	2.94	2.99	2.80
Vacuum Still Overhead	0.36	0.52	0.58	0.43	0.29	0	0.45	0.37	0.43	0.34	0.29	0.42
Inventory Change	0.11	0	0	-0.04	-0.09	-0.45	0	-0.01	0	-0.01	-0.02	-0.02
Hydroclone Overflow	-	-	-	-	-	-	-	-	-	-	-	-
Total*	3.74	3.74	3.71	3.45	3.33	2.13	3.05	3.56	3.28	3.29	3.30	3.26
Temperatures, °F												
Coal Preheater Outlet	720	723	728	723	724	710	714	725	729	726	730	725
Reactor Liquid Phase, Average	824	824	824	825	826	804	823	823	824	824	824	824
Separator, Average	790	768	778	777	792	742	790	795	778	777	776	777
Vacuum Flash Zone	576	571	574	547	532	316 ?	555	557	548	558	560	537
Pressure in Vacuum Flash, Torr	11.2	11.4	13.6	15.2	13.5	12.6	15.0	14.6	11.6	11.0	11.1	11.1
Hydroclone	-	-	-	-	-	-	-	-	-	-	-	-
Pressure, psig												
Unit Back Pressure	2500	----------			2490	2500	----------					
Hydrogen Make-Up	2500	2500	2515	2480	2450	2500	2505	2525	2505	2510	2500	2500
Hydrogen Partial Pressure (Reactor Outlet)			1800									
Recycle Gas, MSCF/Ton Dry Coal		32.9	40.7	23.4			19.0	29.8	34.5	33.7	31.0	29.2
Vent Gas, MSCF/Ton Dry Coal		2.3	2.0	2.3			2.1	2.1	2.6	3.2	3.3	2.9
Hydrogen Purity of Recycle + Vent Gas, %		92.0	91.5	89.8			88.8	90.4	88.9	89.2	90.1	88.6
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)		36.0	41.3	25.6			19.2	30.8	34.5	34.1	32.4	30.0
Make-Up + Recycle Hydrogen												
MSCF/Ton Dry Coal		45.8	52.6	35.9			30.1	40.9	44.4	43.2	41.1	38.4
V % of Make-Up + Recycle Gas		94.6	93.8	93.8			93.4	93.5	92.1	92.2	93.0	92.0
Hydrogen Partial Pressure, psig		2365	2360	2325			2340	2360	2305	2315	2325	2300
Hydrogen Consumption												
MSCF/Ton Dry Coal		9.8	11.3	10.4			10.9	10.0	9.9	9.1	8.7	8.4
W % Dry Coal		2.6	3.0	2.8	2.9	2.7	2.6	2.4	2.3	2.2		
Oil Additions												
Make-Up Oil, Lbs/Lb Dry Coal	0.059	0.059	0	0.060	0.058	0.073	0.046	0	0	0	0	0.022
Lbs/Hr/Ft^3	3.6	3.5	0	3.5	3.6	3.7	2.8	0	0	0	0	1.4
Flush Oil, Lbs/Lb Dry Coal	0.003	0.003	0.004	0.004	0.003	0.004	0.003	0.003	0.004	0.003	0.003	0.003

* Total to reactor, includes make-up oil

Period	9A	9B	10	11	12A	12B	13A	13B	14	15	16	17
OPERATING RESULTS												
Collected Product Quantities, W % Dry Coal												
Atmospheric Still Overhead	13.2	10.2	14.3	14.8	14.0	6.4	7.5	12.6	14.7	14.5	15.4	15.0
Atmospheric Still Bottoms(1)	9.9	0.3	0.5	-3.3	-7.9	-43.2	0.1	0	0	-0.4	-1.6	-1.0
Vacuum Still Overhead(1)	1.2	0.1	0.3	-0.2	11.8	0	0.9	0.3	0.2	0.2	0.4	0.1
Vacuum Still Bottoms	72.0	77.5	71.6	82.4	65.4	118.9	79.1	77.3	73.6	75.2	76.2	77.6
H_2O(2)	8.1	18.1	7.3	9.1	7.7	1.4	5.8	11.2	7.7	9.4	8.8	8.5
C_1-C_3		3.0	2.7	3.1			2.1	2.2	2.4	2.4	2.4	2.6
C_4-C_6		2.4	1.7	1.8			1.8	1.6	1.3	1.2	1.3	1.1
H_2S		1.5	1.0	0.9			1.3	1.0	1.0	1.0	1.0	1.0
CO_2 and CO		0.6	0.5	0.5			0.4	0.5	0.5	0.4	0.4	0.5
Total		113.7	99.9	109.1			99.0	106.7	101.4	103.9	104.3	105.4
Input Quantities, W % Dry Coal												
Dry Coal	100.0	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Moisture in Feed Coal	1.9	1.9	1.8	1.9	1.7	1.7	1.3	1.6	1.7	2.0	1.9	1.8
Make-Up Oil Additions	5.9	5.9	0	6.0	5.8	7.3	4.6	0	0	0	0	2.2
Flush Oil	0.3	0.3	0.4	0.4	0.3	0.4	0.3	0.3	0.4	0.3	0.3	0.3
Hydrogen Reacted		2.6	3.0	2.8			2.9	2.7	2.6	2.4	2.3	2.2
Total Used for Normalization		110.7	105.2	111.1			109.1	104.6	104.7	104.7	104.5	106.5
Normalized Net Product Distribution, W % Dry Coal												
CO, CO_2		0.54	0.55	0.48				0.48	0.49	0.39	0.44	0.46
C_1-C_3 Hydrocarbons in Gases		2.71	2.79	3.13				2.19	2.54	2.43	2.39	2.56
C_4-C_6 Hydrocarbons in Gases		2.22	1.77	1.75				1.55	1.34	1.22	1.27	1.20
IBP-400°F Naphtha		5.96	9.85	9.97				8.14	8.98	8.63	8.98	8.46
400-650°F Distillates		8.84	5.61	7.14				9.75	11.93	13.30	12.49	9.21
650-975°F Distillates			9.38									
975°F+ Residual Oil - Benzene-Soluble		28.38	27.43	28.50				27.94	32.23	30.61	27.63	33.96
Benzene-Insoluble		14.79	14.38	17.83				15.28	13.09	14.59	12.21	12.26
Unreacted Coal		11.86	11.67	12.35				14.33	12.00	9.97	16.08	13.71
Ash		10.40	11.51	12.26				11.51	11.87	11.74	11.81	11.49
H_2O (Net)		14.75	5.19	7.34				9.49	6.14	7.44	6.93	6.84
NH_3 (Forced Nitrogen)			0.56									
H_2S (Forced Sulfur)		2.11	2.08	1.97				1.99	2.03	2.07	2.07	2.06
Total (100 + Hydrogen Reacted)		102.55	102.76	102.71				102.65	102.62	102.39	102.29	102.22
ANALYSES												
Atmospheric Still Overhead												
Gravity, °API	37.0	35.1	35.3	35.4	35.5	31.6	35.9	34.1	33.4	33.5	32.0	32.7
IBP, °F	158	150	148	144	142	138	142	154	138	136	132	140
EP, °F	534	524	515	523	550	525	522	504	500	513	520	528
V % @ 400°F	75	66	68	68	68	57	70	67	62	62	61	59
Gravity, °API, IBP-400°F			37.5									
400°F-EP			22.5									
Carbon, W %			86.52									
Hydrogen, W %			12.40									
Nitrogen, W %			0.13									
Sulfur, W %			0.22									
Phenols, V % Total			4.1									
Atmospheric Still Bottoms												
Gravity, °API	16.5	15.9	16.1	16.4	16.4	14.9	15.4	15.8	15.4	15.6	15.6	15.5
IBP, °F		395	(321)	393	404	432		382	340	344	386	410
EP, °F		720	(755)	709	706	700		716	704	708		
V % @ 400°F		2	(3)	2				2	1	1	1	
V % @ 650°F		92	(90)	91	91	92		91	90	89	86	88
Gravity, °API, IBP-650°F			16.8									
650°F+			5.9									
Carbon, W %			89.34									
Hydrogen, W %			10.19									
Nitrogen, W %			0.17									
Sulfur, W %		<0.03	<0.03	<0.03	<0.03	0.03		<0.03	<0.03	0.02	<0.03	0.02
Vacuum Still Overhead												
Gravity, °API	4.4	5.0	5.7	6.5	7.0		4.3	4.3	5.4	4.9	5.5	5.8
IBP, °F		468	(407)	486	508			510	520	520	522	524
EP, °F			(870)									
V % @ 650°F		33	(48)	45	53			40	38	36	36	47
Carbon, W %			89.84									
Hydrogen, W %			8.98									
Nitrogen, W %			0.34									
Sulfur, W %		0.10	0.03	0.06	0.12			0.09	0.11	0.12	0.09	0.11

(1) Negative Quantities of Atmospheric Still Overhead and Vacuum Overhead Represent Decrease in Inventory of Slurry Oil Drum

(2) Includes Dissolved NH_3 and H_2S Distillation - All ASTM D 86 Except Bracketed Values by ASTM D 1160

Period	9A	9B	10	11	12A	12B	13A	13B	14	15	16	17
ANALYSES (CONTINUED)												
Water												
Nitrogen			2.38									
Sulfur, W %			2.32									
Carbon, W %			1.13									
0-12 Liquid												
Gravity, °API		15.4	15.1	16.0		16.3		14.8	15.6	14.6	14.7	14.5
H_2O, W %			0.0									
0-5 Liquid												
Gravity, °API	18.5	17.8	17.0	17.5	17.8	15.1	16.7	17.0	16.7	16.7	16.9	16.6
Ash, W %			0.0003	0.0007	0.0013	0.0011	0.0002	0.0005	0.0014	0.0002	0.0011	0.0040
H_2O, W %			2.52									
Vacuum Still Bottoms												
W % of Flows from Vacuum Still	62.7	59.5	55.1	62.6	53.0	100.0	54.4	52.4	48.8	52.0	54.3	50.2
Benzene-Soluble, W %		47.68	49.59	49.02				46.41	50.91	51.61	47.07	51.64
Benzene-Insoluble, W %		37.63	34.96	36.25				38.59	33.32	32.74	37.35	33.52
Ash, W %		14.69	15.45	14.73				15.00	15.77	15.65	15.58	14.84
Unreacted Coal, W % (Estimated)		16.75	15.66	14.84				18.68	15.94	13.29	21.08	17.39
Benzene-Insoluble Residuum, W % (Est.)		20.88	19.30	21.41				19.91	17.38	19.45	16.27	16.13
Carbon, W %			71.50									
Hydrogen, W %			5.10									
Nitrogen, W %			0.98									
Sulfur, W %	2.28	2.26	2.17	2.06	2.03		2.20	2.22	2.22	2.19	2.21	2.17
ASTM Ash, W %	15.82	15.75	15.51	14.97	14.50		15.25	14.93	15.21	15.84	15.71	15.38
Benzene-Soluble Oil, IBP, °F			738									
738-975°F, W %			25.8									
975°F+, W %			74.2									
Filter Cake												
W % of Feed to Vacuum Still		33.3	32.0	35.3				25.6	27.6	28.8	33.8	25.0
Benzene-Soluble, W %		40.04	36.74	28.63				29.23	34.49	24.37	26.98	40.39
Benzene-Insoluble, W %		35.33	34.53	38.16				41.64	34.95	36.61	43.42	34.15
Ash, W %		24.63	28.73	33.21				29.13	30.56	39.02	29.60	25.46
Benzene-Insoluble Residuum, W % (Est.)		7.24	5.41	4.71				5.36	4.06	3.47	3.36	4.32
Unreacted Coal, W % (Est.)		28.09	29.12	33.45				36.28	30.89	33.14	40.06	29.83
Ash Content, W %												
0-13 Bottoms		9.18	9.01	8.87				7.49	8.73	8.76	8.37	7.02
Slurry Mixing Tank			3.15	3.29				2.07	2.75	3.47	3.50	2.63
Internal Recycle Oil (Flashed)		7.84	8.75	7.69				9.70	9.49/ 7.94	8.57/ 9.79	8.28/ 8.83	7.87/ 8.19
Atmospheric Still Overhead - 400°F+												
Sulfur, W %	0.03	0.02	0.07	0.05	0.02	0.03	0.01	0.03	0.03	0.02	0.05	0.03
Vacuum Still Bottoms												
IBP-975°F Gravity, °API			-5.5									
Sulfur, W %			0.35									
975°F+ Sulfur, W %			1.20									

Period	9B	10	11	12A	12B	13A	13B	14	15	16	17
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS											
Distillation of Filtrate from Filtration Operation											
Vacuum Distillation											
Final Vapor Temperature, °F	530	543	532				534	527	515	542	*
Pressure, Torr	1.8	0.3	0.8				0.8	6.4	0.0	1.5	0.4
Residue, W % of Filtrate	41.3	40.9	40.1				37.6	38.9	38.0	36.2	29.9
Benzene-Insoluble, W %	36.69	37.12	40.90				40.58	34.37	36.50	42.04	31.33
Carbon, W %		84.95									
Hydrogen, W %		5.88									
Nitrogen, W %		1.38									
Sulfur, W %	1.21	1.20	1.17				1.32	1.25	1.26	1.24	1.34
Ash, W %	0.18	0.28	0.24				0.37	0.24	0.20	0.12	0.20
IBP-975°F, W %		9.8									
975°F+, W %		90.2									
Batch Distillation of Vacuum Bottoms Slurry Product											
Vacuum Distillation											
Final Vapor Temperature, °F	470	390	486				482	489	465	466	447
Pressure, Torr	5.0	15.0	1.2				1.4	1.5	1.2	2.2	7.0
Distillate, W % of Vacuum Bottoms Slurry	5.8	4.8	15.2				10.2	9.7	11.0	11.8	10.3
Gravity, °API	-1.4	-0.1	-4.5				-8.6	-4.5	-3.2	-2.3	0.1
Carbon, W %		88.78									
Hydrogen, W %		8.10									
Nitrogen, W %		0.62									
Sulfur, W %	0.36	0.27	0.36				0.43	0.42	0.31	0.36	0.30
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product											
Constitution, W %											
Batch Still Distillate from Slurry Product	11.2	8.7	26.9				16.0	14.4	17.4	21.1	18.8
Batch Still Residue from Filtrate	83.8	91.3	73.1				84.0	85.6	82.6	78.9	81.2
Composition, W % (Calculated)											
Sulfur, W %	1.11	1.12	0.95				1.18	1.13	1.11	1.05	1.14
Ash	0.16	0.26	0.18				0.31	0.21	0.17	0.09	0.16
Calculated Composition of 400°F+ Liquid											
Constitution, W %											
Atmospheric Still Overhead, 400°F+	6.5	8.9	9.4				8.3	10.6	9.9	12.2	11.8
Atmospheric Still Bottoms	0.7	0.8	-6.6				-0.2	-0.2	-0.8	-3.6	-1.7
Vacuum Still Overhead	-0.5	-0.1	-12.5				-4.2	-0.2	-0.2	0.0	-4.4
Vacuum Still Bottoms	93.4	90.2	109.7				96.1	89.8	91.1	91.5	94.3
Composition, Calculated											
Sulfur, W %	1.04	1.06	1.09				1.14	1.04	1.03	1.00	1.15
Ash	0.15	0.23	0.20				0.30	0.19	0.15	0.07	0.15

* Thermocouple Broke

RUN 130-76 - H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO.6 COAL (HRI 3767)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates (HRI 3556), 45.2 Pounds Dry

Reactor Liquid Phase Depth - 19 Feet, Volume 3.7 Ft^3

Period	18	19A	19B	20	21A	21B	22	23	24A
Date (End of Period), 1976)	3/3	3/3	3/4	3/5	3/5	3/6	3/7	3/7	3/7
Hours of Run - Beginning	339	351	363	375	399	411	423	447	471
End	351	363	375	399	411	423	447	471	475
Catalyst Age, Lbs Dry Coal/Lb Catalyst									
Beginning	1687	1812	1873	1935	2058	2119	2181	2306	2430
End	1812	1873	1935	2058	2119	2181	2306	2430	2451
Coal Feed Rate, Lbs Dry Coal/Hour/ Ft^3 Reactor Liquid Phase	64.2	62.8	62.9	62.5	62.3	62.5	63.9	62.8	63.9
Feed Coal									
W % Moisture	1.72		1.62	1.52	1.65		1.61	1.45	
% Ash (Dry Basis)	11.43		11.45	11.83	11.38		11.36	11.14	
Recycle Flows, Lbs/Lb Dry Coal									
Atmospheric Still Bottoms	2.54	2.64	2.61	2.50	2.17	1.34	1.40	1.32	1.27
Vacuum Still Overhead	0.60	0.53	0.61	0.69	0.66	0.58	0.51	0.56	0.73
Inventory Change	0.02	-0.03	-0.04	0.02	-0.04	0.06	0	0	0.02
Hydroclone Overflow	0	0	0	0	0	1.14	1.23	1.45	1.10
Total *	3.16	3.24	3.31	3.34	2.99	3.04	3.14	3.33	3.08
Temperatures, °F									
Coal Preheater Outlet	723	723	729	722	723	711	716	717	716
Reactor Liquid Phase, Average	824	824	826	825	824	825	825	825	825
Separator, Average	777	772	776	776	772	779	779	776	774
Vacuum Flash Zone	537	527	522	519	549	521	541	535	533
Pressure in Vacuum Flash, Torr	41	18.4	18.4	18.8	18.9	17.5	16.9	16.9	17.1
Hydroclone	-	-	-	-	-	500	518	518	504
Pressure, psig									
Unit Back Pressure	2500	----------	----------	----------	----------	----------	----------	----------	----------
Hydrogen Make-Up	2500	----------	----------	----------	----------	2540	2535	2555	2560
Hydrogen Partial Pressure (Reactor Outlet)						1817	1825		
Recycle Gas, MSCF/Ton Dry Coal	29.1	31.5	38.3	40.1	41.9	38.0	38.0	38.6	
Vent Gas, MSCF/Ton Dry Coal	2.9	3.1	2.5	2.5	4.5	6.2	6.0	6.9	
Hydrogen Purity of Recycle + Vent Gas, %	89.6	90.2	89.1	89.4	89.8	89.3	89.7	88.6	
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)	30.2	32.7	37.8	39.5	42.8	40.5	40.7	41.5	
Make-Up + Recycle Hydrogen									
MSCF/Ton Dry Coal	38.1	41.0	46.0	48.1	50.6	47.9	48.0	48.3	
V % of Make-Up + Recycle Gas	92.7	93.0	91.7	91.9	92.2	92.2	92.4	91.6	
Hydrogen Partial Pressure, psig	2315	2325	2290	2295	2305	2340	2340	2340	
Hydrogen Consumption									
MSCF/Ton Dry Coal	7.9	8.3	8.2	8.6	7.8	7.4	7.3	6.8	
W % Dry Coal	2.1	2.2	2.2	2.3	2.1	2.0	2.0	1.8	
Oil Additions									
Make-Up Oil, Lbs/Lb Dry Coal	0.044	0.036	0.054	0.172	0.118	0.036	0	0	0
Lbs/Hr/Ft^3	2.8	2.2	3.4	10.8	7.3	2.2	0	0	0
Flush Oil, Lbs/Lb Dry Coal	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003

* Total to reactor, includes make-up oil

Period	18	19A	19B	20	21A	21B	22	23	24A
OPERATING RESULTS									
Collected Product Quantities, W % Dry Coal									
Atmospheric Still Overhead	14.9	15.3	8.4	18.8	17.1	18.7	14.8	14.6	17.2
Atmospheric Still Bottoms(1)	1.8	-1.8	-2.5	2.1	-2.4	4.9	0.6	0.8	1.6
Vacuum Still Overhead(1)	0.9	-0.2	-0.2	0.8	-0.6	2.4	0.6	0.6	0.9
Vacuum Still Bottoms	87.6	82.9	80.3	85.3	79.4	72.3	69.0	72.8	65.7
H_2O(2)	7.8	7.4	16.4	12.4	8.8	8.5	8.5	8.6	9.1
C_1-C_3	2.3	2.4	2.3	2.3	2.3	3.0	3.0	3.6	
C_4-C_6	1.1	1.2	0.9	1.1	1.1	1.3	1.2	1.4	
H_2S	1.0	0.9	0.9	1.1	1.1	1.5	1.6	1.8	
CO_2 and CO	0.5	0.4	0.4	0.4	0.5	0.6	0.6	0.7	
Total	108.9	108.5	106.9	124.3	107.3	113.2	99.9	104.9	
Input Quantities, W % Dry Coal									
Dry Coal	100.0	----------	----------	----------	----------	----------	----------	----------	----------
Moisture in Feed Coal	1.8	1.6	1.6	1.6	1.7	1.7	1.7	1.5	1.5
Make-Up Oil Additions	4.4	3.6	5.4	17.2	11.8	3.6	0	0	0
Flush Oil	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Hydrogen Reacted	2.1	2.2	2.2	2.3	2.1	2.0	2.0	1.8	
Total Used for Normalization	108.6	107.7	109.5	121.4	115.9	107.6		103.9	103.6
Normalized Net Product Distribution W % Dry Coal									
CO, CO_2	0.43		0.44	0.36		0.54	0.57	0.67	
C_1-C_3 Hydrocarbons in Gases	2.14		2.34	2.29		2.79	3.10	3.70	
C_4-C_6 Hydrocarbons in Gases	1.08		0.91	1.04		1.19	1.26	1.47	
IBP-400°F Naphtha	7.40		4.57	7.55		7.24	7.79	8.43	
400-650°F Distillates	15.43		7.04	7.83		19.69	16.82	7.15	
650-975°F Distillates				6.21				12.19	
975°F+ Residual Oil - Benzene-Soluble	31.56		29.32	26.99		26.52	24.77	24.84	
Benzene-Insoluble	8.93		13.96	11.04		14.11	15.63	10.02	
Unreacted Coal	15.40		14.31	16.00		9.82	10.71	13.61	
Ash	11.88		12.34	11.31		11.45	11.93	11.51	
H_2O (Net)	5.65		14.99	9.92		6.35	7.14	6.58	
NH_2 (Forced Nitrogen)				0.10				0.09	
H_2S (Forced Sulfur)	2.14		2.04	2.11		2.27	2.23	2.24	
Total (100 + Hydrogen Reacted)	102.05		102.15	102.75*		101.97	101.94	102.50*	
ANALYSES									
Atmospheric Still Overhead									
Gravity, °API	31.9	32.2	31.3	26.7	25.6	25.8	28.0	29.3	29.7
IBP, °F	140	136	140	143		154	139	134	138
EP, °F	520	530	542	577		562	549	530	520
V % @ 400°F	55	59	56	43		43	53	60	64
Gravity, °API, IBP-400°F				35.9				35.2	
400°F-EP				19.3				20.6	
Carbon, W %				86.70				86.05	
Hydrogen, W %				11.29				10.87	
Nitrogen, W %				0.18				0.25	
Sulfur, W %				0.12				0.21	
Phenols, V %								10.0	
Atmospheric Still Bottoms									
Gravity, °API	14.6	13.7	14.1	10.8	9.5	9.3	10.2	11.3	11.4
IBP, °F	406		360	(379)		416	432	(351)	446
EP, °F			700	(765)				(755)	
V % @ 400°F			1	(1)				(1)	
V % @ 650°F	91		91	(89)		84	84	(87)	81
Gravity, °API, IBP-650°F				10.5				12.8	
650°F+				0.5				5.2	
Carbon, W %				89.93				88.77	
Hydrogen, W %				8.99				9.45	
Nitrogen, W %				0.23				0.23	
Sulfur, W %	0.02		0.01	0.02		0.04	0.03	0.09	0.06
Vacuum Still Overhead									
Gravity, °API	5.8	4.8	6.1	3.7	3.4	5.6	6.3	7.7	8.9
IBP, °F	528		528	(448)		480	484	(399)	482
EP, °F				(765)				(840)	
V % @ 650°F	52		56	(58)		66	60	(70)	65
Gravity, °API, IBP-650°F				5.0				10.7	
650°F+				-0.8				3.4	
Carbon, W %				90.97				89.48	
Hydrogen, W %				7.98				9.20	
Nitrogen, W %				0.30				0.22	
Sulfur, W %	0.12		0.09	0.14		0.02	0.06	0.03	0.05

* Hydrogen Consumption from Feed Product Analyses

(1) Negative Quantities of Atmospheric Still Overhead and Vacuum Overhead Represents Decrease in Inventory of Slurry Oil Drum

(2) Includes Dissolved NH_3 and H_2S

Distillation - All ASTM D 86 Except Bracketed Values by ASTM D 1160

Period	18	19A	19B	20	21A	21B	22	23	24A
Water									
Nitrogen, W %				2.99				3.33	
Sulfur, W %				1.24				2.59	
Carbon, W %				1.76				1.11	
Phenols, g/l								7.9	
0-12 Liquid									
Gravity, °API	14.5		13.8	9.3			10.7	11.9	
Water, W %				0.46				1.41	
0-5 Liquid									
Gravity, °API	15.7	15.0	14.8	11.9	11.1	10.5	11.6	12.2	12.9
Ash, W %	0.0008	0.0023	0.0013	0.0010	0.0017	0.0008	0.0027	0.0027	0.0344
Water, W %				1.71					
Vacuum Still Bottoms									
W % of Flows from Vacuum Still	45.5	48.3	45.7	45.0	43.6	43.6	44.8	44.5	38.1
Benzene-Soluble, W %	50.04		50.89	53.77		49.02	46.34	48.84/ 51.37	
Benzene-Insoluble, W %	34.78		34.07	32.63		34.48	36.93	40.54/ 32.70	
Ash, W %	15.18		15.04	13.60		16.50	16.73	16.62/ 15.93	
Unreacted Coal, W % (Estimated)	20.10		17.95	19.22		14.58	15.01	18.83	
Benzene-Insoluble Residuum, W % (Estimated)	14.68		16.12	13.42		18.90	21.92	13.87	
Carbon, W %				73.76				71.80	
Hydrogen, W %				5.21				5.00	
Nitrogen, W %				1.36				1.38	
Sulfur, W %	2.17	2.13	2.09	2.11	2.07	2.14	2.13	2.09	2.06
ASTM Ash, W %	15.22	14.21	15.01	14.07	14.49	16.95	16.86	16.58	
Benzene-Soluble Oil, IBP, °F				535				704	
IBP-650°F, W %				3.32					
650-975°F, W %				36.68				33.1	
975°F+, W %				60.00				66.9	
Filter Cake									
W % of Feed to Vacuum Still	28.7		32.8	22.6		28.4*	9.5	22.2	
Benzene-Soluble, W %	29.52		33.64	24.45		33.38	45.71	34.74	
Benzene-Insoluble, W %	41.25		37.56	45.02		32.80	28.79	36.62	
Ash, W %	29.23		28.80	30.53		33.82	25.50	28.64	
Benzene-Insoluble Residuum, W % (Estimated)	2.55		3.20	1.86		3.57	5.91	2.76	
Unreacted Coal, W % (Estimated)	38.70		34.36	43.16		29.23	22.88	15.01	
Ash, W %									
0-13 Bottoms	7.48		7.35	6.42		9.29			
Slurry Mixing Tank	3.05		3.54	3.45	4.10		5.60/ 6.39	5.81	
Internal Recycle Oil (Flashed)	7.81	8.24	8.56	7.97/ 7.67	6.94	9.47	9.03/ 9.74	10.35/ 8.96	
Hydroclone Feed									
Ash, W %						8.01	9.75	7.33	
Ash, W %**						7.60	9.77	7.03	
Ash, W %***						7.27	7.54	7.02	
Hydroclone Overflow									
Ash, W %						7.10	7.55	6.62	
Hydroclone Underflow									
Ash, W %						7.94	11.53	7.40	
Atmospheric Still Overhead									
400°F+ Sulfur, W %	0.01	0.02	0.03	0.02	0.05	0.11	0.07	0.10	
Vacuum Still Bottoms									
IBP-975°F									
Gravity, °API				-7.1					
Carbon, W %								88.48	
Hydrogen, W %								7.43	
Sulfur, W %				0.37				0.38	
Nitrogen, W %								0.83	
975°F+									
Carbon, W %								85.63	
Hydrogen, W %								5.78	
Nitrogen, W %								1.71	
Sulfur, W %								1.15	
Ash, W %								0.30	

* 0-13 Bottoms

** Calculated from Overflow and Bottoms Analyses, Flows

*** Calculated from Overflow and Vacuum Still Bottoms Analyzing Flows

Period	18	19B	20	21B	22	23
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS						
Distillation of Filtrate from Filtration Operation						
Vacuum Distillation						
Final Vapor Temperature, °F	538	538	510	519		555
Pressure, Torr	1.0	1.3	4.3	0.2		2.4
Residue, W % of Filtrate	29.0	27.7	28.8	42.1		27.3
Benzene-Insoluble, W %	31.46	34.01	37.94	41.77		44.68
Carbon, W %						85.08
Hydrogen, W %						5.94
Nitrogen, W %						1.57
Sulfur, W %	1.37	1.27	1.27	1.07		1.15
Ash, W %	0.50	0.00	0.05	0.38	15.55*	0.30
IBP-975°F, W %						4.9
975°F+, W %						95.1
Batch Distillation of Vacuum Bottoms Slurry Product						
Vacuum Distillation						
Final Vapor Temperature, °F	--	485	460	482	488	485
Pressure, Torr	1.2	1.8	2.8	0.8	1.8	2.4
Distillate, W % Vacuum Bottoms Slurry	9.7	15.8	16.0	11.3	9.7	11.2
Gravity, °API	-6.0	-2.5	-7.8	-5.6	-4.0	-9.4
Carbon, W %						87.95
Hydrogen, W %						7.91
Nitrogen, W %						0.74
Sulfur, W %	0.30	0.35	0.33	0.42	0.44	0.38
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product						
Constitution, W %						
Batch Still Distillate from Slurry Product	17.6	28.0	24.4	16.3	14.2	19.0
Batch Still Residue from Filtrate	82.4	72.0	75.6	83.7	85.8	81.0
Composition, W % (Calculated)						
Sulfur, W %	1.18	1.01	1.04	0.96		1.00
Ash, W %	0.41	0.00	0.04	0.32		0.24
Calculated Composition of 400°F+ Liquid						
Constitution, W %						
Atmospheric Still Overhead, 400°F+	12.0	7.9	20.9	17.5	13.2	11.3
Atmospheric Still Bottoms	2.9	-4.8	4.0	5.3	1.3	1.5
Vacuum Still Overhead	0.8	-11.8	-32.2	-2.5	0.4	0.3
Vacuum Still Bottoms, Solids-Free Oil	84.2	108.6	107.3	79.8	85.1	86.9
Composition						
Sulfur, W %	1.03	1.16	1.12	0.78	(0.86)	0.91
Ash, W %	0.33	0.00	0.04	0.26		0.21

* Paper Leaked During Filtration

PDU RUN 2 - ILLINOIS NO. 6 COAL - FUEL OIL MODE

Although the fuel oil mode had been demonstrated in terms of coal feed space velocity, hydrogen partial pressure and hydrogen ration, Pilot Plant gas velocities were not simultaneously attained due to the lower L/D of the PDU reactor. As previous work had shown that linear gas velocity was an important factor in entrainment and ebullating flow control, as well as a potential factor in catalyst attrition and carryover, this run was designed to demonstrate the fuel oil mode at the Pilot Plant design gas velocity.

The target was a seven-day operation at a gas velocity in the 0.17 to 0.18 fps range to prove operability and to determine if catalyst loss through attrition and/or carryover occurred under these conditions. The run lasted for 272 hours (1509 lbs coal/lb catalyst) with the last seven days achieving the targeted gas velocity with stable ebullating flow. The coal feed rate was 78 lbs/hr/ft^3 of reactor and reactor slurry composition was close to that achieved during PDU Run 1. Coal conversion was about 91% throughout with the 400°F$^+$ fuel oil yield holding at about 54%.

The coal feed for this run was that used in all previous PDU runs in this program, Burning Star Mine, Illinois No. 6 coal.

ANALYSIS OF BURNING STAR MINE, ILLINOIS NO.6 COAL

USED IN RUN 130-77

Hours of Run	As Received	0-272
HRI Number	3751	3751/3767
Moisture, W %	12.21	2.13
Proximate, Dry Basis, W %		
Ash	9.87	11.09
Volatile Matter	34.68	40.30
Fixed CArbon	55.45	48.61
Ultimate Analysis, Dry Basis, W %		
Carbon	71.59	68.88
Hydrogen	4.51	4.54
Nitrogen	1.24	1.06
Sulfur	3.47	3.53
Ash	9.87	11.09
Chlorine	0.08	0.03
Oxygen (Difference)	9.29	10.87
Btu (Dry Basis), Gross		12,529
Sulfur Types		
Pyritic	1.56	1.38
Sulfate	0.11	0.01
Organic	1.80	1.95
Total	3.47	3.34
Mineral Analysis, W % Ignited Basis		
Phosphorous Pentoxide, P_2O_5		0.07
Silica SiO_2		47.60
Ferric Oxide Fe_2O_3		19.09
Alumina Al_2O_3		20.62
Titania TiO_2		0.82
Lime CaO		5.80
Magnesia MgO		0.95
Sulfur Trioxide SO_3		2.74
Potassium Oxide K_2O		1.77
Sodium Oxide Na_2O		0.48
Undetermined		0.06
Alkali, W % of Dry Coal		0.18
Iron, W % of Dry Coal		1.44
Screen Size (U.S.S.)		
+50		3.20
50/70		4.71
70/100		8.35
100/140		11.57
140/200		10.79
200/325		22.32
325/Pan		39.06

RUN 130-77 - H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO. 6 COAL (HRI 3751/3767)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates (HRI 3556), 50.4 Pounds Dry

Reactor Liquid Phase Depth - 19 Feet, Volume 3.7 Ft^3

Period	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6	7	8	9	10	11	12A
Date (End of Period), 1976	3/28	3/29	3/29	3/30	3/30	3/31	3/31	4/1	4/1	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/8
Hours of Run - Beginning	0	12	24	36	48	60	72	84	96	108	120	144	168	192	216	240	264
End	12	24	36	48	60	72	84	96	108	120	144	168	192	216	240	264	272
Catalyst Age, Lbs Dry Coal/ Lb Catalyst - Beginning	0	46	102	162	233	313	390	449	518	586	654	788	923	1058	1191	1330	1466
End	46	102	162	233	313	390	449	518	586	654	788	923	1058	1191	1330	1466	1509
Coal Feed Rate, Lbs Dry Coal/ Hour/ Ft^3 Reactor Liquid Phase	51.7	64.5	67.2	81.1	91.3	86.9	67.1	77.8	77.5	77.6	76.0	76.6	76.3	75.8	79.1	77.0	74.0
Feed Coal																	
W % Moisture		2.62	1.12	0.95	1.67	1.47	1.17	1.66		1.54	2.05	1.67	2.05	2.37	1.97	2.23	
% Ash (Dry Basis)		11.66	11.22	11.16	10.99	11.00	11.27	11.41		11.18	11.02	10.74	10.74	10.85	11.23	10.99	
Recycle Flows, Lbs/Lb Solids																	
Atmospheric Still Bottoms	1.42	2.38	2.82	2.11	1.53	0.94	1.66	1.52	1.59	1.64	1.85	1.75	1.81	1.92	1.63	1.57	1.88
Vacuum Still Overhead	0.65	0.51	0.35	0.28	0.27	0.01	0.15	0.24	0.26	0.27	0.16	0.12	0.11	0.05	0.22	0.09	0
From Inventory	+0.31	+0.03	+0.02	+0.01	-0.05	+0.06	-0.24	-0.11	-0.04	-0.04	-0.05	-0.02	-0.05	-0.04	-0.07	0.03	-0.02
Hydroclone Overflow (Oil)	0	0	0	0	0.49	0.95	1.14	1.00	1.01	1.01	0.92	0.94	0.97	0.80	0.88	1.02	1.00
Total *	2.59	3.02	3.28	2.40	2.26	2.59	3.21	2.65	2.82	2.88	2.88	2.83	2.94	2.81	2.80	2.65	2.90
Temperatures, °F																	
Coal Preheater Outlet	618	679	694	707	704	675	671	696	720	730	732	736	743	744	754	751	754
Reactor Liquid Phase, Average	809	843	848	847	848	849	847	848	848	847	847	848	847	848	848	848	846
Separator, Average	717	776	767	771	780	787	764	759	776	772	779	771	789	791	779	788	788
Vacuum Flash Zone	462	492	510	519	511	398	542	540	563	566	565	564	556	552	517	577	548
Pressure in Vacuum Flash, Torr	10.2	9.3	9.1	9.6	10.1	33	106	38	35	33	23	17.5	48	35	28	35	25
Hydroclone	-	-	-	-	-	471	522	520	516	512	510	-	-	-	-	-	520
Pressure, psig																	
Unit Ba . Pressure	2500	2500	2500	2505	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
Hydrogen Make-Up	2530	2530	2535	2540	2530	2550	2560	2555	2530	2550	2565	2590	2595	2590	2585	2600	2605
Hydrogen Partial Pressure (Reactor Outlet)		1317		1562	1450			1687		1782	1805	1764	1850	1808	1830	1840	
Recycle Gas, MSCF/Ton Dry Coal	12.6	11.6	12.7	19.5	19.6	17.6	24.9	24.8	30.3	37.0	37.7	36.8	40.4	39.5	39.1	39.8	40.8
Vent Gas, MSCF/Ton Dry Coal	2.2	1.8	1.8	2.4	1.6	1.2	2.4	3.8	4.4	5.1	6.6	6.0	5.8	6.1	6.3	6.9	6.6
Hydrogen Purity of Recycle Gas + Vent, %	90.8	90.7	86.6	89.6	85.6	84.0	87.4	87.7	83.2	88.4	89.7	88.8	90.6	89.8	91.4	91.2	
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)	16.4	14.8	15.2	21.8	19.9	17.6	26.3	26.9	30.7	39.4	41.6	39.8	43.7	43.2	43.7	44.8	(45.3)
Make-Up + Recycle Hydrogen																	
MSCF/Ton Dry Coal	35.0	29.7	31.4	35.2	32.5	32.7	46.1	42.7	45.8	53.9	55.6	54.1	57.3	56.4	56.2	57.4	(59.3)
V % of Make-Up + Recycle Gas	96.8	96.5	94.9	94.5	92.0	92.1	93.6	93.3	90.0	92.6	93.5	92.9	93.8	93.4	94.4	94.2	
Hydrogen Partial Pressure, psig	2450	2440	2405	2400	2325	2345	2395	2385	2275	2360	2395	2405	2435	2415	2440	2450	
Hydrogen Consumption																	
MSCF/Ton Dry Coal	18.6	15.0	16.3	13.4	12.6	15.1	19.8	15.7	15.1	14.5	13.9	14.3	13.6	13.2	12.5	12.7	
W % Dry Coal	5.0	4.0	4.3	3.6	3.4	4.0	5.3	4.2	4.0	3.9	3.7	3.8	3.6	3.5	3.3	3.4	
Oil Additions																	
Make-Up Oil, Lbs/Lb Dry Coal	0.207	0.105	0.094	0	0.024	0.680	0.535	0	0	0	0	0	0	0	0	0	0
Lbs/Hr/Ft^3	10.7	6.8	6.3	0	2.2	59.1	36.0	0	0	0	0	0	0	0	0	0	0
Flush Oil, Lbs/Lb Dry Coal	0.004	0.003	0.003	0.002	0.002	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.002	0.003

*Include Make-Up Oil

RUN 130-77 - OPERATING RESULTS

Period	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6	7	8	9	10	11	12A
Collected Product Quantities																	
W % Dry Coal																	
Atmospheric Still Overhead	0.2	11.1	21.3	16.8	14.0	6.5	25.1	19.3	16.3	16.5	15.9	17.8	20.7	21.0	20.2	20.4	19.5
Atmospheric Still Bottoms (1)	-21.0	-1.6	-1.8	-0.5	4.7	-5.5	23.9	11.4	3.7	4.9	9.3	4.8	-5.0	-3.4	-6.4	3.9	-1.0
Vacuum Still Overhead (1)	-9.5	-0.1	0	0.1	0.8	0	2.3	2.2	0.9	1.1	0.8	0.2	0	0.2	-0.5	0.5	0.3
Vacuum Still Bottoms	105.6	76.5	68.7	65.9	55.5	124.0	98.6	60.0	59.1	59.9	59.3	59.5	65.6	68.4	70.1	65.2	71.9
H_2O (2)	2.8	16.3	7.9	13.0	12.6	27.4	7.4	9.0	9.1	10.0	9.3	9.3	8.8	8.9	9.3	8.9	8.1
C_1-C_3	2.9	3.8	4.7	3.8	3.6	4.8	5.2	4.9	5.5	5.4	5.2	5.4	5.1	5.4	5.3	5.4	
C_4-C_6	3.1	2.5	4.2	2.2	2.7	2.2	2.9	2.5	3.6	3.8	3.3	3.1	2.6	2.9	3.0	2.9	
H_2S	1.8	1.3	1.9	1.1	1.7	1.5	1.7	1.5	2.1	1.6	2.0	2.1	1.8	2.2	2.2	2.2	
CO_2 and CO	0.4	0.3	0.5	0.4	0.5	0.5	0.3	0.5	0.6	0.6	0.7	0.7	0.6	0.8	0.8	0.8	
Total	86.3	110.1	108.1	102.8	96.1	161.4	167.4	111.3	100.9	103.1	105.8	102.9	100.2	106.4	104.0	110.2	
Input Quantities, W % Dry Coal																	
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture In Feed Coal	2.7	2.7	1.2	1.0	1.7	1.5	1.2	1.7	1.6	1.6	2.1	1.7	2.1	2.4	2.0	2.3	2.3
Make Up Oil Additions	20.7	10.5	9.4	0	2.4	68.0	53.5	0	0	0	0	0	0	0	0	0	0
Flush Oil	0.4	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.3
Hydrogen Reacted	5.0	4.0	4.3	3.6	3.4	4.0	5.3	4.2	4.0	3.9	3.7	3.8	3.6	3.5	3.3	3.4	
Total Used for Normalization	128.8	117.5	115.2	104.8	107.7	173.8	160.3	106.2	105.9	105.7	106.1	105.8	106.0	106.2	105.6	105.9	
Coal Conversion		89.9		91.4				92.4	91.8	91.8	91.8	91.3	90.8	90.6	91.2	91.1	89.5
Normalized Net Product Distribution																	
W % Dry Coal																	
CO, CO_2		0.31		0.41				0.49		0.60	0.67	0.72	0.63	0.78	0.76	0.80	
C_1-C_3		4.02		3.82				4.65		5.53	5.30	5.47	5.37	5.41	5.32	5.28	
C_4-C_6		2.68		2.22				2.34		3.19	3.39	3.19	2.72	2.85	3.11	2.81	
IBP-400°F Naphtha		7.72		12.01				9.50		11.16	11.70	14.26	14.21	12.82	11.73	11.44	
400-650°F Distillates		9.05		16.13				28.28		20.83	11.72	16.33	14.95	14.22	15.96	11.26	
650-975°F Distillates											9.43					9.23	
975°F+ Residual Oil																	
Benzene Soluble		24.17		23.50				21.78		22.02	22.97	23.38	25.80	26.99	24.80	21.52	
Benzene Insoluble		14.11		9.51				9.54		10.27	10.84	10.69	10.00	11.54	12.88	12.85	
Unconverted Coal		11.80		9.99				7.20		7.84	7.25	8.31	8.94	8.59	8.92	8.46	
Ash		13.29		11.29				11.10		11.45	11.01	11.24	11.99	11.44	10.11	11.28	
H_2O (Net)		14.68		12.28				6.84		8.56	6.50	7.83	7.19	6.51	7.39	5.92	
NH_3 (Forced Nitrogen)											0.20					0.14	
H_2S (Forced Sulfur)		2.13		2.31				2.41		2.35	2.44	2.41	2.22	2.30	2.31	2.27	
Total (100 + Hydrogen Reacted)		103.94		103.93				104.13		103.80	103.41	103.81	103.51	103.46	103.28	103.27	

(1) Negative Quantities of Atmospheric Still Overhead and Vacuum Overhead Represent Loss in Inventory of Feed Coal Slurry Oil Tank

(2) Includes Dissolved NH_3 and H_2S

RUN 130-77 - ANALYSES

Period	1A	1B	2B	2B	3A	3B	4A	4B	5A	5B	6	7	8	9	10	11	12A
Atmospheric Still Overhead																	
Gravity, °API		34.9	35.0	36.1	33.7	32.2	28.7	28.9	33.6	34.3	35.[illegible]	36.2	33.7	32.5	32.9	33.0	32.7
IBP, °F		164	140	176	150	130		120		134	148	124	126	132	138	136	136
EP, °F		576	542	520	518	520		540		520	53[illegible]	505	510	505	522	536	544
V % @400°F		68	68	73	68	58		55		69	78	80	68	64	60	60	62
Gravity, °API																	
IBP-400°F											40.4					39.6	
400°F-EP											20.5					21.7	
Carbon, W %											84.79					85.63	
Hydrogen, W %											11.48					11.37	
Nitrogen, W %											0.18					0.16	
Sulfur, W %											0.07					0.05	
Phenols, V % Total											6.0					6.0	
V % IBP-400°F											5.0						
Atmospheric Still Bottoms																	
Gravity, °API	11.8	12.6	12.0	12.2	11.8	9.0	5.1	6.6	8.4	10.0	10.0	10.5	11.3	12.0	12.9	13.4	13.3
IBP, °F		350		356		368		394		384	(3[illegible]4)	398	390	40[illegible]	392	(334)	
EP, °F		712		734							810					795	
V % @400°F		<2		<2		<2		<1		<1	<2	<1	<1		<2		
V % @650°F		90		87		84		77		79	(80)	76	78	8[illegible]	84	(85)	
Gravity, °API																	
IBP-650°F											12.5					14.8	
650°F+											1.3					5.9	
Carbon, W %											88.91					87.92	
Hydrogen, W %											9.11					9.66	
Nitrogen, W %											0.30					0.24	
Sulfur, W %		<0.03		<0.03		0.09		<0.03		<0.03	0.02	<0.03	<0.03	0.02	<0.03	0.06	
Vacuum Still Overhead																	
Gravity, °API	2.4	4.2	2.1	1.5	2.5		-0.5	0.0	0.7	1.9	2.7	3.3	5.8	5.6	8.6	8.6	7.1
IBP, °F		496		510				470		448	(332)	436	436	430	432	(361)	
EP, °F											902					884	
V % @650°F		49		38				39		40	(51)	53	53	54	68	(65)	
Gravity, °API																	
IBP-650°F											9.0					11.1	
650°F+											-2.5					3.3	
Carbon, W %											90.02					89.55	
Hydrogen, W %											8.28					8.95	
Nitrogen, W %											0.48					0.35	
Sulfur, W %		<0.03		<0.03				0.07		0.08	0.10	0.09	0.08	0.[illegible]1	0.07	0.16	
Water																	
Nitrogen, W %											3.19					2.72	
Sulfur, W %											2.60					1.54	
Carbon, W %											1.55					1.67	
0-12 Liquid																	
Gravity, °API		12.3		13.0		5.5		7.3		8.0	8.9	9.0	10.3	11.8	13.3	12.5	
0-5 Liquid																	
Gravity, °API	13.6	16.4	15.8	15.6	15.3	13.5	9.9	10.1	11.5	12.1	12.9	13.4	13.9	14.4	14.7	15.1	15.4
Ash, W %		0.0001	0.0002	0.0001	0.0009	0.0004	0.0009	0.0003	0.0003	0.0003	0.0009	0.0016	0.0012	0.0012	0.0013	0.0030	0.0028

Distillations - All ASTM D86 Except Bracketed Values from ASTM D 1160

RUN 130-77 - ANALYSES (CONTINUED)

Period	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6	7	8	9	10	11	12A
Vacuum Still Bottoms																	
W % of Flows from Vacuum Still	53.8	47.6	50.6	55.2	51.4	92.3	75.5	53.0	51.1	51.1	56.2	53.3	61.6	66.6	57.7	63.8	70.8
Benzene--Soluble, W %		51.89		54.46				53.11		51.48	50.97	50.67	55.01	53.26	54.19	48.19	49.70
Benzene-Insoluble, W %		48.11		29.03				28.19		29.73	30.48	31.00	27.55	29.81	31.30	33.88	33.33
Ash, W %		16.31		16.51				18.70		18.79	18.55	18.33	17.44	16.93	14.51	17.93	16.97
Unreacted Coal, W % (Estimated)		10.82		14.73				12.12		12.87	12.22	12.22	13.56	12.72	12.81	13.43	
Benzene-Insoluble Residuum W % (Estimated)		20.98		14.30				16.07		16.86	18.26	18.26	17.44	17.09	18.49	20.43	
Carbon, W %											71.43					71.63	
Hydrogen, W %											4.52					4.55	
Nitrogen, W %											1.41					1.43	
Sulfur, W %	1.55	1.86	1.93	2.00	2.02		2.26	2.10	2.09	2.14	2.11	2.04	2.08	2.00	1.93	2.14	2.12
Oxygen, W % (By Difference)																	
ASTM Ash, W %	12.64	16.56	17.42	16.69	16.66		19.38	19.56	18.94	19.05	18.77	18.54	18.21	17.34	15.73	17.67	17.29
Coke/Ash Ratio (DMF Extraction)		0.700		0.693				0.573		0.642	0.660	0.636	0.690	0.708	0.711	0.685	0.752
Volatile Matter, W % (D-3175)											37.34	39.16	43.98	40.77	44.81	40.99	
Benzene Soluble Oil, IBP °F											758					510	
510-650°F, W %																1.0	
650-975°F, W %											24.1					29.2	
975°F+, W %											75.9					69.8	
Filter Cake																	
W % of Feed to Vacuum Still		21.6		24.6				25.1		26.0	33.3	8.6		34.1	21.1	28.6	22.1*
Benzene-Soluble, W %		33.84		34.87				31.89		30.37	31.00	30.73		30.57	25.07	25.69	37.61
Benzene-Insoluble, W %		29.03		32.82				28.97		30.38	30.07	31.99		32.71	37.06	34.56	34.23
Ash, W %		37.13		32.31				39.14		39.25	38.93	37.28		36.72	37.87	39.75	28.16
Benzene-Insoluble Residuum, W %		4.39		3.98				3.60		3.50	4.42	4.48		5.12	3.63	5.05	
Unreacted Coal, W % (Estimated)		24.64		28.84				25.37		26.88	25.65	27.53		27.59	33.43	29.51	
Carbon, W %											54.29						
Hydrogen, W %											4.04						
Nitrogen, W %											0.79					0.75	
Sulfur, W %											3.54					1.77	
O-13 Bottoms																	
Ash, W %		8.43		8.71													
Slurry Mixing Tank																	
Ash, W %		2.80		3.69				4.88		4.68	5.25	4.89	4.90	5.19	4.77	6.62	
Internal Recycle Oil (Flashed)																	
Ash, W %				7.76				7.12		6.80	8.02	7.46	8.24	8.30	8.13	9.29	

* Filtration of Period 11 Hydroclone Overflow Sample, Regular Filtration of Hydroclone Bottoms apparently failed (18.9 % Ash in 975°F+ Recovered)

RUN 130-77 - ANALYSES (CONTINUED)

Period	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6	7	8	9	10	11	12A
Hydroclone Feed																	
Ash, W %					9.41	0.41	6.34	7.23	7.00	6.81	8.11	8.91	8.31	9.13	7.65	8.46	9.71
Ash, W %*							6.79	7.22	7.30	7.41	8.06	8.88	8.87	9.98	7.69	8.38	9.97
Ash, W %**							9.16	7.41	7.10	7.08	8.09	8.44	8.48	9.65	7.20	8.60	9.93
Hydroclone Overflow																	
Ash, W %					7.94	3.85	3.72	4.56	4.60	4.47	5.81	6.37	6.07	7.80	5.01	6.52	8.28
Hydroclone, Underflow																	
Ash, W %					11.64	7.28	9.87	9.98	10.10	10.41	10.48	11.81	12.06	12.22	10.01	10.78	12.34
Atmospheric Still Overhead																	
IBP-400°F																	
Sulfur, W %											0.04					0.13	
Nitrogen, W %											0.12						
400°F+																	
Sulfur, W %		0.02	0.03	0.03	0.03	0.02		0.03		0.03	0.03	0.02	0.04	0.03	0.04	0.05	0.06
Nitrogen, W %											0.29						
Atmospheric Still Bottoms																	
IBP-650°F, Gravity, °API											12.6					14.8	
Sulfur, W %											0.03					0.03	
Nitrogen, W %											0.21						
650°F+, Gravity, °API																5.9	
Sulfur, W %											0.05					0.12	
Nitrogen, W %											0.45						
Vacuum Still Overhead																	
IBP-650, Gravity, °API											9.0					11.1	
Sulfur, W %											0.09					.03	
Nitrogen, W %											0.32						
650°F+, Gravity, °API											-2.5					3.3	
Sulfur, W %											0.11					0.22	
Nitrogen, W %											0.62						
Vacuum Still Bottoms, IBP-975°F, °API											-7.9					-6.8	
Carbon, W %											88.92					90.12	
Hyd gen, W %											7.25						
Sulfur, W %											0.29					0.25	
Nitrogen, W %											0.78					0.93	

* Caluclated from Overflow & Underflow analysis, flows

** C 'culated from Overflow & Vacuum Bottoms analyses, flows

RUN 130-77 CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS

Period	1B	2B	4B	5A	5B	6	7	8	9	10	11
Distillation of Filtrate From Filtration Operation											
Vacuum Distillation											
Final Vapor Temperature, °F	548	550	500		550	540	588		530	534	512
Pressure, Torr	1.3	0.4	1.0		2.0	0.5	0.8		2.0	2.0	1.3
Residuum, W % of Filtrate	28.9	32.6	46.8		39.7	46.1	43.6		46.4	38.7	43.8**
Analysis											
Volatile Matter (D-3175)						37.54	40.02				
Carbon, W %						88.22*					
Hydrogen						5.71*					
Nitrogen						1.76*					
Sulfur	0.84	0.96	0.72			0.82*	0.87		1.06	1.01	0.98
Ash	0.00	0.27	0.05			0.36*	0.25		0.31	0.38	0.23
IBP-975°F						4.6					
975°F+						95.4*					
Batch Distillation of Vacuum Bottoms Slurry Product											
Vacuum Distillation											
Final Vapor Temperature, °F	489	475	490				480	478		350	360
Pressure, Torr	1.4	2.1	1.3			1.7	1.4	2.0	2.0	2.0	2.0
Distillate, W % of Vacuum Bottoms Slurry	18.9	15.7	12.7			10.2	8.6	13.8	2.1	7.4	8.8
Analysis, Gravity, °API	-4.7	-2.1	-6.0			-6.0	-8.3	-3.1	-7.7	-3.0	-2.9
IBP, °F						622					
50 V %, °F						855					
EP, °F						975					
Residue, W %						6.6					
Sulfur, W %	0.14	0.20	0.23			0.31	0.30	0.27	0.37	0.32	0.30
Calculated Composition of Solids-Free Oil In Vacuum Bottoms Slurry Product											
Constitution, W %											
Batch Still Distillate From Slurry Product	27.3	23.0	18.4			14.7	12.6	19.8	3.0	10.2	12.8
Batch Still Residuum From Filtrate	72.7	77.0	81.6			85.3	87.4	80.2	97.0	89.8	87.2
Composition, W % (Calculated)											
Carbon, W %						88.32					
Hydrogen, W %						5.94					
Nitrogen, W %						1.54					
Sulfur, W %	0.65	0.79	0.63			0.72	0.80		1.04	0.94	0.89
Ash, W %	0.00	0.20	0.04			0.30	0.22		0.30	0.34	0.20
Calculated Composition of 400°F+ Liquid											
Constitution, W %											
Atmospheric Still Overhead, 400°F+	8.6	10.2	14.7	10.8	10.7	8.4	8.0	15.1	15.5	16.3	15.3
Atmospheric Still Bottoms	-4.5	-2.9	12.8	9.5	9.3	16.5	8.9	-9.6	-4.7	-8.2	5.8
Vacuum Still Overhead	-23.1	-0.5	3.6	0.9	1.6	1.0	0.2	-0.6	-0.8	-2.4	0.4
Vacuum Still Bottoms, Solids-Free Oil	119.0	93.2	68.9	78.8	78.4	74.1	82.9	95.2	90.1	94.4	78.5
Composition											
Carbon, W %						88.34					
Hydrogen, W %						6.84					
Nitrogen, W %						1.22					
Sulfur, W %	0.77	0.73	0.44			0.54	0.66		0.94	0.89	0.71
Ash, W %	0.00	0.19	0.03			0.22	0.18		0.27	0.32	0.16

* Analyses of 975°F+; 975°F+ had 39.5% volatile matter

** Distillation of Filtrate from Filtration of Hydroclone Overhead

PDU RUN 3 - ILLINOIS NO. 6 COAL - FUEL OIL MODE

PDU 3 (Run 130-78) was undertaken to demonstrate the fuel oil mode of operation at the remaining Pilot Plant design conditions: coal space velocity, hydrogen to coal ratio and recycle slurry oil composition. Compared to the previous fuel oil mode demonstration run, PDU 1, this represented a 50% increase in the amount of excess hydrogen, a 10% decrease in total slurry oil, a 50% increase in the slurry oil residuum concentration and a 12% increase in reactor volume space velocity, which was compensated for by an equivalent increase in catalyst loading.

The run lasted for 12 days to a catalyst age of 1500 lbs coal/lb catalyst with an average 400°F$^+$ fuel oil yield of 51 W % of dry coal. The fuel oil was about 36% distillate and had a sulfur content of 0.6 W % at 1500 lbs/lb catalyst life and 0.5 W % at 1000. This sulfur level was lower than had been predicted. Coal conversion ranged from 93% of m.a.f. coal at the start of the run to 91% near the end of the run. The spent catalyst flowed freely from the reactor and contained 5.5 W % carbon (oil-free) and slightly over 4% metals.

The production of 400°F-material, which had been expected to decrease from that of PDU 1 because of the reduced concentration of 400-975°F material in the recycle, actually increased, possibly because of incresed hydrogen partial pressure and slightly increased reactor temperature.

ANALYSES OF BURNING STAR MINE ILLINOIS NO.6 COAL

USED IN PDU RUN 3

Hours of Run	As-Received	0-274
HRI Number	3790	3790
Moisture, W %	12.39	2.25
Proximate, Dry Basis, W %		
Ash	10.61	10.88
Volatile Matter	42.05	41.79
Fixed Carbon	47.34	47.33
Ultimate Analysis, Dry Basis, W %		
Carbon	70.83	69.52
Hydrogen	4.67	4.71
Nitrogen	1.38	1.25
Sulfur	3.28	3.34
Chlorine		0.02
Ash	10.62	10.88
Oxygen (Difference)	9.19	10.28
Btu (Dry Basis)	12,724	12,695
Sulfur Types		
Pyritic	1.20	1.65
Sulfate	0.00	0.00
Organic	2.08	1.69
Total	3.28	3.34
Mineral Analysis, W % Ignited Basis		
Phosphorous Pentoxide, P_2O_5	0.07	0.08
Silica SiO_2	50.35	48.26
Ferric Oxide Fe_2O_3	16.60	18.33
Alumina Al_2O_3	20.66	19.70
Titania TiO_2	0.90	0.90
Lime CaO	4.90	5.70
Magnesia MgO	0.90	0.86
Sulfur Trioxide SO_3	2.61	2.61
Potassium Oxide K_2O	2.09	2.02
Sodium Oxide Na_2O	0.68	0.68
Undetermined		0.86
Iron, W % of Dry Coal		1.48
Screen Size (U.S.S.)		
+50		3.48
50/70		4.64
70/100		7.78
100/140		10.77
140/200		10.74
200/325		27.39
325/Pan		35.20

RUN 130-78 - H-COAL OPERATIONS ON BURNING STAR MINE, ILLINOIS NO.6 COAL (HRI 3790)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates (HRI 3556), 50.6 Pounds Dry

Reactor Liquid Phase Depth - 19 Feet, Volume 3.7 Ft^3

Period	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11	12A
Date (End of Period), 1976	4/25	4/26	4/26	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6	5/6
Hours of Run - Beginning	4	16	28	40	52	76	100	124	148	172	196	220	244	268
End	16	28	40	52	76	100	124	148	172	196	220	244	268	274
Catalyst Age, Lbs Dry Coal/Lb Catalyst														
Beginning	11	58	118	186	254	389	512	646	780	914	1051	1191	1330	1468
End	58	118	186	254	389	512	646	780	914	1051	1191	1330	1468	1502
Coal Feed Rate, Lbs Dry Coal/Hour/Ft^3														
Reactor Liquid Phase	52.9	68.6	77.4	76.9	77.1	77.2	76.4	76.6	76.3	77.9	79.7	79.0	78.4	77.9
Feed Coal														
Moisture, W %	2.26	2.72		2.06	2.14	2.28	2.26	2.53	2.68	2.72	2.64	2.37	1.67	
Ash (Dry Basis), W %	11.40	11.05		10.49	10.56	10.82	10.72	10.65	10.41	10.49	11.33	10.86	11.01	
Recycle Flows, Lbs/Lb Solids														
Atmospheric Still Bottoms	1.45	1.96	1.51	1.35	1.01	0.58	0.52	0.57	0.56	0.58	0.51	0.49	0.49	0.46
Vacuum Still Overhead	0.62	0.50	0.32	0.39	0.19	0.17	0.08	0.10	0.05	0.03	0.13	0.11	0.13	0.17
From Inventory	-0.05	-0.01	-0.05	-0.08	-0.12	0	-0.03	+0.04	0.03	0	+0.01	+0.13	-0.03	0
Hydrocyclone Overflow (Oil)	[illegible]	[illegible]	0.58	0.71	0.85	1.01	[illegible]	1.02	1.03	1.00	1.03	[illegible]	[illegible]	1.11
Total	2.38	2.45	2.36	2.37	1.93	1.76	1.66	1.73	1.67	1.61	1.73	1.71	1.71	1.74
Temperatures, °F														
Coal Preheater Outlet	577	653	661	671	662	658	656	662	680	651	668	675	675	679
Reactor Liquid Phase, Average	812	840	846	847	848	847	847	847	847	847	848	848	848	848
Separator	773	754	753	765	761	756	750	751	748	751	749	746	745	747
Vacuum Flash Zone	465	514	515	545	569	564	564	563	565	558	560	564	566	562
Pressure in Vacuum Flash, Torr	13.6	12.6	11.9	28	18.0	17.0	14.8	13.3	12.6	12.0	11.8	11.9	13.0	11.6
Hydrocyclone			525	531	574	583	604	590	566	606	627	640	633	630
Pressure, psig														
Unit Back Pressure	2700	2690	2710	2680	2680	2645	2635	2625	2610	2680	2640	2620	2605	2600
Hydrogen Make-Up	2690	2690	2720	2680	2690	2715	2745	2710	2710	2815	2750	2750	2735	2715
Hydrogen Partial Pressure (Reactor Outlet)	1890	1560		1660	1680	1730	1701	1740	1670	1750	1760	1760	1750	1750
Recycle Gas, MSCF/Ton Dry Coal	16.1	10.7	13.9	23.7	23.7	24.0	23.8	23.6	23.6	23.9	23.4	23.5	23.9	23.5
Vent Gas, MSCF/Ton Dry Coal	4.7	5.2	4.4	4.4	5.3	5.5	6.1	5.9	6.3	6.1	6.7	7.1	7.2	7.1
Hydrogen Purity of Recycle Gas + Vent, %	93.8	91.6	91.4	90.3	87.0	87.0	85.9	87.0	84.8	86.1	87.0	87.2	87.9	87.2
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)	23.2	18.1		27.4	26.7	27.0	27.0	27.3	26.8	27.5	27.9	28.4	29.1	28.5
Make-Up Hydrogen + Recycle Hydrogen														
MSCF/Ton Dry Coal	41.2	33.4	34.4	42.6	41.9	41.9	42.1	42.0	41.6	42.5	41.6	41.9	42.6	42.1
V % of Make-Up + Recycle Gas	97.7	97.4	96.6	94.9	93.2	93.1	92.6	93.2	92.1	92.8	93.2	93.3	93.6	93.4
Hydrogen Partial Pressure, psig	2625	2620	2630	2540	2505	2525	2540	2525	2495	2610	2560	2565	2560	2535
Hydrogen Consumption														
MSCF/Ton Dry Coal	18.0	15.3		15.3	15.2	14.9	15.1	14.7	14.7	15.0	13.7	13.5	13.4	13.5
W % Dry Coal	4.8	4.1		4.1	4.0	4.0	4.0	3.9	3.9	4.0	3.7	3.6	3.6	3.6
Oil Additions														
Make-Up Oil, Lbs/Lb Dry Coal	0.360	0	----	----	----	----	----	----	----	----	----	----	----	----
Lbs/Hr/Ft^3	19.0	0	----	----	----	----	----	----	----	----	----	----	----	----
Flush Oil, Lbs/Lb Dry Coal	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.002	0.003

RUN 130-78 - OPERATING RESULTS

Period	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11	12A
Collected Product Quantities, W % Dry Coal														
Atmospheric Still Overhead	19.8	18.9	14.8	19.3	18.5	16.0	16.0	15.4	15.8	17.0	16.8	17.0	16.1	16.8
Atmospheric Still Bottoms(1)	3.8	1.4	4.2	7.1	14.4	12.1	15.1	10.5	11.6	10.5	6.9	4.1	2.8	7.9
Vacuum Still Overhead(1)	1.7	0.7	0.9	2.4	2.4	0.6	0.8	0.1	0.1	0.4	0.3	2.2	5.1	2.0
Vacuum Still Bottoms	90.2	65.2	55.6	58.9	50.4	54.6	52.4	58.4	54.3	54.3	59.6	58.3	57.8	58.9
H_2O(2)	5.8	10.0	9.1	16.0	11.1	9.7	9.9	9.6	10.4	9.6	9.9	9.8	10.6	9.0
C_1-C_3	5.7	7.9		6.2	6.9	6.7	7.7	7.3	8.5	7.9	7.6	7.3	7.1	7.4
C_4-C_6	2.0	2.4		1.4	3.1	2.7	2.5	2.9	2.8	3.6	2.8	3.3	3.6	3.9
H_2S	2.1	1.4		1.4	2.0	2.0	2.1	2.1	2.3	2.3	2.4	2.3	2.4	2.5
CO and CO_2	0.4	0.5		0.4	0.6	0.7	0.8	0.9	1.0	1.1	0.9	1.1	1.1	1.2
Total	131.5	108.4		113.1	109.4	105.1	107.3	107.2	106.7	106.7	107.2	105.4	106.6	109.6
Input Quantities, W % Dry Coal														
Dry Coal	100.0	----------												
Moisture in Feed Coal	2.3	2.8	2.1	2.1	2.2	2.3	2.3	2.6	2.8	2.8	2.7	2.4	1.7	1.7
Make-Up Oil Additions	36.0											0	0	0
Flush Oil	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.3
Hydrogen Reacted	4.8	4.1		4.1	4.0	4.0	4.0	3.9	3.9	4.0	3.7	3.6	3.6	3.6
Total Used for Normalization	143.4	107.2		106.4	106.5	106.6	106.6	106.8	107.0	107.1	106.6	106.3	105.5	105.6
Coal Conversion, W %		92.3		91.8	92.5	91.4	90.7	90.2	89.1	89.5	88.6	87.4	87.5	87.8
Normalized Net Product Distribution, W % Dry Coal														
CO, CO_2		0.43		0.33	0.64	0.71	0.81	0.91	1.06	1.06	0.93	1.07	1.07	1.07
C_1-C_3 Hydrocarbons in Gases		7.78		5.77	6.87	6.78	7.62	7.22	8.48	7.86	7.56	7.41	7.18	7.18
C_4-C_6 Hydrocarbons in Gases		2.36		1.30	3.07	2.72	2.46	2.90	2.84	3.62	2.82	3.27	3.63	3.76
IBP-400°F Naphtha		9.64		13.54	14.62	12.92	13.09	13.40	12.72	15.01	13.95	13.97	11.90	12.73
400-650°F Distillates		23.50		20.84	15.69	22.88	25.30	19.54	21.19	10.12	16.64	15.11	9.31	18.33
650-975°F Distillates					9.59					8.80			10.46	
975°F+ Residual Oil														
Benzene-Soluble		25.50		22.00	17.65	20.23	18.29	18.19	20.37	17.39	23.08	22.30	18.41	21.92
Benzene-Insoluble		7.01		6.33	9.11	10.08	9.48	14.90	10.41	14.00	9.70	11.95	11.31	11.29
Unconverted Coal		7.17		8.01	5.57	6.33	5.93	6.23	6.16	6.03	8.08	7.25	8.46	7.39
Ash		11.25		10.55	10.55	11.38	10.86	11.22	10.39	10.73	11.21	11.18	11.00	10.49
H_2O (Net)		6.96		12.78	7.69	7.44	7.61	6.84	7.70	6.24	7.17	7.53	8.03	7.03
NH_3 (Forced Nitrogen)					0.68					0.53			0.35	
H_2S (Forced Sulfur)		2.41		2.58	2.62	2.46	2.58	2.53	2.56	2.55	2.48	2.52	2.53	2.38
Total (100 + Hydrogen Reacted)		104.01		104.03	104.33	103.93	104.03	103.88	103.88	103.96	103.63	103.56	103.64	103.57

(1) Negative quantities of atmospheric still overhead and vacuum overhead are decreases of inventory of slurry oil holding tank

(2) Includes dissolved NH_3 + H_2S

RUN 130-78 - ANALYSES

Period	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11	12A
Atmospheric Still Overhead														
Gravity, °API	29.3	31.3	39.2	38.4	37.9	38.0	37.3	37.8	37.4	35.5	35.4	36.1	34.9	35.5
IBP, °F		148		136	120	120	122	126	112	130	130	134	137	144
EP, °F		590		554	540	512	480	486	496	488	498	497	502	508
V % @ 400°F		55		78	80	82	84	89	82	88	85	84	77	80
Gravity, °API - IBP-400°F					42.3					40.7			36.4	
400°F-EP					21.1					20.1			18.8	
Carbon, W %					87.78					87.37			87.86	
Hydrogen, W %					12.34					12.08			12.01	
Nitrogen, W %					0.18					0.15			0.28	
Sulfur, W %					0.16					0.12			0.13	
Phenols, V % Total					1.5					7.5			8.5	
V % IBP-400°F					2.0					6.5			7.5	
Atmospheric Still Bottoms														
Gravity, °API	10.2	12.1	13.3	14.4	13.0	11.9	10.9	11.1	10.6	10.1	10.3	10.3	10.4	10.9
IBP, °F		386		344	(353)	396	418	420	408	(372)	444	452	(392)	
EP, °F					(790)					(810)			(800)	
V % @ 400°F		1		2	(3)	1				(1)			(1)	
V % @ 650°F		91		87	(85)	83	80	76	74	(75)	74	74	(79)	
Gravity, °API - IBP-650°F					14.3					12.9			13.3	
650°F-EP					2.0					-0.9			1.9	
Carbon, W %					88.45					86.90			88.01	
Hydrogen, W %					9.44					8.81			9.17	
Nitrogen, W %					0.46					0.46			0.57	
Sulfur, W %		0.01		<0.03	<0.03	<0.03	0.03	<0.03	0.02	0.08	0.02	0.02	<0.03	
Vacuum Still Overhead														
Gravity, °API	3.4	2.6	6.1	7.0	6.4	6.6	5.6	5.4	5.3	4.8	4.6	5.1	5.0	5.6
IBP, °F		526		440	(341)	428	428	406	445	(345)	496	436	(390)	
EP, °F					(790)					(910)			(905)	
V % @ 650°F		44		57	(60)	50	52	57	48	(43)	52	59	(64)	
Gravity, °API - IBP-650°F					12.5					11.2			10.5	
650°F+					0.9					-1.4			-0.7	
Carbon, W %					89.33					87.65			88.62	
Hydrogen, W %					8.88					8.19			8.58	
Nitrogen, W %					0.54					0.64			0.67	
Sulfur, W %		<0.03		<0.03	<0.03	0.06	0.06	0.05	0.08	0.07	0.03	0.13	0.09	
Water														
Nitrogen, W %					3.40					3.25			3.06	
Sulfur, W %					3.66					2.79			3.17	
Carbon, W %					1.19					1.40			1.49	
0-12 Liquid - Gravity, °API		13.3		14.9	12.3	11.5	10.3	11.0	10.2	9.4	11.7	11.1	11.4	11.4
0-5 Liquid														
Gravity, °API	13.2	14.8	15.4	15.4	15.0	14.3	13.6	13.6	13.2	12.9	12.9	12.8	13.7	13.0
Ash, W %		0.0019	0.0003	0.0003	0.0005	0.0009	0.0004	0.0002	0.0002	0.0008	0.0003	0.0006	0.0009	0.0003

Distillations - All ASTM D-86 Except Bracketed Values From ASTM D-1160 Modified

RUN 130-78 - ANALYSES (CONTINUED)

Period	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11	12A
Vacuum Still Bottoms														
W % of Flows from Vacuum Still	55.1	43.8	47.6	45.9	50.4	53.3	57.8	58.5	60.9	62.2	58.3	57.2	54.9	54.6
Benzene-Soluble, W %		60.29		54.37	48.51	49.56	49.82	43.94	50.66	43.45	50.75	48.41	46.36	48.99
Benzene-Insoluble, W %		22.15		26.29	29.95	29.78	29.43	36.61	30.33	36.82	30.21	32.60	34.47	32.67
Ash, W %		17.56		19.34	21.54	20.66	20.75	19.45	19.01	19.73	19.04	18.99	19.17	18.34
Unreacted Coal, W % (Estimated)		11.20		14.68	11.38	11.49	11.32	10.79	11.28	11.08	13.73	12.31	14.74	12.92
Benzene-Insoluble Residuum, W % (Estimated)		10.95		11.61	18.61	18.29	18.11	25.82	19.05	25.74	16.48	20.29	19.72	19.75
Carbon, W %					68.77					70.83			70.35	
Hydrogen, W %					4.60					4.55			4.45	
Nitrogen, W %					1.19					1.36			1.51	
Sulfur, W %	1.58	1.96	1.92	2.01	2.10	2.17	2.09	1.97	2.02	2.10	2.03	1.94	1.98	1.97
ASTM Ash, W %	13.80	17.86	17.98	19.70	21.55	20.98	21.77	20.28	21.25	20.30	19.44	19.67	19.36	19.07
Coke/Ash Ratio		0.589		0.637	0.620	0.658	0.728	0.735	0.848	0.853	0.875	0.977	0.994	0.964
Benzene-Soluble Oil, IBP, °F														
IBP-650°F, W %					660					610			760	
650-975°F, W %					25.7					25.8			30.8	
975°F+, W %					74.3					73.2			69.2	
Filter Cake														
W % of Feed to Vacuum Still		21.7		21.8	28.2	26.1	27.1	27.0	26.9	29.6	26.1	27.0	24.7	26.8
Benzene-Soluble, W %		32.35		32.91	28.09	23.66	23.49	24.11	26.97	24.79	28.15	24.21	20.00	28.82
Benzene-Insoluble, W %		27.51		30.21	27.15	29.32	29.27	32.48	30.03	31.00	34.70	32.24	36.53	31.96
Ash, W %		40.14		36.88	44.76	47.02	47.24	43.41	43.00	44.21	44.15	43.55	43.47	39.22
Benzene-Insoluble Residuum, W %		1.90		2.23	3.58	3.17	3.51	5.05	4.52	6.17	2.86	4.02	3.09	4.33
Unreacted Coal, W % (Estimated)		25.61		27.98	23.57	26.15	25.76	25.90	25.51	24.83	31.84	28.22	33.44	27.63
Carbon, W %					49.83					52.40			52.54	
Hydrogen, W %					3.44					3.83			3.70	
Nitrogen, W %					0.68					0.88			0.81	
Sulfur, W %					3.66					3.71			3.49	
O-13 Bottoms - Ash, W %		8.85												
Slurry Mixing Tank - Ash, W %		3.45		3.93	5.79	6.53	7.46	6.31	6.30	6.64	6.71	6.18	6.04	
Internal Recycle Oil (Flashed) - Ash, W %				8.29	9.68	9.99	10.89	9.54	9.59	9.66	9.89	9.08	8.88	
Hydroclone Feed														
Ash, W %				7.69	8.84	8.98	9.19	10.90	9.38	9.30	8.45	9.08	8.24	7.32
Ash, W %*				5.93	8.69	8.19	9.76	9.48	10.08	10.28	8.65	8.65	7.93	7.54
Ash, W %**				7.20	8.12	7.95	9.12	8.96	9.36	9.08	8.03	8.03	7.44	7.27
Hydroclone Overflow														
Gravity, °API						-10.5	-15.0	-12.2	-14.6	-16.5	-12.4	-12.2	-11.0	-13.3
ASTM Distillation (Vacuum) - IBP, °F						401	401	382	394	399	425			
10, W %						516	534	516	553	556	563	425	425	423
30						650	721	690	721	721	703			
50						826	920	863	924	944	880	693	721	680
V % @ 650°F						30	21.5	28	23	22	26	29	33	29
V % @ 975°F						63	55	60	54	53.5	58	58	61	59.5
W % 975°F+ (Oil + Solids)						44.4	52.7	48.5	53.3	54.9	49.6	49.4	45.2	49.0
Ash, W %				4.32	5.41	5.25	6.97	6.80	7.08	7.31	5.62	5.72	5.10	4.85

* Calculated from overflow and underflow analyses, flows

** Calculated from overflow and vacuum still bottoms analyses, flows

RUN 130-78 - ANALYSES (CONTINUED)

Period	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11	12A
Hydroclone Underflow - Ash, W %				6.96	12.00	11.71	14.25	13.11	14.76	14.95	12.78	12.74	11.78	11.02
Atmospheric Still Overhead														
IBP-400°F														
Carbon, W %										87.93				
Hydrogen, W %										12.55				
Sulfur, W %					0.05					0.09				0.11
Nitrogen, W %					0.08					0.11				0.18
400°F+														
Carbon, W %										88.16				
Hydrogen, W %										10.48				
Sulfur, W %		0.03		0.01	0.02	0.11	0.03	0.06	[illegible]	0.04	0.02	0.06	0.05	0.07
Nitrogen, W %					0.26					0.40				0.45
Atmospheric Still Bottoms														
IBP-650°F														
Gravity, °API					14.3					12.9				13.3
Carbon, W %										88.65				
Hydrogen, W %										9.54				
Sulfur, W %					0.03					0.03				0.03
Nitrogen, W %					0.31					0.58				0.42
650°F+														
Gravity, °API					2.0					-0.9				1.9
Carbon, W %										88.75				
Hydrogen, W %										8.31				
Sulfur, W %					0.03					0.08				0.06
Nitrogen, W %					0.82					0.78				0.82
Vacuum Still Overhead														
IBP-650°F														
Gravity, °API					12.5					11.2				10.5
Carbon, W %										89.38				
Hydrogen, W %										9.17				
Sulfur, W %					0.03					0.03				0.03
Nitrogen, W %					0.41					0.48				0.54
650°F+														
Gravity, °API					-0.9					-1.4				-0.7
Carbon, W %										91.64				
Hydrogen, W %										7.93				
Sulfur, W %					0.07					0.14				0.19
Nitrogen, W %					0.93					0.82				0.95
Vacuum Still Bottoms														
IBP-975°F														
Gravity, °API					-8.3					-17.6				-12.1
Carbon, W %					89.15					89.23				88.72
Hydrogen, W %					6.79					6.72				6.50
Sulfur, W %					0.12					0.23				0.35
Nitrogen, W %					0.92					1.02				1.16

RUN 130-78 - CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS

Period	1B	2B	3	4	5	6	7	8	9	10	11	12
Distillation of Filtrate from Filtration Operation												
Vacuum Distillation												
Final Vapor Temperature, °F	560	555	563	550	560	540	518	556	533	549	521	506
Pressure, Torr	1.2	0.8	0.9	0.8	0.8	0.9	0.9	1.0	0.5	3.6	0.4	0.30
Residue, W % of Filtrate	29.1	25.3	39.3	36.1	43.0	41.0	49.7	48.1	39.7	42.8	40.7	38.8
Analysis												
Benzene-Insoluble	42.18	22.35	33.82	31.54	37.03	36.52	38.03	33.95	42.19	39.42	48.15	
DMF-Insoluble			4.67					12.57			14.30	
Carbon, W %*			87.89					87.80			87.68	88.83
Hydrogen, W %*			5.61					5.27			5.24	5.54
Nitrogen, W %*			1.56					1.60			1.55	1.98
Sulfur, W %*	0.80	0.76	0.68	0.69	0.66	0.69	0.71	0.62	0.68	0.71	0.77	0.78
Ash, W %	0.18	0.42	0.50	0.47	0.45	0.07	0.38	0.24	0.51	0.35	0.40	
IBP-975°F, V %			3.2					3.8			3.3	
975°F+, V %			96.8					96.2			96.7	100
Batch Distillation of Vacuum Bottoms Slurry Product												
Vacuum Distillation												
Final Vapor Temperature, °F	498	478	502	468	485	450	494	488	450	495	491	
Pressure, Torr	1.3	1.2	1.5	1.0	1.5	1.1	1.0	1.4	3.6	0.4	2.8	
Distillate, W % of Vacuum Bottoms Slurry	18.7	12.2	12.8	10.9	13.0	10.4	11.4	11.2	9.6	8.5	8.6	
Analysis												
Gravity, °API	-4.2	1.1	-5.6	-4.7	-8.4	-8.0	-8.4	-7.1	-8.6	-7.3	-7.8	
Sulfur, W %	0.20	0.16	0.19	0.19	0.25	0.26	0.28	0.23	0.28	0.30	0.33	
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product												
Constitution, W %												
Batch Still Distillate from Slurry Products	26.2	18.5	19.1	16.1	19.1	14.9	16.4	16.2	14.3	12.4	13.0	(13.0)
Batch Still Residue from Filtrate	73.8	81.5	80.9	83.9	80.9	85.1	83.6	83.8	85.7	87.6	87.0	(87.0)
Composition, W % (Calculated)												
Carbon, W %			88.12	88.12				88.04	88		87.90	
Hydrogen, W %			5.83					5.51			5.51	
Nitrogen, W %			1.44					1.50			1.47	
Sulfur, W %	0.64	0.63	0.59	0.60	0.58	0.62	0.64	0.55	0.62	0.65	0.71	0.72
Ash, W %	0.13	0.33	0.41	0.39	0.36	0.06	0.32	0.20	0.48	0.30	0.35	
Calculated Composition of 400°F+ Liquid Product												
Constitution, W %												
Atmospheric Still Overhead, 1400°F+	16.0	8.8	7.6	6.1	5.2	3.6	6.1	4.5	5.6	6.5	6.5	6.9
Atmospheric Still Bottoms	2.0	14.0	26.1	23.1	26.5	20.2	21.0	20.8	14.3	7.5	5.6	13.7
Net Vacuum Still Overhead**	0.5	3.9	3.8	0.5	1.2	-0.3	-0.3	0.1	-0.0	4.0	9.9	3.2
Vacuum Still Bottoms, Solids Free Oil	87.5	73.2	62.5	70.3	67.0	76.5	73.3	84.5	80.1	82.0	78.1	76.2
Composition (Calculated)												
Carbon, W %			88.25					88.13			88.00	
Hydrogen, W %			7.25					6.56			6.41	
Nitrogen, W %			1.05					1.23			1.23	
Sulfur, W %	0.53	0.48	0.38	0.45	0.40	0.49	0.48	0.43	0.50	0.55	0.57	0.56
Ash, W %	0.11	0.23	0.26	0.27	0.24	0.04	0.23	0.15	0.38	0.24	0.27	

* Analysis of 975°F+ Residue

** Vacuum Still Overhead Less Make-Up and Flush Oil

PDU RUN 4 - ILLINOIS NO. 6 COAL - SYNCRUDE MODE

PDU Run 4 (Run 130-79) was undertaken to simulate Pilot Plant syncrude mode operation on Illinois No. 6 coal with maximum possible residuum recycle. The run matched the design coal rate per unit reactor volume, excess hydrogen flow and hydrogen partial pressure.

Coal was fed for a total of 603 hours with shutdown occurring at a catalyst age of 1464 lbs coal/lb catalyst. Total distillate yield was about 52% at a catalyst age of 300-500 lbs/lb (the Pilot Plant design yield), gradually falling off to about 46% at 1000 lbs/lb and yielding about 43% at 1500 lbs/lb was approached.

ANALYSIS OF ILLINOIS NO.6 BURNING STAR MINE COAL USED IN RUN 130-79

HRI Number	3790	3790	3790
Hours of Run	As-Received	0-403	403-603
Moisture, W %	12.39	2.39	1.75
Proximate, Dry Basis, W %			
Ash	10.61	10.73	10.86
Volatile Matter	42.05	36.06	
Fixed Carbon	47.34	53.21	
Ultimate, Dry Basis, W %			
Carbon	70.83	69.20	68.65
Hydrogen	4.67	4.63	4.56
Nitrogen	1.38	1.23	1.20
Sulfur	3.30	3.53	3.37
Ash	10.62	10.73	10.86
Chlorine	0.03	0.03	
Oxygen (Difference)	9.17	10.65	11.40
Btu (Dry Basis), Gross	12724	12621	
Sulfur Forms, W % (Dry)			
Pyritic	1.20	1.48	1.56
Sulfate	0.00	0.03	0.01
Organic	1.89	1.85	1.77
Total	3.09	3.36	3.34
Mineral, W % Ignited Basis:			
Phosphorous Pentoxide, P_2O_5	0.07	0.02	
Silica SiO_2	50.35	47.38	
Ferric Oxide Fe_2O_3	16.60	19.29	
Alumina Al_2O_3	20.66	17.65	
Titania TiO_2	0.90	0.77	
Lime CaO	4.90	6.45	
Magnesia MgO	0.90	0.75	
Sulfur Trioxide SO_3	2.61	4.60	
Potassium Oxide K_2O	2.09	1.77	
Sodium Oxide Na_2O	0.68	0.72	
Undetermined	0.24	0.60	
Screen Size (U.S.S.)			
+50		5.55	3.69
50/70		5.35	3.98
70/100		9.79	7.17
100/140		13.66	12.20
140/200		13.73	14.69
200/325		22.40	18.94
325/Pan		29.51	39.33

RUN 130-79 - H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO. 6 COAL (HRI 3790)
Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates (HRI 3556), 49.2 Pounds Dry
Reactor Liquid Phase Depth - 19 Feet, Volume 3.7 Ft^3

Period	1A	1B	2	3	4A	4B	5	6	7	8	9
Date (End of Period), 1976	5/31	6/1	6/2	6/2	6/5	6/6	6/7	6/8	6/9	6/10	6/11
Hours of Run-Beginning	0	12	24	48	55	67	79	101	127	151	175
End	12	24	48	55	67	79	103	127	151	175	199
Catalyst Age, Lb Dry Coal/Lb Catalyst											
Beginning	0	26	54	109	125	150	177	232	290	347	400
End	26	54	109	125	150	177	232	290	347	400	459
Coal Feed Rate, Lbs Dry Coal/Hour/ Ft^3 Reactor Liquid Phase	28.6	31.4	30.2	30.5	27.9	29.8	30.7	32.0	31.4	29.1	32.7
Feed Coal											
W % Moisture		2.46	2.74			2.91	2.08	1.80	2.29	1.89	2.10
% Ash (Dry Basis)		10.43	10.54			11.16	11.17	11.10	10.91	10.61	10.97
Recycle Flows, Lbs/Lb Solids											
Atmospheric Still Bottoms	1.63	1.28	1.38	1.38	1.53	1.21	0.28	0.52	0.66	0.48	0.54
Vacuum Still Overhead	0.95	0.82	0.81	0.76	1.38	0.69	1.25	0.57	0.09	0.03	0
From Inventory	0.89	0.12	(-0.18)	0.03	0.17	0.15	(-0.05)	(-0.06)	(-0.11)	0.10	(-0.05)
Hydroclone Overflow (Oil)	0	0	0	0	0	0.44	0.96	1.18	1.38	1.38	1.27
Total	3.59	2.22	2.21	2.17	3.08	2.49	2.44	2.17	2.02	1.99	1.76
Temperature, °F											
Coal Preheater Outlet	640	655	660	673	650	693	701	683	646	648	635
Reactor Liquid Phase, Average	816	846	849	848	821	848	849	843	849	847	848
Separator, Average	692	714	737	729	701	709	712	731	726	740	742
Vacuum Flash Zone	460	523	536	527	509	543	580	535	523	528	527
Pressure in Vacuum Flash, Torr	10.7	9.5	9.2	9.1	9.4	9.6	12.5	55	38	9.5	9.4
Hydroclone	--	--	--	--	--	512	560	544	511	540	586
Pressure, psig											
Unit Back Pressure	2710	2740	2735	2740	2655	2700	2700	2700	2700	2695	2755
Hydrogen Make-Up	2700	2750	2700	2750	2675	2650	2645	2650	2650	2685	2740
Hydrogen Partial Pressure (Reactor Outlet)		1705	1725				1730	1770	1850	1880	1860
Recycle Gas, MSCF/Ton Dry Coal	26.3	24.1	27.3			30.6	30.3	30.5	32.2	34.1	29.6
Vent Gas, MSCF/Ton Dry Coal	6.7	8.8	8.0			6.6	6.8	6.2	7.3	8.6	7.8
Hydrogen Purity of Recycle Gas+Vent, %	94.0	90.7	90.7			90.1	89.7	88.9	89.6	88.6	87.9
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)	35.0	32.3	34.4			35.8	35.3	34.3	37.3	40.3	35.2
Make-Up Hydrogen + Recycle Hydrogen MSCF/Ton Dry Coal	62.3	57.0	59.8			59.9	58.2	56.9	59.9	63.9	57.2
V % of Make-Up + Recycle Gas	97.5	96.2	95.9			95.2	94.9	94.4	94.7	94.3	94.1
Hydrogen Partial Pressure, psig	2630	2645	2590			2520	2510	2500	2510	2530	2575
Hydrogen Consumption (Gas Flows, Analyses)											
MSCF/Ton Dry Coal	27.3	24.6	25.4			24.1	22.9	22.6	22.6	23.6	21.9
W % Dry Coal	7.3	6.6	6.8			7.1	6.1	6.0	6.0	6.3	5.8
Oil Additions											
Make-Up Oil, Lbs/Lb Dry Coal	0.119	0	0.204	0	0	0	0	0	0	0	0
Lb/Hr/Ft^3	3.4	0	6.2	0	0	0	0	0	0	0	0
Flush Oil, Lbs/Lb Dry Coal	0.007	0.006	0.006		0.007	0.007	0.007	0.006	0.007	0.007	0.006

Period	1A	1B	2	3	4A	4B	5	6	7	8	9
OPERATING RESULTS											
Collected Product Quantities											
W % Dry Coal											
Atmospheric Still Overhead	2.0	44.4	33.6		32.8	33.3	26.1	29.6	31.3	31.9	27.5
Atmospheric Still Bottoms (1)	(-55.7)	(-5.7)	12.7		(-7.9)	(-8.7)	2.0	3.1	11.5	9.7	14.4
Vacuum Still Overhead(1)	(-32.1)	(-3.2)	7.4		(-7.6)	(-4.4)	5.4	3.4	(-0.5)	(-4.5)	0.8
Vacuum Still Bottoms	119.4	36.3	44.5		70.6	43.9	41.4	38.6	30.5	34.0	35.4
H_2O (2)	-3.7	32.4	14.2		18.7	12.5	13.8	10.8	10.3	10.4	9.2
C_1-C_3	5.0	9.2	8.8			7.8	8.8	8.1	8.5	11.6	11.2
C_4-C_6	4.3	6.0	6.3			4.7	4.6	5.0	4.7	5.1	4.2
H_2S	0.8	1.3	1.0			1.0	1.0	1.4	1.5	2.1	2.1
CO_2 and CO	0.3	0.5	0.4			0.3	0.4	0.5	0.5	0.6	0.6
Total	40.3	121.2	128.9			90.4	103.5	100.5	98.3	100.9	105.4
Input Quantities, W % Dry Coal											
Dry Coal	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture in Feed Coal	2.5	2.5	2.8		3.0	3.0	2.1	1.9	2.3	1.8	2.2
Make-Up Oil Additions	11.9	0	20.4		0	0	0	0	0	0	0
Flush Oil	0.7	0.6	0.6		0.7	0.7	0.7	0.6	0.7	0.7	0.6
Hydrogen Reacted (Gas Flows)	7.3	6.6	6.8			6.4	6.1	6.0	6.0	6.3	5.8
Total Used for Normalization	122.4	109.7	130.6			110.1	108.9	108.5	109.0	108.8	108.-
Coal Conversion, W % of M.A.F. coal		94.6				94.0	93.4	94.8	95.2	95.8	95.5
Normalized Net Product Distribution											
W % Dry Coal											
CO, CO_2			0.46			0.56	0.45	0.45	0.52	0.70	0.66
C_1-C_3 Hydrocarbons in Gases			8.93			9.61	9.07	8.73	9.36	12.58	11.14
C_4-C_6 Hydrocarbons in Gases			6.38			5.81	4.81	5.36	5.12	5.54	4.21
IBP-400°F Naphtha			25.32			28.75	21.11	23.92	27.73	27.87	23.08
400-650°F Distillates			18.24			-1.35	17.61	19.50	15.89	14.66	27.53
650-975°F Distillates									5.62		
975°F+ Residual Oil											
Benzene Soluble			14.28			24.43	19.93	15.25	11.44	12.14	11.83
Benzene Insoluble			1.53			4.00	1.93	3.24	2.09	3.47	3.36
Unconverted Coal			4.78			6.40	5.60	5.05	4.52	4.47	3.80
Ash			10.96			13.39	10.73	12.01	11.62	12.73	10.35
H_2O (Net)			13.11			12.32	12.12	9.78	8.07	9.42	7.10
NH_3 (Forced Nitrogen)									1.10		
H_2S (Forced Sulfur)			2.68			2.51	2.72	2.69	2.77	2.64	2.77
Total (100+H_2 Reacted)			106.67			106.45	106.07	106.00	105.85*	106.22	105.84
ANALYSES											
Atmospheric Still Overhead											
Gravity, °API		33.8	36.8	40.5	36.0	36.6	40.3	37.1	36.0	35.0	36.5
IBP/10°F		148/218	133/209	126/194		150/216	130/202	145/211	132/200	130/208	126/200
30/50		302/372	271/341	244/300		280/354	256/316	273/340	270/334	282/342	258/330
70/90		412/454	390/436	356/420		398/442	376/432	382/440	376/428	384/449	376/414
FBP		518	401	480		502	506	505	502	466	468
V % @ 400°F		64	76	85		72	80	77	82	82	85
Carbon, W %									87.27		
Hydrogen, W %									12.08		
Nitrogen, W %									0.095		
Sulfur, W %									0.06		
Phenols, V % Total									3.0		
V % IBP-400°F									3.0		

(1) Negative Quantities of Atmospheric Still Overhead & Vacuum Overhead Are Decreases of Inventory Slurry Oil Holding Tank.
(2) Include Dissolved NH_3 & H_2S (3) ASTM Distillation Cut Points
* H_2 Consumption Calculated Using Feed, Product Analyses

Period	1A	1B	2	3	4A	4B	5	6	7	8	9
ANALYSES (continued)											
Atmospheric Still Bottoms											
Gravity, °API	12.0	12.0	12.6		11.7	11.6	13.2	12.6	12.4	11.5	11.6
IBP, °F		472	460			430	424	426	(390)	436	463
10/30		510/532	488/518			463/492	456/484	454/486	(481/513)	468/502	490/516
50/70		556/588	550/594			528/568	516/556	520/564	(548/600)	536/590	552/606
90/FBP		658/712	686/>760			640/720	666/723		(700/820)		
V % @ 400°F		--	--			--	--	--	1	--	--
V % @ 650°F		86	85			93	88	87	(80)	80	80
Residue, W %									2.3		
Carbon, W %									89.48		
Hydrogen, W %									9.41		
Nitrogen, W %									0.31		
Sulfur, W %		0.03	0.03			<0.03	0.03	<0.03	<0.03	<0.03	<0.03
Vacuum Still Overhead											
Gravity, °API	5.5	8.4	7.8	8.8	3.4	6.6	9.9	10.7	9.2	7.2	6.0
IBP/10		454/490	430/494			438/506	434/478	422/468	(383/474)	435/494	450/496
30/50		542/586	540/586			560/510	520/562	508/548	(524/587)	548/608	554/
70/90		634/	650/				614/	606/	(657/775)		
FBP									(900)		
V % @ 650°F		75	70			67	81	81	(66)	62	60
Residue, W %									2.4		
Carbon, W %									89.50		
Hydrogen, W %									8.92		
Nitrogen, W %									0.31		
Sulfur, W %		0.03	0.03			0.03	0.03	0.03	0.03	0.03	<0.03
Water											
Ammonia, W %									5.18		
Sulfur, W %									2.71		
Carbon, W %									1.20		
0-12 Liquid, Gravity, °API		20.1	23.3			22.6	23.6	24.3	24.7	21.8	20.8
0-5 Liquid, Gravity, °API	13.8	15.5	15.4	16.0	13.5	13.9	13.9	14.9	15.1	14.4	14.2
Ash, W %	0.0012	0.0005	0.0004	0.0009	0.0007	0.0018	0.0014	0.0024	0.0048	0.0027	0.0013
Vacuum Still Bottoms											
W % of Flows from Vacuum Still	41.6	20.3	23.6		25.1	24.4	16.9	21.9	32.2	43.6	47.9
Benzene-Soluble, W %		57.12	48.80	56.40		55.94	57.17	51.14	45.63	44.66	48.36
Benzene-Insoluble, W %		16.19	15.05	18.36		19.26	17.66	19.96	19.71	21.26	21.11
Ash, W %		26.69	26.15	25.24		24.80	25.17	28.90	34.66	34.08	30.53
Unreacted Coal, W % (Estimated)		12.50				11.85	13.14	12.16	13.48	11.97	11.20
Benzene-Insoluble Residuum, W % (Estimated)		3.69				7.44	4.52	7.80	6.23	9.29	9.91
Carbon, W %									67.79		
Hydrogen									3.74		
Nitrogen, W %									0.76		
Sulfur, W %	1.49	2.27	2.27	2.18	1.79	2.13	2.23	2.34	2.68	2.74	2.69
ASTM Ash, W %	16.84	25.31	25.79	25.14	19.06	24.76	25.78	27.41	31.30	32.85	30.89

Distillation - All ASTM D-86 - Except Bracketed Values From ASTM D-1160 (Modified)

Period	1A	1B	2	3	4A	4B	5	6	7	8	9
ANALYSES (continued)											
Vacuum Still Bottoms (continued)											
Coke/Ash Ratio											
(DMF Extraction by Filtration)		0.465	0.436	0.477		0.474	0.447	0.448	0.452	0.472	0.484
Benzene Soluble Oil											
IBP, °F									695		
IBP-975°F, W %									25.2		
975°F+, W %									74.8		
Filter Cake											
W % of Feed to Vacuum Still		14.1				20.4	9.7	22.9	33.2	30.8	32.1
Benzene-Soluble, W %		35.23				36.81	37.60	45.29	33.52	34.23	31.76
Benzene-Insoluble, W %		20.85				20.54	21.61	16.82	19.22	18.64	19.78
Ash, W %		43.92				42.25	40.79	37.89	47.26	47.13	48.46
Benzene-Insoluble Residuum, W %		0.29				0.75	0.31	0.88	0.84	2.08	2.00
Unreacted Coal, W % (Estimated)		20.56				20.19	21.30	15.94	18.38	16.56	17.78
Carbon, W %									45.34		
Hydrogen, W %									3.37		
Nitrogen, W %									0.42		
Sulfur, W %									3.72		
O-13 Bottoms											
Ash, W %		6.18									
Slurry Mixing Tank											
Ash, W %		4.09	3.93			3.60	4.05	5.02	6.53	6.73	7.61
Internal Recycle Oil (Flashed)											
Ash, W %							10.75	16.43	14.71	14.07	12.47
Hydroclone Feed											
Ash, W %							4.48	4.85	5.49	6.29	7.23
Ash, W %*							3.81	4.45	5.50	6.42	7.29
Ash, W %**							3.06	3.47	4.39	6.21	7.38
Hydroclone Overflow											
Gravity, °API							7.9	4.8	-2.7	-7.2	-7.1
ASTM Distillation											
IBP, °F							348	374	401	420	413
10							461	470	497	497	516
30							510	527	563	593	626
50							569	593	649	722	770
70							627	735	810	860	
90							869				
W % @ 650°F/W % @ 975°F							73/93***	65/89	52/82	42/77****	35/71.5
W % 975°F+ (Includes Solids)							9.4***	16.3	25.0	32.0****	35.7
Ash, W %							1.23	1.58	2.93	4.73	5.92
Hydroclone Underflow											
Ash, W %							5.66	8.33	15.50	15.66	14.27

* Calculated from Overflow and Underflow Analyses, flows
** Calculated from Overflow and Vacuum Bottoms Analyses, flows
*** 955°F end point
**** 965°F end point

Period	1A	1B	2	3	4A	4B	5	6	7	8	9
Atmospheric Overhead											
IBP-400°F Gravity, °API									39.2		
Carbon, W %									88.59		
Hydrogen, W %									11.74		
Sulfur, W %									<0.03		
Nitrogen, W %									0.094		
400°F+ Gravity, °API									21.1		
Sulfur, W %		0.03	.0.03	<0.03		<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Atmospheric Still Bottoms											
IBP-650°F Gravity, °API									13.4		
650°F Gravity, °API									2.3		
Vacuum Still Overhead											
IBP-650°F Gravity, °API									13.3		
650°F+ Gravity, °API									0.1		
Vacuum Still Bottoms											
IBP-975°F Gravity, °API									-6.7		
Carbon, W %									90.56		
Hydrogen, W %									7.12		
Sulfur, W %									0.12		
Nitrogen, W %									0.62		
975°F Oil Gravity, °API											
Carbon, W %									89.36		
Hydrogen, W %									5.56		
Sulfur, W %									0.26		
Nitrogen, W %									1.42		
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS											
Distillation of Filtrate from Filtratio Operation											
Vacuum Distillation											
Final Vapor Temperature, °F		455				600	602	560	582	568	577
Pressure, Torr		0.8				4.2	7.6	0.9	1.7	0.9	1.3
Residue, W % of Filtrate		2.1				11.5	7.9	14.1	19.8	27.0	26.6
Sulfur, W %		0.32				0.33	0.39	0.33	0.34	0.33	0.42
Ash, W %		0.11				0.06	0.60	0.11	0.18	0.14	1.25
Benzene Insoluble, W %		18.03				13.08	18.69	15.80	27.06	24.36	26.14
Batch Distillation of Vacuum Bottoms Slurry Product											
Vacuum Distillation											
Final Vapor Temperature, °F		470	532			490	381	512	525	522	523
Pressure, Torr		3.4	2.2			3.8	4.0	4.5	4.4	4.3	3.8
Distillate, W % Vacuum Bottoms Slurry		15.1	21.8			6.6	6.4	11.0	7.7	8.9	10.0
Gravity, °API		-2.7	-0.2			-4.9	-4.0	-5.5	-6.4	-6.5	-6.5
Sulfur		0.03	0.03			0.03	<0.03	<0.03	<0.03	<0.03	<0.03

Period	1A	1B	2	3	4A	4B	5	6	7	8	9
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS (continued)											
Calculated Composition of Solids-Free Oil In Vacuum Bottoms Slurry Product											
Constitution, W %											
Batch Still Distillate from Slurry Product		62.9	34.9			10.4	10.4	18.7	14.9	16.5	17.2
Batch Still Residue from Filtrate		37.1	65.1			89.6	89.6	81.3	85.2	83.5	82.8
Composition, W % (Calculated)											
Carbon, W %									89.70		
Hydrogen, W %									6.57		
Nitrogen, W %									1.19		
Sulfur, W %		0.14	0.22			0.30	0.36	0.27	0.29	0.28	0.35
Ash, W %		0.04				0.05	0.52	0.09	0.15	0.12	0.99
Calculated Composition of 400°F+ Liquid Product											
Constitution, W %											
Atmospheric Still Overhead, 400°F+			15.8			46.2	15.0	21.0	19.3	22.6	10.7
Atmospheric Still Bottoms			6.2			-46.6	5.3	7.2	34.2	26.6	46.7
Vacuum Still Overhead			1.1			-25.8	13.2	7.3	-3.0	-15.8	-3.7
Vacuum Still Bottoms Solids Free Oil			76.9			126.3	66.5	64.5	49.5	66.5	46.3
Composition, W %											
Sulfur, W %			0.18			0.37	0.25	0.18	0.16	0.20	0.18
Ash, W %						0.06	0.35	0.06	0.07	0.08	0.46

RUN 130-79 - H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO. 6 COAL (HRI 3790)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates (HRI 1556), 49.2 Pounds Dry

Reactor Liquid Phase Depth - 19 Feet, Volume 3.7 Ft^3

Period	10	11	12	13	14	15	16	17	18A
Date (End of Period), 1976	6/12	6/13	6/14	6/15	6/16	6/17	6/18	6/19	6/19
Hours of Run - Beginning	199	223	247	271	295	319	343	367	391
End	223	247	271	295	319	343	367	391	403
Catalyst Age, Lb Dry Coal/Lb Catalyst									
Beginning	459	518	578	638	698	759	820	880	940
End	518	578	638	698	759	820	880	940	970
Coal Feed Rate, Lbs Dry Coal/Hour/ Ft^3 Reactor Liquid Phase	32.7	33.2	33.1	33.7	33.5	33.7	33.4	33.2	33.7
Feed Coal									
W % Moisture	2.09	1.82	1.64	1.30	1.52	1.68	2.14	2.36	
% Ash (Dry Basis)	10.45	11.03	11.20	10.63	10.78	11.02	11.04	10.64	
Recycle Flows, Lbs/Lb Solids									
Atmospheric Still Bottoms	0.43	0.37	0.38	0.40	0.41	0.46	0.52	0.24	0.29
Vacuum Still Overhead	0	0	0.04	0.06	0.05	0.07	0.02	0	0.14
From Inventory	1.25	1.09	1.24	1.16	1.19	1.15	1.14	1.15	1.05
Hydroclone Overflow (Oil)	0.01	0.09	(-0.01)	0.04	(-0.02)	0	(-0.04)	0.27	0.33
Total	1.69	1.55	1.65	1.66	1.63	1.68	1.64	1.66	1.81
Temperature, °F									
Coal Preheater Outlet	638	647	642	651	657	660	656	659	680
Reactor Liquid Phase, Average	848	849	848	848	848	848	848	847	848
Separator, Average	740	732	737	732	734	742	699	671	670
Vacuum Flash Zone	527	526	539	537	541	551	555	550	541
Pressure, Vacuum Flash, Torr	9.3	9.8	9.7	9.7	9.6	9.7	9.8	9.9	9.9
Hydroclone	615	622	631	602	578	606	614	615	618
Pressure, psig									
Unit Back Pressure	2680	2675	2675	2630	2605	2590	2600	2590	2605
Hydrogen Make-Up	2690	2675	2660	2610	2620	2600	2605	2585	2605
Hydrogen Partial Pressure (Reactor Outlet)	1850	1845	1830	1720	1765	1815	1780	1835	1855
Recycle Gas, MSCF/Ton Dry Coal	30.2	29.7	30.2	29.0	28.9	28.3	28.1	24.2	23.4
Vent Gas, MSCF/Ton Dry Coal	7.6	7.8	8.2	7.3	7.4	6.3	4.2	7.4	9.9
Hydrogen Purity of Recycle Gas + Vent, %	88.2	88.1	88.6	88.3	88.8	89.5	88.8	91.6	91.8
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)	35.7	35.0	36.2	34.6	35.0	35.3	39.1	37.9	36.7
Make-Up Hydrogen + Recycle Hydrogen									
MSCF/Ton Dry Coal	57.3	56.3	56.9	55.0	55.3	55.9	59.7	58.8	56.8
V % of Make-Up + Recycle Gas	94.1	94.1	94.3	94.2	94.5	94.9	95.0	96.6	96.7
Hydrogen Partial Pressure, psig	2530	2515	2505	2455	2475	2465	2475	2495	2520

Period	10	11	12	13	14	15	16	17	18A
OPERATING RESULTS									
Hydrogen Consumption (Gas Flows, Analyser)									
MSCF/Ton Dry Coal	21.6	21.3	20.7	20.4	20.3	20.6	20.6	20.8	20.0
W % Dry Coal	5.8	5.6	5.5	5.4	5.4	5.5	5.5	5.5	5.3
Oil Additions									
Make-Up Oil, Lbs/Lb Dry Coal	0	0	0	0	0	0	0	0	0
Lb/Hr/Ft^3	0	0	0	0	0	0	0	0	0
Flush Oil, Lbs/Lb Dry Coal	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Collected Product Quantities									
W % Dry Coal									
Atmospheric Still Overhead	27.2	22.9	27.5	25.5	23.3	22.3	20.8	20.3	27.5
Atmospheric Still Bottoms(1)	13.5	3.2	12.9	9.7	14.8	13.8	17.7	6.0	8.9
Vacuum Still Overhead (1)	0.7	8.0	1.0	0.8	1.6	0.1	(-1.1)	3.7	(-7.8)
Vacuum Still Bottoms	36.7	37.6	36.9	40.8	37.6	41.9	38.4	44.1	53.1
H_2O (2)	9.7	9.4	11.8	15.1	10.7	8.8	10.7	10.6	10.8
C_1-C_3	10.2	10.7	10.5	10.5	11.0	9.7	10.4	9.1	10.3
C_4-C_6	5.0	4.4	3.9	4.3	4.7	5.2	7.4	5.0	4.1
H_2S	2.0	1.8	1.8	2.0	2.2	2.2	2.5	1.5	2.3
CO_2 and CO	0.6	0.6	0.6	0.7	0.7	0.7	1.1	1.0	0.7
Total	105.6	98.6	106.9	109.4	106.6	104.7	107.9	101.3	109.9
Input Quantities, W % Dry Coal									
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture in Feed Coal	2.1	1.9	1.7	1.3	1.5	1.7	2.2	2.5	2.4
Make-Up Oil Additions	0	0	0	0	0	0	0	0	0
Flush Oil	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6
Hydrogen Reacted (Gas Flows)	5.8	5.6	5.5	5.4	5.4	5.5	5.5	5.5	5.3
Total Used for Normalization	108.5	108.1	107.8	107.3	107.5	137.8	108.3	108.7	108.3
Coal Conversion, W % of M.A.F. coal	96.4	96.0	94.5	95.0	93.5	33.9	94.8	93.6	
Normalized Net Product Distribution(3)									
CO, CO_2	0.60	0.62	0.59	0.70	0.73	0.74	1.06	1.05	
C_1-C_3 Hydrocarbons in Gases	10.57	11.60	10.48	10.23	11.13	9.87	10.52	9.52	
C_4-C_6 Hydrocarbons in Gases	5.11	4.87	3.84	4.14	4.87	5.26	7.42	5.17	
IBP-400°F Naphtha	21.67	20.85	21.61	20.26	18.91	18.42	17.11	17.59	
400-650°F Distillates	24.67	22.15	16.17	19.91	23.89	24.52	23.71	12.13	14.17
650-975°F Distillates			7.68					9.28	
975°F+ Residual Oil									
Benzene Soluble	12.94	15.92	13.70	13.97	13.49	14.68	14.02	15.65	
Benzene Insoluble	3.68	3.61	3.51	4.70	3.60	4.81	4.55	4.04	
Unconverted Coal	3.89	3.61	4.60	4.56	5.81	5.65	4.63	6.75	
Ash	12.18	11.31	10.62	10.82	10.88	10.46	10.98	12.56	
H_2O (Net)	7.82	8.40	9.10	13.39	9.27	7.28	8.66	7.84	
NH_3 (Forced Nitrogen)			0.96					0.84	
H_2S (Forced Sulfur)	2.65	2.68	2.72	2.72	2.73	2.66	2.76	2.54	
Total (100 + Hydrogen Reacted)	105.71	105.62	105.58*	105.38	105.33	105.37	105.43	104.96*	

(1) Negative Quantities of Atmospheric Still Overhead and Vacuum Overhead are Decreases of Inventory of Slurry Oil Holding Tank
(2) Includes Dissolved NH_3 and H_2S
(3) ASTM Distillation Cut Points
* Hydrogen Consumption by Feed, Product Analyses

Period	10	11	12	13	14	15	16	17	18A
ANALYSES									
Atmospheric Still Overhead									
Gravity, °API	35.1	36.6	36.3	35.7	35.6	36.0	36.4	37.5	35.9
IBP/10 °F	152/208	120/196	124/206	130/208	136/200	130/208	130/210	129/209	130/208
30/50	275/340	260/326	272/336	276/338	270/332	270/330	270/326	286/338	274/334
70/90	377/421	366/390	380/426	376/418	378/420	374/418	370/424	381/439	374/416
FBP	472	460	472	474	472	466	460	479	466
V % 400°F	79	85	80	83	82	82	83	84	84
Carbon, W %			86.23					87.39	
Hydrogen, W %			11.97					12.12	
Nitrogen, W %			0.18					0.18	
Sulfur, W %			0.11					0.14	
Phenols, V % Total			5.5					7.1	
V % IBP-400°F			5.2					6.5	
Atmospheric Still Bottoms									
Gravity, °API	11.3	10.9	11.4	11.0	11.2	11.5	11.4	11.8	12.2
IBP °F	474	486	(393)	460	454	444	454	(383)	456
10/30	508/535	508/540	(490/525)	486/512	474/510	474/510	480/512	(484/524)	484/512
50/70	573/630	582/624	(558/616)	550/604	548/604	540/594	546/600	(567/627)	550/604
90/FBP			(717/805)					(715/775)	
V % @ 400°F	--	--	--	--	--	--	--	--	--
V % @ 650°F	76	76	(78)	80	80	80	83	(75)	79
Carbon, W %			88.95					88.47	
Hydrogen, W %			9.31					9.46	
Nitrogen, W %			0.21					0.54	
Sulfur, W %	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	<0.03
Vacuum Still Overhead									
Gravity, °API	5.7	5.4	6.0	5.8	6.0	5.1	4.9	5.0	6.6
IBP/10	500/552	465/506	(415/512)	464/510	466/516	462/512	462/528	(424/519)	452/490
30/50	600	565/628	(510/640)	564/622	566/628	582/644	582/644	(601/705)	572
70/90			(715/795)					(748/808)	
FBP			(900)					(910)	
V % @ 650°F	46	57	(52)	59	58	52	48	(45)	49
Carbon, W %			89.27					89.21	
Hydrogen, W %			8.59					8.63	
Nitrogen, W %			0.50					0.58	
Sulfur, W %	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
Water									
Ammonia, W %			5.34					4.55	
Sulfur, W %			2.90					3.02	
Carbon, W %			1.43					1.58	
O-12 Liquid, Gravity, °API	18.5	19.7	19.5	17.8	19.2	15.4	15.0	15.9	
H_2O, W %			0.51					0.82	
O-5 Liquid, Gravity, °API	14.6	14.0	14.2	13.7	13.0	13.8	13.2	13.3	13.9
Ash, W %	0.0009	0.0008	0.0018	0.0005	0.0009	0.0004	0.0028	0.0036	0.0019
H_2O, W %			10.6					9.7	

Distillations - All ASTM D-86 - Except Bracketed Values From ASTM D-1160 (Modified)

Period	10	11	12	13	14	15	16	17	18A
ANALYSES CONTINUED									
Vacuum Still Bottoms									
W % of Flows From Vacuum Still	51.3	50.8	55.4	54.3	52.9	55.1	57.4	58.4	53.8
Benzene-Soluble, W %	49.05	49.08	49.63	49.35	46.96	49.05	48.26	47.65	55.04
Benzene-Insoluble, W %	19.60	23.16	21.82	23.35	24.60	24.30	23.56	24.18	22.32
Ash, W %	31.35	27.76	28.55	27.30	28.44	26.65	28.18	28.17	22.64
Unreacted Coal, W % (Estimated)	9.53	8.86	12.37	11.49	15.20	13.13	11.88	15.13	
Benzene-Insoluble Residuum, W % (Estimated)	10.07	14.30	9.45	11.86	9.40	11.17	11.68	9.05	
Carbon, W %			63.20					63.09	
Hydrogen, W %			4.08					4.17	
Nitrogen, W %			0.96					0.96	
Sulfur, W %	2.62	2.58	2.55	2.40	2.45	2.35	2.33	2.50	2.20
ASTM Ash, W %	30.25	31.18	29.44	28.20	28.33	26.40	27.23	26.34	23.00
Coke/Ash Ratio (DMF Extraction by Filtration)	0.477	0.507	0.517	0.528	0.545	0.549	0.506	0.528	0.587
Benzene Soluble Oil									
IBP, °F			595					705	
IBP-975°F, W %			25.8					26.4	
975°F+, W %			74.2					73.6	
Filter Cake									
W % of Feed to Vacuum Still	34.6	28.5	32.9	28.6	31.0	29.3	35.9	28.4	**
Benzene-Soluble, W %	29.28	28.09	30.50	27.99	20.99	20.21	20.62	26.84	
Benzene-Insoluble, W %	18.06	19.51	22.59	23.13	28.48	27.52	24.96	26.90	
Ash, W %	52.66	52.40	46.91	48.88	50.53	52.27	54.42	46.26	63.01
Benzene-Insoluble Residuum, W %	2.06	2.78	2.27	2.55	1.48	1.76	2.03	2.06	
Unreacted Coal, W % (Estimated)	17.78	16.00	16.73	20.32	20.58	27.00	25.76	24.84	
Carbon, W %			41.18					50.10	24.03
Hydrogen, W %			2.99					3.49	1.30
Nitrogen, W %			0.61					0.67	0.72
Sulfur, W %			1.51					3.85	5.99
Slurry Mixing Tank									
Ash, W %	6.22	7.12	7.79	7.86	8.24	7.94	8.84	7.70	
Internal Recycle Oil (Flashed)									
Ash, W %	13.05	12.97	12.05	14.26	12.51	12.50	13.09	11.59	
Hydroclone Feed									
Ash, W %	7.62	8.28	7.18	7.91	7.38	7.98	8.73	9.02	7.71
Ash, W % *	7.57	8.77	7.85	8.78	7.79	8.09	8.80	9.39	7.45
Ash, W % ***	7.66	8.56	8.02	8.02	7.59	8.04	8.77	9.27	7.20
Hydroclone Overflow									
Gravity, °API	-12.2	-9.8	-13.4	-10.7	-13.2	-13.2	-16.4	-17.1	
ASTM Distillation									
IBP, °F	437	400	415	420	411	418	423	415	
10	527	516	516	516	516	539	541	556	
30	633	623	630	631	674	684	722	702	
50	777	768	745	785	740	815	826	820	
V % @650°F/V % @975°F	34/71	36.5/70.5	34/68	34/69	27/68.5	29/66	24.5/64	26/66	
W % 975°F+ (Including Solids)	38.4	38.4	41.7	39.7	41.4	42.7	46.7	44.9	
Ash, W %	6.21	7.12	6.58	6.55	6.19	6.77	7.65	8.11	5.81

* Calculated from Overflow and Underflow Analysis, flows

** Analysis of Period 17 Filter Cake with oil removed by dimethylformamid.

*** Calculated from Overflow and Vacuum Bottoms Analysis, flows

Period	10	11	12	13	14	15	16	17	18A
ANALYSES (continued)									
Hydroclone Underflow									
Ash, W %	14.89	17.16	15.12	19.83	16.25	14.80	15.81	16.15	13.55
Atmospheric Overhead									
IBP-400°F Gravity, °API			39.6					39.0	
Carbon, W %			87.59					86.68	
Hydrogen, W %			12.72					12.74	
Sulfur, W %			0.03					0.05	
Nitrogen, W %			0.13					0.16	
400°F+ Gravity, °API			21.2					20.9	
Sulfur, W %	0.03	0.03	0.03	0.03	0.03	0.03	<0.03	0.04	0.05
Atmospheric Still Bottoms									
IBP-650°F, Gravity, °API			14.3					14.7	
650°F+ Gravity, °API			2.0					4.0	
Vacuum Still Overhead									
IBP-650°F Gravity, °API			12.5					12.0	
650°F+ Gravity, °API			0.1					0.8	
Vacuum Still Bottoms									
IBP-975°F Gravity, °API			-6.7					-9.6	
Carbon, W %			89.75					89.73	
Hydrogen, W %			6.80					6.98	
Sulfur, W %			0.15					0.16	
Nitrogen, W %			0.80					1.04	
975°F+ Oil Gravity, °API									
Carbon, W %								88.11	
Hydrogen, W %								5.40	
Sulfur, W %								0.56	
Nitrogen, W %								1.55	
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS									
Distillation of Filtrate from Filtration Operation									
Vacuum Distillation									
Final Vapor Temperature, °F	566	562	538	561	550	563	558	562	
Pressure, Torr	1.6	1.5	0.6	0.4	0.4	0.3	0.2	0.2	
Residue, W % of Filtrate	29.4	28.1	35.5	31.2	33.9	31.4	36.2	37.4	
Sulfur, W %	0.30	0.54	0.34	0.35	0.35	0.31	0.40	0.51	
Ash, W %	0.16	1.29	0.06	0.17	0.11	0.19	0.14	0.21	
Benzene-Insoluble, W %	27.0	21.03	24.11	27.92	29.22	33.22	34.87	37.52	
Batch Distillation of Vacuum Bottoms Slurry Product									
Vacuum Distillation									
Final Vapor Distillation, °F	522	519	535	537	521	521	509	518	442
Pressure, Torr	3.8	3.1	5.7	4.4	4.5	3.7	3.2	2.8	5.0
Distillate, W % Vacuum Bottoms Slurry	12.2	11.7	8.6	10.5	3.2	11.4	8.6	14.5	9.4
Gravity, °API	-6.1	-6.6	-6.4	-7.4	-5.0	-6.8	-7.4	-5.7	-4.1
Sulfur, W %	0.03	0.03	0.03	0.03	0.06	0.13	0.08	0.12	0.12

Period	10	11	12	13	14	15	16	17	18A
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS (continued)									
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product									
Constitution, W %									
Batch Still Distillate from Slurry Product	20.8	18.5	14.6	17.2	14.6	18.9	14.4	25.6	
Batch Still Residue from Filtrate	79.2	81.5	85.4	82.8	85.4	81.1	85.6	74.4	
Composition, W % (Calculated)									
Sulfur, W %	0.24	0.44	0.30	0.29	0.30	0.26	0.35	0.41	
Ash, W %	0.12	1.00	0.05	0.14	0.09	0.15	0.12	0.16	
Calculated Composition of 400°F+ Liquid Product									
Constitution, W %									
Atmospheric Still Overhead, 400°F+	15.6	9.9	14.7	12.0	11.3	10.3	9.3	9.1	
Atmospheric Still Bottoms	27.9	8.9	30.7	24.9	33.1	32.0	39.1	23.9	
Vacuum Still Overhead	1.7	19.3	1.2	0.2	3.0	-1.1	-3.7	5.6	
Vacuum Still Bottoms Solids-Free Oil	54.8	61.9	58.4	62.9	52.6	58.8	55.3	61.4	
Composition, W %									
Sulfur, W %	0.15	0.28	0.18	0.20	0.17	0.16	0.21	0.26	
Ash, W %	0.07	0.62	0.03	0.09	0.05	0.09	0.07	0.10	

RUN 130-79 - H-COAL OPERATIONS ON BURNING STAR MINE ILLINOIS NO. 6 COAL (HRI 3790)

Catalyst - American Cyanamid HDS-1442A, 1/16" Extrudates (HRI 3556), 49.2 Pounds Dry

Reactor Liquid Phase Depth - 19 Feet, Volume 3.7 Ft^3

Period	19B	20A	20B	21	22	23	24	25	26	27
Date (End of Period) 1976	6/23	6/23	6/24	6/25	6/26	6/27	6/28	6/29	6/30	7/1
Hours of Run-Beginning	403	411	423	435	459	483	507	531	555	579
End	411	423	435	459	483	507	531	555	579	603
Catalyst Age, Lb Dry Coal/Lb Catalyst										
Beginning	970	989	1019	1048	1107	1164	1224	1281	1339	1402
End	989	1019	1048	1107	1164	1224	1281	1339	1402	1464
Coal Feed Rate, Lbs Dry Coal/Hour/ Ft^3 Reactor Liquid Phase	31.7	33.1	31.8	32.7	31.7	33.1	31.4	32.3	34.8	34.5
Feed Coal										
W % Moisture	2.49		1.90	2.10	2.01	2.34	2.09	0.91	0.63	1.28
% Ash (Dry Basis)	10.86		11.53	10.92	11.26	10.73	10.76	10.68	10.45	10.52
Recycle Flows, Lbs/Lb Solids										
Atmospheric Still Bottoms	0.62	0.54	0.46	0.47	0.42	0.43	0.60	0.62	0.54	0.32
Vacuum Still Overhead	0.32	0.50	0.09	0.17	0.14	0.16	0.13	0.10	0.08	0.02
From Inventory	0.52	(-0.19)	(-0.03)	0.03	0.03	0.08	0.02	(-0.04)	(-0.01)	0.27
Hydroclone Overflow (Oil)	0	1.04	1.27	1.10	1.27	1.16	1.17	1.23	1.12	1.13
Total	1.46	1.89	1.79	1.82	1.86	1.83	1.92	1.91	1.73	1.74
Temperature, °F										
Coal Preheater (Outlet)	651	632	638	654	670	675	682	684	675	697
Reactor Liquid Phase, Average	811	840	849	847	848	848	847	845	848	849
Separator, Average	681	716	712	715	719	721	732	731	736	730
Vacuum Flash Zone	487	529	550	546	559	548	556	557	551	525
Pressure in Vacuum Flash, Torr	11.5	9.9	9.8	9.7	9.8	9.9	10.4	10.2	10.5	10.3
Hydroclone		550	577	589	578	608	616	614	620	619
Pressure, psig										
Unit Back Pressure	2700	2700	2700	2700	2700	2700	2650	2655	2700	2700
Hydrogen Make-Up	2680	2700	2710	2710	2710	2690	2640	2655	2700	2740
Hydrogen Partial Pressure (Reactor Outlet)			1700	1825	1830	1795	1735	1825	1910	1890
Recycle Gas, MSCF/Ton Dry Coal		27.1	30.4	29.8	29.9	27.9	30.3	36.8	28.1	22.3
Vent Gas, MSCF/Ton Dry Coal		4.8	7.6	7.7	7.9	7.5	6.8	4.9	10.8	14.2
Hydrogen Purity of Recycle Gas + Vent, %		85.3	87.7	88.6	87.1	85.7	85.9	87.0	90.1	89.5
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)		28.8	35.4	35.3	35.2	32.6	34.0	38.7	37.6	34.5
Make-Up Hydrogen + Recycle Hydrogen										
MSCF/Ton Dry Coal		50.3	57.3	56.2	56.2	52.7	54.3	57.3	57.6	55.6
V % of Make-Up + Recycle Gas		92.7	93.9	94.3	93.6	93.0	92.7	92.3	95.4	96.0
Hydrogen Partial Pressure, psig		2500	2545	2555	2535	2500	2445	2450	2575	2630
Hydrogen Consumption (Gas Flows, Analyses)										
MSCF/Ton Dry Coal		21.4	21.9	20.8	21.0	20.2	20.2	18.6	20.0	21.0
W % Dry Coal		5.7	5.8	5.5	5.6	5.4	5.4	4.9	5.3	5.6
Oil Additions										
Make-Up Oil, Lbs/Lb Dry Coal	0	0	0	0	0	0	0	0	0	0
Lbs/Hr/Ft^3	0	0	0	0	0	0	0	0	0	0
Flush Oil, Lbs/Lb Dry Coal	0.006	0.006	0.006	0.006	0.007	0.006	0.007	0.007	0.006	0.006

Period	19B	20A	20B	21	22	23	24	25	26	27
OPERATING RESULTS										
Collected Product Quantities										
W % Dry Coal										
Atmospheric Still Overhead	5.6	19.9	22.3	26.0	27.8	29.8	29.4	24.9	26.0	26.3
Atmospheric Still Bottoms (1)	(-33.4)	19.2	15.5	6.9	11.2	2.2	(-1.4)	4.4	10.8	-16.5
Vacuum Still Overhead (1)	5.3	10.7	1.6	(-1.4)	2.9	(-1.5)	0.4	1.7	1.1	-2.3
Vacuum Still Bottoms	82.3	50.2	33.9	46.7	39.5	44.0	49.5	44.8	42.2	12.4
Hydroclone Underflow + Samples										53.6
H_2O (2)	4.8	8.4	12.7	10.7	8.3	8.4	10.4	9.4	9.0	9.2
C_1-C_3		8.4	10.0	9.6	11.0	10.5	10.0	9.1	9.4	9.1
C_4-C_6		4.6	4.5	4.9	5.0	4.3	4.3	3.8	3.6	3.8
H_2S		2.2	2.2	2.4	2.4	2.2	2.2	1.9	2.1	1.9
CO_2 and CO		0.6	0.6	0.8	0.7	0.8	0.8	0.6	0.7	0.8
Total		124.2	103.3	106.6	108.8	100.7	105.6	100.6	104.9	98.8
Input Quantities, W % Dry Coal										
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture in Feed Coal	2.6	1.9	2.0	2.2	2.0	2.3	2.1	0.9	0.6	1.3
Make-Up Oil Additions	0	0	0	0	0	0	0	0	0	0
Flush Oil	0.6	0.6	0.6	0.6	0.7	0.6	0.7	0.7	0.6	0.6
Hydrogen Reacted (Gas Flows)		5.7	5.8	5.5	5.6	5.4	5.4	4.9	5.3	5.6
Total Used for Normalization		108.2	108.4	108.3	108.3	108.3	108.2	106.5	106.5	107.5
Coal Conversion, W % of M.A.F. coal			94.8	94.7	95.5	94.8	93.5	93.2	94.8	94.8
Normalized Net Product Distribution										
W % Dry Coal										
CO, CO_2			0.62	0.75	0.68	0.80	0.78	0.62	0.78	0.3
C_1-C_3 Hydrocarbons in Gases			10.48	9.77	10.96	11.45	10.05	9.68	9.55	9.8
C_4-C_6 Hydrocarbons in Gases			4.62	4.93	5.01	4.70	4.33	4.00	3.64	4.0
IBP-400°F Naphtha			18.59	19.27	18.02	21.94	18.91	19.04	19.71	20.3
400-650°F Distillates										
650-975°F Distillates			27.59	19.70	27.43	15.29	21.14	18.32	14.68	19.0
975°F+ Residual Oil									9.43	
Benzene-Soluble			9.96	15.42	15.10	16.79	13.91	16.08	15.12	23.6
Benzene-Insoluble			5.18	8.16	5.20	7.82	7.97	6.05	6.07	
Unconverted Coal			4.25	4.95	3.77	5.24	6.17	7.11	4.67	5.6
Ash			10.72	11.53	10.72	12.21	11.38	12.50	10.37	11.9
H_2O (net)									7.93	
NH_3 (Forced Nitrogen)			11.27	8.63	6.20	6.77	8.33	9.12	0.70	8.5
H_2S (Forced Sulfur)			2.51	2.33	2.45	2.29	2.37	2.33	2.45	2.4
Total (100+H_2 Reacted)			105.78	105.45	105.54	105.30	105.34	104.86	105.10*	105.50
ANALYSES										
Atmospheric Still Overhead										
Gravity, °API	33.3	34.3	35.2	32.8	32.8	32.5	31.9	32.5	33.3	33.3
IBP/10 °F	136/220		138/200	136/214	100/224	130/216	158/220	128/218	132/214	130/224
30/50	292/350		266/328	290/348	290/350	300/356	306/362	294/350	294/348	298/354
70/90	382/434		376/420	390/446	406/460	420/450	408/480	394/442	388/434	394/446
FBP	474		476	506	506	510	500	502	498	500

Period	19B	20A	20B	21	22	23	24	25	26	27
ANALYSES (continued)										
Atmospheric Still Overhead (continued)										
V % @ 400°F	83		81	75	67	70	66	74	76	72
Carbon, W %									88.17	
Hydrogen, W %									11.84	
Nitrogen, W %									0.21	
Sulfur, W %									0.18	
Phenols, V % Total									10.5	
V % IBP-400°F									7.5	
Atmospheric Still Bottoms										
Gravity, °API	12.3	6.3	7.7	8.3	9.6	9.6	9.8	9.6	10.0	10.6
IBP °F	360		444	450	472	485	460	468	(391)	466
10/30	414/442		474/512	474/510	510/547	518/550	515/555	494/526	(501/529)	486/514
50/70	476/526		554/604	548/600	583/637	582/636	585/635	564/620	(570/618)	550/596
90/FBP	634								(730/840)	
V % @ 400°F	6		--	--	--	--	--	--	--	--
V % @ 650°F	91		81	82	76	76	75	77	(76)	83
Carbon, W %									89.07	
Hydrocarbon, W %									9.11	
Nitrogen, W %									0.45	
Sulfur, W %	0.02		0.03	0.03	0.09	0.07	0.10	0.15	0.14	0.08
Vacuum Still Overhead										
Gravity, °API	4.7	0.7	2.7	3.8	4.7	5.4	5.7	5.8	6.3	5.6
IBP/10	422/490		442/506	458/498	476/525	496/540	505/548	480/520	(427/522)	
30/50	540/584		560/616	558/614	585/635	590/650	598/650	570/628	(583/642)	
70/90	628								(699/788)	
FBP									(905)	
V % @ 650°F	77		64	64	54	50	50	60	(53)	
Carbon, W %									89.53	
Hydrogen, W %									8.47	
Nitrogen, W %									0.49	
Sulfur, W %	0.07		<0.03	0.02	0.10	0.10	0.13	0.11	0.12	
Water										
Ammonia, W %									4.67	
Sulfur, W %									2.73	
Carbon, W %									2.01	
0-12 Liquid Gravity, °API	13.2		18.2	17.4	18.3	17.5	16.9	16.9	16.0	15.7
0-5 Liquid Gravity, °API	8.5	8.7	9.9	10.7	12.5	12.3	12.0	11.3	12.2	13.0
Ash, W %	0.0010	0.0023	0.0020	0.0016	0.0005	0.0010	0.0035	0.0082	0.0065	0.0067
Vacuum Still Bottoms										
W % of Flows from Vacuum Still	57.5	38.6	45.8	49.0	50.8	52.3	56.4	55.9	57.6	
Benzene-Soluble, W %	60.88		42.69	47.42	40.62	48.52	57.84	46.49	41.13	49.09
Benzene-Insoluble, W %	26.47		27.81	27.97	22.49	26.60	29.29	27.45	24.86	28.29
Ash, W %	12.45		30.50	24.61	26.89	24.88	23.57	26.06	24.01	22.6
Unreacted Coal, W % (Estimated)			12.08	10.56	9.45	10.67	12.78	14.82	10.81	10.05

Distillations - All ASTM D-86 - Except Bracketed Values From ASTM D-1160 (Modified)

Period	19B	20A	20B	21	22	23	24	15	26	27
ANALYSES (continued)										
Vacuum Still Bottoms (continued)										
Benzene-Insoluble Residuum, W % (Estimated)			14.73	17.41	13.04	15.93	16.51	12.62	14.05	18.24
Carbon, W %									66.59	
Hydrogen, W %									4.25	
Nitrogen, W %									1.20	
Sulfur, W %	1.79	2.11	2.68	2.38	2.45	2.32	2.18	2.22	2.22	2.11
ASTM Ash, W %	12.86	21.39	30.94	25.74	27.70	25.76	23.76	24.12	24.45	22.95
Coke/Ash Ratio										
(DMF Extraction by Filtration)	0.556		0.459	0.537	0.515	0.600	0.690	0.644	0.604	0.645
Benzene Soluble Oil										
IBP, °F									680	
IBP-975°F, W %									31.5	
975°F+, W %									68.5	
Filter Cake										
W % of Feed to Vacuum Still			26.0	30.0	30.0	25.3	28.8	32.8	31.5	33.6
Benzene-Soluble, W %			24.80	20.11	25.35	26.20	12.05	26.14	25.69	26.73
Benzene-Insoluble, W %			22.95	25.62	21.11	24.32	31.95	23.11	25.09	26.00
Ash, W %			52.25	54.27	53.54	49.48	56.00	50.75	49.22	47.27
Benzene-Insoluble Residuum, W %			2.26	2.34	2.29	3.11	1.59	2.13	2.93	4.99
Unreacted Coal, W % (Estimated)			20.69	23.28	18.82	21.21	30.36	27.93	22.16	21.01
Carbon, W %									43.79	
Hydrogen, W %									2.81	
Nitrogen, W %									0.58	
Sulfur, W %									3.82	
Slurry Mixing Tank										
Ash, W %	3.87		7.52	6.81	7.58	7.41	7.76	7.37	7.45	
Internal Recycle Oil (Flashed)										
Ash, W %				11.90	11.71	10.92	10.48	10.72	10.17	11.68
Hydroclone Feed										
Ash, W %			7.83	6.87	7.55	6.76	6.84	7.29	7.53	8.53
Ash, W % *			6.93	6.55	6.92	6.51	7.10	7.06	7.66	8.82
Ash, W % **			6.27	6.45	6.84	6.65	6.87	6.89	7.58	
Hydroclone Overflow										
Gravity, °API			-9.4	-9.6	-10.5	-8.9	-10.7	-10.3	-13.8	-14.2
ASTM Distillation										
IBP			402	408	418	424	432	425	432	432
10			516	516	516	516	539	539	539	534
30			614	621	621	623	640	633	633	648
50			722	755	750	763	778	774	771	835
70					975					
V % @ 650°F/V % @ 975°F			40/73	37.5/70.5	37.5/70	36.5/71	38/68.5	33.5/68	34.0/68.5	30.5/61
W % 975°F+ (Includes Solids)			34.5	37.1	38.5	36.8	39.3	39.9	41.3	47.5
Ash, W %			4.87	4.90	5.45	5.14	5.34	5.48	6.19	7.13
Hydroclone Underflow										
Ash, W %			18.64	13.10	14.57	12.71	14.65	14.50	14.53	17.70

* Calculated from Overflow and Underflow Analyses, flows
** Calculated from Overflow and Vacuum Bottoms Analyses, flows

Period	19B	20A	20B	21	22	23	24	25	26	27
ANALYSES (continued)										
Atmospheric Overhead										
IBP-400°F Gravity, °API									36.2	
Carbon, W %									87.27	
Hydrogen, W %									12.45	
Sulfur, W %									0.13	
Nitrogen, W %									0.17	
400°F+ Gravity, °API									19.5	
Sulfur, W %	0.03		0.03	0.03	0.09	0.08	0.13	0.11	0.13	0.03
Atmospheric Still Bottoms										
IBP-650°F Gravity, °API									13.6	
650°F+ Gravity, °API									2.3	
Vacuum Still Overhead										
IBP-650°F Gravity, °API									10.9	
650°F+ Gravity, °API									1.9	
Vacuum Still Bottoms										
IBP-975°F Gravity, °API									-8.6	
Carbon, W %									89.97	
Hydrogen, W %									7.00	
Sulfur, W %									0.23	
Nitrogen, W %									1.02	
975°F+ Oil Gravity, °API										
Carbon, W %									88.26	
Hydrogen, W %									5.34	
Sulfur, W %									0.51	
Nitrogen, W %									1.92	
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCTS										
Distillation of Filtrate from Filtration Operation										
Vacuum Distillation										
Final Vapor Temperature, °F			470	544	542	548	555	553	552	570
Pressure, Torr			2.6	3.5	1.9	0.2	0.4	3.0	0.2	0.6
Residue, W % of Filtrate			34.0	34.5	37.9	36.7	35.2	40.9	37.6	41.0
Sulfur, W %			0.64	0.42	0.39	0.46	0.48	0.68	0.53	0.51
Ash, W %			2.15	0.14	0.04	0.15	0.47	2.52	0.15	
Benzene Insoluble, W %				31.06	27.17	27.84	39.49	31.29	28.81	
IBP-975°F									3.6	
975°F+									96.4	
Batch Distillation of Vacuum Bottoms Slurry Product										
Vacuum Distillation										
Final Vapor Temperature, °F	520		488	501	492	490	510	493	529	
Pressure, Torr	2.4		3.0	3.2	3.3	4.0	4.0	3.6	2.2	
Distillate, W % Vacuum Bottoms Slurry	28.4		11.0	10.6	8.8	10.4	14.8	9.4	5.3	
Gravity, °API	-8.3		-8.0	-6.8	-6.2	-6.7	-7.2	-7.1	-4.0	
Sulfur, W %	0.24		0.12	0.32	0.22	0.27	0.34	0.23	0.22	

PHASE II - DOE/PARTICIPANTS PROGRAM

The overall objective of the Phase II program was to achieve maximum assurance of successful operations in the H-Coal Pilot Plant. The specific objectives were:

1. Modify the PDU to simulate as closely as possible the Pilot Plant and to increase the reliability and productivity of PDU operation.

2. Duplicate on the PDU, as closely as possible, the operating conditions for the H-Coal Pilot Plant as stated in the Technical Management Plan.

3. Develop Pilot Plant emergency operating procedures by exploring potential failure modes and responses on the PDU.

4. Provide training for Pilot Plant operating personnel.

5. Identify improved high density and high activity catalysts for use in the H-Coal Pilot Plant.

6. Confirm the design of the reactor ebullating cup for the H-Coal Pilot Plant.

7. Conduct certain process engineering studies leading to optimization of the H-Coal Process and improvement of the design data base.

PDU RUN 5 - ILLINOIS NO. 6 COAL - SYNCRUDE MODE

Run 5 was undertaken to simulate as closely as possible syncrude mode operations in the H-Coal Pilot Plant when using Illinois No. 6 coal with continuous catalyst addition and withdrawal. The process conditions were the same as those specified for the Pilot Plant for this type of operation. In every significant respect this PDU run met each of the targeted specifications.

The run lasted for thirty days. Operation was smooth, and there were no significant operating problems even though this was the first demonstration of the catalyst addition-withdrawal system in an actual PDU operation. The principal achievements of PDU Run 5 were:

- catalyst replacement at a rate of one pound per ton of coal without interruption in operations of the PDU
- thirty days of sustained operation with excellent stability
- successful demonstration of the operating parameters for Pilot Plant syncrude operation with Illinois No. 6 coal
- data for comparison with previous projections of steady state yields based on runs without catalyst addition
- data on the viscosity of fresh vacuum still bottoms

One of the most significant achievements of PDU Run 5 was a demonstration of the catalyst addition-withdrawal system which was designed and built by HRI and installed as an integral component of the Process Development Unit. Its use in PDU Run 5 provided operating experience applicable to a similar system in the 600 T/D H-Coal Pilot Plant under construction at Catlettsburg, Kentucky. The distillate yields of this operation with catalyst addition and withdrawal reached catalyst steady state in ten days and essentially confirmed predictions based on previous runs in which the deactivation of a single batch of catalyst was monitored.

DATA CORRELATION

ILLINOIS COAL - SYNCRUDE MODE

	Bench Unit Design Basis	PDU Correlation Without Catalyst Addition	PDU Observed With Catalyst Addition
C_1-C_3, W %	8.3	9.6	11.2
C_4-400°F, W %	17.4	25.7	18.7
400-975°F, W %	34.9	25.9	29.1
975°F+, W %	14.9	15.8	19.7
Unreacted, W %	3.9	5.4	5.3

Differences in source of Illinois coal, catalyst and operating conditions may prevent exact comparison

ANALYSIS OF ILLINOIS NO. 6 BURNING STAR, MINE #2 COAL FOR PDU RUN 5 (RUN 130-82)

HRI No.	3918	3944	3918	3806	3944
Feed to Period	As Received		1-9	10-17	18-30
Hours on Run			0-212	212-404	404-716
Moisture, W %					
Proximate, Dry Basis, W %					
Ash	11.13	11.75	10.88	10.48	10.61
Volatile Matter	36.01	35.56	38.27	38.86	37.90
Fixed Carbon	52.86	52.69	50.85	50.66	51.49
Ultimate, Dry Basis, W %					
Carbon	70.83	71.52	69.48	69.66	70.88
Hydrogen	5.04	5.05	5.01	5.10	4.91
Nitrogen	1.45	1.36	1.29	1.22	1.47
Sulfur (LECO)	4.06	3.52	3.55	3.60	3.47
Ash	11.13	11.75	10.88	10.48	10.61
Chlorine	0.07	0.10	0.06	0.06	0.07
Oxygen (Difference)	7.42	6.70	9.73	9.88	8.57
Sulfur in Ash, W %	-	-	1.57	1.70	1.11
Sulfur (Eschka), W %	-	-	3.47	3.56	3.47
Sulfur Forms, Dry Basis, W %					
Pyritic	-	-	1.16	1.18	1.29
Sulfate	-	-	0.19	0.16	0.07
Heating Value, Btu/Lb	-	-	12,428	12,557	12,620
Sieve Analysis, Screen Size (U.S.S.)					
+50	-	-	7.70	9.38	2.59
50/70	-	-	7.07	8.18	2.75
70/100	-	-	9.95	11.43	5.82
100/140	-	-	11.56	12.41	8.68
140/200	-	-	10.98	10.91	10.31
200/325	-	-	19.50	18.84	23.42
-325	-	-	33.29	28.85	46.43
Mineral Analysis, W % Ignited					
Silica, SiO_2	-	-	45.12	46.62	47.83
Alumina, Al_2O_3	-	-	19.54	18.95	18.07
Titania, TiO_2	-	-	0.77	0.77	0.85
Ferric Oxide, Fe_2O_3	-	-	20.65	19.36	17.81
Lime, CaO	-	-	6.50	5.97	7.40
Magnesia, MgO	-	-	0.80	0.86	0.90
Potassium Oxide, K_2O	-	-	1.67	0.45	1.81
Sodium Oxide, Na_2O	-	-	0.39	4.25	0.45
Sulfur Trioxide, SO_3	-	-	3.19	4.26	3.66
Phos. Pent., P_2O_5	-	-	0.02	0.03	0.01
Undetermined	-	-	1.35	0.87	1.21
Total			100.00	100.00	100.00

POU RUN 5 (130-82) - H-COAL OPERATIONS ON BURNING STAR MINE, ILLINOIS NO. 6 COAL (HRI 3918)

CATALYST - AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830) 96.7 LBS DRY INITIAL CHARGE

REACTOR LIQUID PHASE DEPTH 19 FEET, VOLUME 7.49 FT^3

Period	1A	1B	2A	2B	3	4	5	6	7	8
Date, End of Period (1977)	9/4	9/5	9/5	9/6	9/7	9/8	9/9	9/10	9/11	9/12
Hours of Run - Beginning	0	9	21	33	45	59	93	117	141	165
End	89	21	33	45	69	93	117	141	165	189
Catalyst Inventory, Beginning, Lbs.	96.7	96.7	96.0	96.0	101.8	101.6	100.6	100.5	100.0	100.0
Catalyst Added	0.00	0.00	0.00	0.00	5.80	3.33	1.51	4.17	6.04	0.00
Catalyst Withdrawn	0.00	0.00	0.70	0.00	0.00	3.49	5.66	4.24	4.25	0.00
Catalyst Age (End), Lbs Dry Coal/Lb Catalyst										
Average*	.14	38	66	95	149	202	253	300	340	398
Original Charge**	14	38	66	95	154	213	272	330	389	447
Catalyst Added, Cumulative, Lbs/Ton Dry Coal	0.00	0.00	0.00	0.00	0.77	0.87	1.02	1.09	1.24	1.08
Coal Feed (Dry), Lbs/Hr/Ft^3 Reactor Volume	21.2	26.0	29.5	31.7	33.2	33.0	33.4	32.5	32.6	32.3
Moisture, W %		4.60		3.39	2.86	3.59	3.50	3.45	2.44	2.70
Ash, % (Dry Basis)		10.34		10.84	10.83	10.49	11.17	11.09	10.81	11.03
Recycle Flows, Lbs/Lb Solids										
Atmospheric Still Bottoms	1.183	1.287	1.171	0.907	0.775	0.769	0.720	0.660	0.658	0.589
Vacuum Still Overhead	0.022	0.054	0.084	0.147	0.178	0.181	0.194	0.107	0.120	0.139
Inventory Change	0.461	0.108	0.032	-0.053	-0.075	0.052	0.007	0.015	-0.017	-0.050
Hydroclone Overflow (Oil)	1.089	0.954	0.973	0.948	0.926	1.042	0.954	0.990	0.986	1.011
Make-Up Oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	1.833	2.185	2.197	2.056	1.953	1.940	1.862	1.742	1.782	1.789
Temperatures, °F										
Coal Preheater Outlet	620	723	722	716	710	706	711	717	723	738
Reactor Liquid Phase - Average	811	839	848	850	849	849	848	849	849	849
Maximum	816	846	856	858	858	858	857	857	857	856
Separator	749	787	798	801	779	797	795	794	795	-
Hydroclone	460	488	501	510	501	549	555	555	554	551
Vacuum Still Flash Zone	428	491	487	510	501	549	555	555	535	538
Pressure in Vacuum Flash, Torr	4.0	8.2	6.8	3.3	3.0	2.8	2.7	2.5	2.3	2.4
Pressure, psig										
Unit Back Pressure	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700
Hydrogen Make-Up	2740	2725	2750	2750	2750	2750	2760	2800	2815	2795
Hydrogen Partial Pressure (Reactor Outlet)			1380	1550	1525	1610	1670	1690	1710	1660
Recycle Gas, MSCF/Ton Dry Coal	72.2	30.1	34.6	37.0	33.0	35.1	35.6	37.4	38.2	38.3
Vent Gas, MSCF/Ton Dry Coal			2.56	2.07	2.43	3.12	3.51	3.83	4.19	2.98
Hydrogen Purity of Recycle Gas & Vent, %	87.2	77.8	71.3	77.3	75.9	78.4	79.4	80.5	80.0	78.0
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)			27.3	31.4	27.9	30.8	32.1	34.2	35.2	33.1
Make-Up Hydrogen + Recycle Hydrogen										
MSCF/Ton Dry Coal			49.8	53.0	49.7	52.0	52.9	52.6	55.7	52.4
V % of Make-Up & Recycle Gas			83.4	86.3	86.2	87.3	87.8	87.8	87.9	86.2
Hydrogen Partial Pressure, psig			2300	2380	2380	2410	2440	2470	2490	2420
Hydrogen Consumption***										
MSCF/Ton Dry Coal			22.0	21.6	21.9	21.2	20.8	18.4	20.5	19.3
W % Dry Coal			5.84	5.72	5.81	5.61	5.52	4.87	5.44	5.12
Oil Additions										
Make-Up Oil - Lbs/Lb Dry Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lbs/Hr/Ft^3 Reactor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flush Oil, Lbs/Lb Dry Coal		0.0039		0.0030	0.0030	0.0032	0.0032	0.0032	0.0031	0.0031

* Average age weighed by proportions of catalyst of various ages in bed

** Age of portion of original catalyst remaining in bed

*** Orifice for fresh hydrogen, meter for product gases with analysis

Period	1A	1B	2A	2B	3	4	5	6	7	
Collected Product Quantities, W % of Dry Coal										
Atmospheric Still Overhead	1.92	18.36	26.28	31.54	32.54	32.10	33.24	32.04	32.88	35.5
Atmospheric Still Bottoms(1)	57.45	12.71	15.87	10.50	4.58	5.10	4.86	6.47	2.74	2.0
Vacuum Still Overhead(1)	1.11	0.92	0.74	-0.34	-1.10	1.53	0.56	0.63	0.12	-0.6
Vacuum Still Bottoms	8.47	30.90	30.82	33.93	37.96	37.54	40.19	36.90	39.90	41.3
H_2O(2)	19.06	8.93	13.37	13.30	12.78	12.91	11.58	13.38	12.84	12.7
C_1-$_3$	3.29	6.43	6.23	8.55	8.30	8.53	8.68	9.32	10.19	9.2
C_4-C_6	2.96	4.80	3.14	3.61	4.26	3.78	3.70	3.73	3.63	3.5
H_2S in Gases	1.56	1.14	0.97	0.97	0.97	1.33	1.34	1.51	1.00	1.1
CO_2 & CO	0.11	0.13	0.18	0.23	0.28	0.42	0.36	0.40	0.37	0.3
Total	71.87	84.32	97.60	102.30	100.57	103.24	104.51	104.38	103.67	105.4
Input Quantities, W % of Dry Coal										
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.
Moisture in Feed Coal		4.82	(4.16)	3.51	2.80	3.70	3.63	3.57	2.50	2.7
Make-Up Oil Additions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Flush Oil	0.51	0.39	0.30	0.30	0.30	0.30	0.30	0.32	0.31	0.3
Hydrogen Reacted(7)			5.84	5.72	5.80	5.61	5.52	4.84	5.44	5.1
Total Used for Normalization			100.30	109.45	108.90	(5)	109.45		96.4	96.
Coal Conversion, W % of M.A.F. Coal(6)		96.0		94.5	94.7	95.2	94.6		96.4	96.
Normalized Net Product Distribution(3) W % of Dry Coal										
CO, CO_2				0.24	0.30	0.44	0.37	0.41	0.38	0.3
C_1-C_3 Hydrocarbons in Gases				9.06	8.90	8.96	9.04	9.66	10.55	9.4
C_4-C_6 Hydrocarbons in Gases				3.82	4.57	3.95	3.85	3.87	3.76	3.6
IBP-400°F Naphtha				21.74	19.11	17.41	17.21	16.85	16.24	15.8
400-650°F Distillates				27.38	26.43	20.76	28.61	27.59	23.67	25.7
650-975°F Distillates						7.69				
975°F+ Residual Oil(4)										
Toluene Soluble				13.16	13.43	14.25	15.91	13.86	16.67	15.9
Toluene Insoluble				1.23	2.72	4.75	3.25	4.52	6.14	6.3
Unconverted Coal				5.05	5.19	3.97	5.00	4.24	3.49	3.5
Ash				11.24	12.16	10.87	11.84	11.48	11.78	12.0
H_2O (Net)				10.14	10.48	8.45	8.06	9.87	10.38	9.8
NH_3 (Forced Nitrogen)						1.03				
H_2S (Forced Sulfur)				2.65	2.52	2.49(5)	2.38	2.49	2.39	2.9
Total (100 + Hydrogen Reacted)				105.72	105.80	105.04	105.52	104.84	105.44	105.1

(1) Negative quantities of atmospheric still overhead and vacuum overhead are decreases of inventory of slurry oil holding tank

(2) Includes dissolved NH_3 and H_2S

(3) ASTM distillation cut points

(4) Period 4 based on vacuum distillation of toluene soluble oil in vacuum bottoms. Other periods based on batch distillation assay of vacuum bottoms, estimating IBP-975°F in vacuum bottoms as 1.24 times amount of distillate obtained (average of Periods 4, 15, 23, and 29 assays).

(5) Hydrogen consumption by coal feed and product hydrogen analyses, ammonia formation by nitrogen balance.

(6) Based on filtration of product slurry fed to vacuum still, unless otherwise stated.

(7) Orifice for fresh hydrogen, meter for product gases with analysis.

PDU RUN 5 (130-82) - ANALYSES

Period	1A	1B	2A	2B	3	4	5	6	7	8
Atmospheric Still Overhead										
Gravity, °API	41.5	43.7	42.1	36.8	34	32.9	32.0	31.7	30.3	29.4
10 V %	174	146	148	206	148	126	146	152	142	134
30	213	207	210	245	228	225	232	224	222	229
50	248	241	254	296	306	303	316	320	314	326
70	289	280	294	355	376	380	395	392	398	415
90	358	336	348	410	435	450	455	460	460	475
FBP	462	431	449	476	490	525	525	550	534	540
V % @ 400°F	555	532	545	510	554	570	590	570	587	594
Carbon, W %	78	84	80	68	58	55	53	54	51	47
Hydrogen, W %						88.10				
Nitrogen, W %						11.76				
Sulfur, W %						0.17				
Phenols, V %						0.07				
						5.4				
Atmospheric Still Bottoms										
Gravity, °API	16.2	16.4	14.5	13.9	12.5	11.2	10.5	9.6	9.2	9.6
IBP, °F		418		430	465	(403)	458	460	467	465
10 V %		469		486	506	(491)	519	516	525	532
30		520		535	550	(550)	570	570	575	590
50		562		575	595	(585)	616	612	616	634
70		616		625	650	(637)				
90						(715)				
FBP						(883)				
V % @ 400°F	0	0	0	0	0	0	0	0	0	0
V % @ 650°F	0	80	0	76	70	/73	66	64	62	58
Carbon, W %						89.99				
Hydrogen, W %						9.41				
Nitrogen, W %						0.37				
Sulfur, W %						<0.03				
Vacuum Still Overhead										
Gravity, °API		9.6	9.2	8.3	6.8	5.7	4.6	3.8	2.6	2.9
IBP, °F		510		472	486	(424)	492	520	535	
10 V %		565		535	545	(525)	570	582	595	
30		618		590	605	(595)	640			
50						(667)				
70						(723)				
90						(825)				
FBP						(914)				
V % @ 650°F		48		50	45	(47)	34	29	25	
Carbon, W %						90.78				
Hydrogen, W %						8.68				
Nitrogen, W %						0.42				
Sulfur, W %		0.055		<0.03	<0.03	<0.03	<0.03	<0.03	0.09	
Water										
Nitrogen, W %						4.46				
Sulfur, W %						2.93				
Carbon, W %						2.38				
0-5 Liquid										
Gravity, °API	16.5		16.5	16.2	14.7	13.2	12.9	12.7	12.3	11.5
Ash, W %	0.0006		0.0013	0.0021	0.0020	0.0024	0.0006	0.0008	0.0012	0.0006
Vacuum Distillation										
IBP, °F						(331)				
10 V %						(445)				
30						(515)				
50						(571)				
70						(634)				
90						(760)				
FBP						(855)				
V % @ 400°F						(6.5)				
V % @ 650°F						(74)				
Residue, W %						(2.5)				
0-12 Liquid										
Gravity, °API		21.8		19.8	18.4	17.6	16.7	14.8	13.5	
Vacuum Distillation										
IBP, °F						(296)				
10 V %						(424)				
30						(491)				
50						(530)				
70						(576)				
90						(665)				
FBP						(730)				
V % @ 400°F						(6.5)				
V % @ 650°F						(89)				
W % Residue						(1.0)				

Distillations - ALL ASTM D-86 except bracketed values from ASTM D-1160 (modified)

Period	1A	1B	2A	2B	3	4	5	6	7	8
Vacuum Still Bottoms										
W % of Flows from Vacuum Still				51.3	50.6	49.5	51.5	55.2	55.6	54.8
Toluene Soluble, W %		50.88		51.37	51.25	53.26	52.50	46.77	48.65	47.63
Toluene Insoluble, W %		16.85		17.47	19.43	22.14	19.71	22.89	23.31	23.44
Ash, W %		32.27		31.16	29.32	24.60	27.79	30.34	28.04	28.93
Unreacted Coal, W % (Estimated)		11.09		14.05	12.74	10.07	11.95	(11.09)	8.45	8.31
Toluene Insoluble Resid, W % (Estimated)		5.76		3.42	6.69	12.07	7.76	(11.80)	14.86	15.13
Carbon, W %						63.83				
Hydrogen, W %						4.25				
Nitrogen, W %						0.90				
Sulfur, W %	2.19	2.72	2.68	2.85	2.86	2.99	3.04	3.06	3.06	2.89
ASTM Ash, W %		32.12	32.67	31.29	29.87	27.61	28.28	29.99	28.52	28.48
Coke/Ash Ratio,										
DMF Extraction by Filtration		0.469		0.462	0.463	0.528	0.497	0.480	0.518	0.503
DMF Soluble, W %		52.85		54.89	59.12	62.72	58.12	54.54	57.41	56.64
Toluene-Extracted Oil										
IBP, °F						745				
Distillate to 975°F, W %						25.6				
Filter Cake										
W % of Feed to Vacuum Still		46.2		37.8	28.2	32.6	12.1	14.2	12.4	13.0
Toluene-Soluble, W %		33.59		32.33	32.47	32.25	33.66		26.42	31.62
Toluene-Insoluble, W %		18.32		21.55	21.47	21.46	21.99		19.38	18.11
Ash, W %		48.09		46.12	46.06	46.29	45.15		54.20	50.27
Toluene-Insoluble Residues, W %		1.08		0.76	1.46	2.51	1.78		3.06	3.58
Unreacted Coal, W % (Estimated)		16.52		20.79	20.01	18.95	19.41		16.32	14.53
Carbon, W %						48.67				
Hydrogen, W %						3.50				
Sulfur, W %						4.22				
Nitrogen, W %						0.61				
Catalyst Withdrawals										
Withdrawals, Oil Laden Pounds			1.33			6.44	10.75	8.63	12.57	
Oil, W %			41.46			27.18	29.56	31.80	27.56	
Molybdenum (Oil-Free), W %			8.09			6.70	6.73	6.49	6.44	
Estimated Catalyst Content, Lbs.*			0.70			3.49	5.66	4.24	4.25	
Hydroclone Feed										
Ash, W %		17.03	14.86	15.81	14.11	14.58	13.66	18.19	16.67	15.99
Hydroclone Overflow										
Gravity, °API		-8.3		-8.6	-8.7	-9.0	-12.3	-14.8	-13.4	-13.8
Distillation (D-1160)										
IBP, °F		429		424	444	436	473	451	468	485
10 V %		553		539	556	546	587	615	618	614
30		626		635	665	650	711	720	733	729
50		711		756	778	765	797	873	876	868
70		872				975				
EP		975		975	975	975	975	975	975	975
V % @ 650°F		37		33	29	30	23.5	17	15.5	16
V % @ 975°F		76		68	70	70	65.5	58.5	60.5	59.5
W % 975°F+ (Includes Solids)		33.9		39.4	38.3	38.1	44.3	50.2	47.5	49.2
Ash, W %		7.05	9.11	7.27	6.69	6.52	6.76	8.22	8.11	7.88
Hydroclone Underflow										
Ash, W %		17.54	21.97	19.34	20.09	20.29	19.97	18.78	17.35	16.60
Atmospheric Overhead										
IBP-400°F										
Gravity, °API						43.3				
Sulfur, W %						<0.03				
Nitrogen, W %						0.11				
Phenols, V %						3.00				
400°F+										
Gravity, °API						21.7				
Sulfur, W %						0.02				
Nitrogen, W %						0.27				
Atmospheric Still Bottoms										
IBP-650°F										
Gravity, °API						14.6				
Sulfur, W %						<0.03				
Nitrogen, W %						0.21				
Phenols, V %						2.5				
650°F+										
Gravity, °API						2.6				
Sulfur, W %						0.04				
Nitrogen, W %						0.51				
Vacuum Still Overhead										
IBP-650°F										
Gravity, °API						12.1				
Sulfur, W %						<0.03				
Nitrogen, W %						0.26				

*Basis, 9.00% Molybdenum in Fresh Catalyst

POU RUN 5 (130-82) - ANALYSIS (CONTINUED)

Period	1B	2B	3	4	5	6	7	8
Vacuum Still Overhead								
650°F+								
Gravity, °API				0.6				
Sulfur, W %				0.03				
Nitrogen, W %				0.57				
Vacuum Still Bottoms								
Toluene-Extracted Oil, IBP-975°F								
Gravity, °API				-5.6				
Carbon, W %				90.03				
Hydrogen, W %				7.01				
Sulfur, W %				0.03				
Nitrogen, W %				0.69				
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCT								
Batch Distillation of Filtrate from Filtration of Vacuum Still Feed								
Final Vapor Temperature, °F	490	560	565	569	562	560		550
Pressure, Torr	2.2	0.8	9	0.7	5.4	0.8		1.2
Residue, W % of Filtrate	48.9	23.4	41.2	29.3	55.5	50.0		47.9
Analysis of Residue								
Sulfur, W %	0.18	0.28	0.52	0.51				
IBP, °F								
Distillate to 975°F, W %				0.8				
Analysis of 975°F+								
ASTM Ash, W %				1.45				
Carbon, W %				88.59				
Hydrogen, W %				5.65				
Sulfur, W %				0.60				
Nitrogen, W %				1.33				
Toluene-Extraction of Residue								
Insolubles (Except Ash), W %	9.26	20.93	16.93	26.33	23.23	26.10	27.50	24.40
Ash, W %	0.38	0.25	2.45	1.61	24.70	25.38	25.13	19.38
DMF Extraction of Residue								
Insolubles (Except Ash), W %				8.21				
Ash, W %				2.10				
Batch Distillation of Vacuum Bottoms Slurry Product								
Final Vapor Temperature, °F	460	511	535	551	521	458	550	488
Pressure, Torr	3.5	1.6	1.0	3.0	2.0	2.0	5.0	2.6
Distillate, W % of Vacuum Bottoms Slurry	20.5	11.8	14.3	12.5	11.4		6.3	8.3
Vacuum Distillate								
Gravity, °API	-0.1	-3.2	-4.8	-4.0	-4.6	-4.5		-4.8
IBP, °F				637				
10 V %				763				
30				842				
50				886				
70				933				
90								
FBP				975				
V % @ 650°F				0.6				
V % @ 975°F				85				
Residue, W %				17.1				
Sulfur, W %				0.11				
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product								
Constitution, W %								
Batch Still Distillate from Slurry Product		21.6	24.9	20.1	18.9	14.9	10.0	13.1
Batch Still Residue from Filtrate		78.4	75.1	79.9	81.1	85.1	90.0	86.8
Composition, W % (Calculated)								
Carbon, W %				88.91				
Hydrogen, W %				5.95				
Nitrogen, W %				1.19				
Sulfur, W %		0.23	0.40	0.41				
Ash, W %		0.20	1.84	1.29				
Calculated Composition of 400°F+ Liquid Product								
Constitution, W %								
Atmospheric Still Overhead, 400°F-		27.9	37.1	34.3	36.9	35.6	38.[illegible]	42.3
Atmospheric Still Bottoms		26.6	11.5	11.3	10.6	14.6	1[illegible]	4.4
Vacuum Still Overhead		-1.6	-3.5	2.7	0.6	0.7	-0.4	-2.1
Vacuum Still Bottoms, Solids-Free Oil		47.0	54.9	51.7	52.4	49.1	56.0	55.4
Composition, W %								
Carbon, W %								
Hydrogen, W %				7.94				
Nitrogen, W %				0.76				
Sulfur		0.13	0.25	0.24				
Ash, W %		0.09	1.01	0.67				

POU RUN 5 (130-82) - H-COAL OPERATIONS ON BURNING STAR MINE, ILLINOIS NO. 6 COAL

(HRI 3918 3944 - PERIOD 17 AND THEREAFTER)

CATALYST - AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830) 96.7 LBS DRY INITIAL CHARGE

REACTOR LIQUID PHASE DEPTH 19 FEET, VOLUME 7.49 FT^3

Period	9	10	11	12	13	14	15	16	17	18
Date, End of Period (1977)	9/13	9/14	9/15	9/16	9/17	9/18	9/19	9/20	9/21	9/22
Hours of Run - Beginning	189	213	237	261	285	309	333	357	381	405
End	213	237	261	285	308	333	357	381	405	429
Catalyst Inventory, Beginning, Lbs.	99.8	99.8	99.6	99.3	99.1	100.6	100.0	99.7	99.2	99.2
Catalyst Added	4.11	0.00	3.98	3.87	4.11	1.45	3.98	3.68	3.87	0.00
Catalyst Withdrawn	4.35	0.00	4.20	4.18	4.27	0.00	4.53	3.96	4.11	0.00
Catalyst Age (End), Lbs Dry Coal/Lb Catalyst										
Average*	440	499	539	577	613	662	694	723	755	811
Original Charge**	506	565	625	684	744	802	860	915	976	1032
Catalyst Added, Cumulative, Lbs/Ton Dry Coal	1.11	1.00	1.03	1.05	1.08	1.04	1.06	1.08	1.09	1.03
Coal Feed (Dry), Lbs/Hr/Ft^3 Reactor Volume	32.8	32.5	33.3	32.8	32.9	32.5	32.4	30.5	32.0	30.8
Moisture, W %	2.51	2.92	2.50	2.58	3.19	2.91	3.23	4.19	2.61	4.21
Ash, % (Dry Basis)	11.12	10.17	10.62	10.19	10.59	10.69	10.17	10.47	10.28	10.66
Recycle Flows, Lbs/Lb Solids										
Atmospheric Still Bottoms	0.603	0.627	0.581	0.607	0.621	0.611	0.607	0.836	0.720	0.696
Vacuum Still Overhead	0.112	0.125	0.093	0.074	0.005	0.008	0.000	0.009	0.028	0.013
Inventory Change	0.026	0.017	0.034	0.028	0.021	-0.022	0.003	-0.030	0.031	0.017
Hydroclone Overflow (Oil)	0.975	0.947	0.924	0.996	1.021	1.010	1.031	0.975	0.947	1.018
Make-Up Oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.849	1.664	0.000
Total	1.693	1.682	1.582	1.650	1.625	1.651	1.635	1.850	1.665	1.710
Temperature, °F										
Coal Preheater Outlet	730	734	731	732	725	728	728	753	748	757
Reactor Liquid Phase - Average	851	851	851	850	851	850	852	849	852	850
Maximum	859	858	859	858	860	859	861	857	860	858
Separator	794	793	792	789	790	791	792	793	792	789
Hydroclone	544	554	558	553	553	545	554	560	567	574
Vacuum Still Flash Zone	541	537	533	535	535	534	537	533	534	538
Pressure In Vacuum Flash, Torr	2.3	2.2	2.2	2.2	2.3	2.4	2.2	2.2	2.2	2.2
Pressure, psig										
Unit Back Pressure	2710	2700	2700	2700	2700	2710	2700	2700	2700	2700
Hydrogen Make-Up	2795	2800	2820	2810	2840	2850	2850	2820	2830	2840
Hydrogen Partial Pressure (Reactor Outlet)	1540	1580	1510	1630	1450	1580	1480	1650	1680	1680
Recycle Gas, MSCF/Ton Dry Coal	36.4	37.3	34.7	35.1	35.3	36.1	36.2	40.5	36.7	39.5
Vent Gas, MSCF/Ton Dry Coal	2.61	3.24	3.17	3.35	2.82	3.39	3.61	3.80	3.94	4.21
Hydrogen Purity of Recycle Gas & Vent, %	72.7	74.9	71.7	77.6	69.8	72.7	70.7	77.5	79.0	79.6
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)	29.5	31.6	28.4	30.9	27.7	29.4	29.1	35.6	34.3	36.2
Make-Up Hydrogen + Recycle Hydrogen										
MSCF/Ton Dry Coal	48.7	50.9	47.4	50.0	47.8	49.7	49.5	56.1	53.0	54.2
V % of Make-Up & Recycle Gas	83.0	84.5	82.8	86.4	81.8	83.6	82.3	82.3	86.0	87.0
Hydrogen Partial Pressure, psig	2330	2380	2350	2440	2330	2400	2360	2440	2470	2480
Hydrogen Consumption***										
MSCF/Ton Dry Coal	19.2	19.3	19.0	19.1	20.1	20.3	20.4	20.5	18.7	18.0
W % Dry Coal	5.09	5.12	5.03	5.07	5.33	5.38	5.40	5.44	4.95	4.76
Oil Additions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Make-Up Oil - Lbs/Lb Dry Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lbs/Hr/Ft^3 Reactor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flush Oil, Lbs/Lb Dry Coal	0.0031	0.0031	0.0031	0.0031	0.0032	0.0032	0.0033	0.0034	0.0032	0.0033

* Average age weighed by proportions of catalyst of various ages in bed

** Age of portion of original catalyst remaining in bed

*** Orifice for fresh hydrogen, meter for product gases with analysis

PDU RUN 5 (130-82) - OPERATING RESULTS

Period	9	10	11	12	13	14	15	16	17	18
Collected Product Quantities										
W % Dry Coal										
Atmospheric Still Overhead	27.91	27.31	26.59	25.36	24.15	25.04	24.67	27.08	28.34	28.22
Atmospheric Still Bottoms (1)	6.93	6.31	7.87	7.30	9.88	9.84	12.57	3.07	3.79	5.94
Vacuum Still Overhead (1)	0.88	0.71	0.94	0.76	0.02	0.52	-2.51	3.60	0.56	0.46
Vacuum Still Bottoms (2)	40.66	45.33	42.05	46.38	42.72	43.11	41.28	44.36	42.61	43.11
H_2O	12.80	12.26	12.04	12.54	12.62	12.23	12.05	12.41	12.11	13.07
C_1-C_3	10.38	11.25	11.09	11.04	10.91	11.43	11.77	11.71	11.60	11.89
C_4-C_6	3.87	4.35	4.17	3.78	4.54	5.19	5.33	4.27	4.21	5.34
H_2S in Gases	1.25	1.67	1.72	1.34	1.69	1.86	1.81	1.89	1.84	2.07
CO_2 & CO	0.41	0.49	0.51	0.44	0.61	0.69	0.68	0.43	0.47	0.76
Total	104.69	109.68	106.98	108.94	107.14	109.91	107.65	108.82	105.53	110.86
Input Quantities, W % of Dry Coal										
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture in Feed Coal	2.57	3.01	2.56	2.65	3.30	3.00	3.34	4.37	2.68	4.40
Make-up Oil Additions										
Flush Oil	0.31	0.31	0.31	0.31	0.32	0.32	0.33	0.34	0.32	0.33
Hydrogen Reacted (7)	5.09	5.12	5.03	5.07	5.33	5.38	5.40	5.44	4.95	4.76
Total Used for Normalization	107.97	108.44	107.90	108.03	108.95	108.70	(5)	110.15	107.95	109.49
Coal Conversion, W % of M.A.F. Coal (6)	93.9	96.4	95.5	95.0	94.9	95.6	95.2	95.0	95.4	94.5
Normalized Net Product Distribution (3)										
W % of Dry Coal										
CO, CO_2	0.42	0.48	0.51	0.43	0.62	0.68	0.68	0.44	0.48	0.75
C_1-C_3 Hydrocarbons in Gases	10.59	11.07	11.13	10.87	11.05	11.27	11.80	11.86	11.35	11.75
C_4-C_6 Hydrocarbons in Gases	3.95	4.28	4.19	3.72	4.60	5.12	5.34	4.32	4.30	5.28
IBP-400°F Naphtha	13.63	14.12	14.03	14.40	13.60	13.23	14.11	14.97	15.81	14.66
400-650°F Distillates	26.84	24.43	25.16	23.46	24.85	25.76	18.21	24.48	22.72	24.25
650-975°F Distillates							7.59			
975°F+ Residual Oil (4)										
Toluene Soluble	15.77	14.62	17.23	17.92	18.57	19.28	15.92	17.71	15.83	17.13
Toluene Insoluble	3.49	9.37	6.67	6.73	4.43	4.87	4.38	5.20	6.10	4.56
Unconverted Coal	5.86	3.58	4.01	4.78	4.85	3.97	4.67	4.77	4.99	5.01
Ash	11.65	11.95	10.32	10.99	11.14	10.50	11.01	11.61	11.18	10.91
H_2O							7.66			
NH_3 (Forced Nitrogen)	10.14	8.72	9.20	9.36	9.13	8.73	0.76	7.85	9.36	8.17
H_2S (Forced Sulfur)	2.75	2.48	2.57	2.40	2.46	2.48	2.71	2.28	2.33	2.30
Total (100 + Hydrogen Reacted)	105.09	105.12	105.02	105.07	105.30	105.38	104.83	105.49	104.95	104.76

(1) Negative quantities of atmospheric still overhead and vacuum overhead are decreases of inventory of slurry oil holding tank

(2) Includes dissolved NH_3 and H_2S

(3) ASTM distillation cut point

(4) Period 15 based on vacuum distillation of toluene soluble oil in vacuum bottoms. Other periods based on batch distillation assay of vacuum bottoms, estimating IBP-975°F in vacuum bottoms as 1.24 times amount of distillate obtained (Average of Periods 4, 15, 23 & 28 Assays)

(5) Hydrogen consumption by coal feed and product hydrogen analyses. Ammonia formation by nitrogen balance

(6) Based on filtration of product slurry fed to vacuum still, unless otherwise noted

(7) Orifice for fresh hydrogen, meter for product gases with analysis

PDU RUN 5 (130-32) - ANALYSES

Period	9	10	11	12	13	14	15	16	17	18
Atmospheric Still Overhead										
Gravity, °API	30.8	31.1	30.7	32.0	31.9	32.5	31.8	31.2	30.8	30.5
IBP, °F	134	145	141	136	140	150	142	146	133	136
10 V %	226	226	220	224	226	234	230	243	221	215
30	315	310	310	294	300	310	308	315	306	308
50	388	387	382	367	376	380	380	380	379	383
70	463	449	450	432	432	440	431	434	437	446
90	547	522	518	510	512	518	501	500	500	506
FBP	591	596	582	578	562	550	555	575	565	567
V % @ 400°F	52	56	56	61	59	57	60	58	58	56
Carbon, W %							88.26			
Hydrogen, W %							11.49			
Nitrogen, W %							0.35			
Sulfur, W %							0.23			
Phenols, V %							12.0			
Atmospheric Still Bottoms										
Gravity, °API	8.7	8.8	8.1	8.3	8.4	8.9	8.9	8.7	9.1	8.7
IBP, °F	462	436	454	462	444	440	(389)	440	454	449
10 V %	520	517	506	510	504	496	(488)	494	503	513
30	578	575	567	568	560	554	(556)	555	559	567
50	624	621	621	614	610	600	(601)	600	616	612
70							(657)			
90							(720)			
FBP							(858)			
V % @ 400°F							(1)			
V % @ 650°F	62	60	62	62	65	67	(68)	68	65	66
Carbon, W %							90.47			
Hydrogen, W %							8.79			
Nitrogen, W %							0.57			
Sulfur, W %							0.04			
Vacuum Still Overhead										
Gravity, °API	1.8	1.4	1.0	1.3	1.3	1.0	0.8	1.4	1.3	1.2
IBP, °F	520	500	476	496	510	518	(453)	494	515	510
10 V %	595	600	600	586	590	586	(534)	575	572	579
30							(640)			650
50							(705)			
70							(755)			
90							(841)			
FBP							(962)			
V % @ 650°F	25	22	26	26	26	26	(33)	29	29	30
Carbon, W %							91.56			
Hydrogen, W %							7.66			
Nitrogen, W %							0.70			
Sulfur, W %	0.03	0.047	0.11	0.101	0.096	0.072	0.10	0.12	0.116	0.089
Water										
Nitrogen, W %							3.97			
Sulfur, W %							2.59			
Carbon, W %							3.71			
0-5 Liquid										
Gravity, °API	10.9	11.0	11.0	10.6	11.8	10.8	10.3	11.1	11.2	10.8
Ash, W %	0.0006	0.0017	0.0007	0.0014	0.0005	0.0009	0.0009	0.0019	0.0016	0.0082
Vacuum Distillation										
IBP, °F										
10 V %										
30										
50										
70										
90										
FBP										
V % @ 400°F										
V % @ 650°F										
Residue, W %										
0-12 Liquid										
Gravity, °API	12.6	12.8	13.1	12.5	12.5	13.4	12.7	12.3	13.6	13.6
Vacuum Distillation										
IBP, °F										
10 V %										
30										
50										
70										
90										
FBP										
V % @ 400°F										
V % @ 650°F										
Residue, W %										

Distillations - All ASTM D-86 except bracketed values from ASTM D-1160 (modified)

POU RUN 5 (130-82) - ANALYSES (CONTINUED)

Period	9	10	11	12	13	14	15	16	17	18
Vacuum Still Bottoms										
W % of Flows from Vacuum Still	567	58.5	58.9	56.7	57.3	57.2	58.3	55.6	56.8	57.9
Toluene Soluble, W %	48.54	46.00	49.61	50.94	52.61	53.79	51.77	52.81	49.17	52.16
Toluene Insoluble, W %	22.53	29.03	25.32	25.20	21.45	20.80	21.88	22.81	24.47	28.44
Ash, W %	28.93	24.97	25.07	23.36	25.94	25.41	26.35	24.88	26.26	25.40
Unreacted Coal, W % (Estimated)	14.12	8.03	9.51	10.46	11.21	9.35	11.28	10.63	11.45	11.75
Toluene-Insoluble Resid, W % (Estimated)	8.41	21.00	15.81	14.74	10.24	11.45	10.60	11.58	14.02	10.69
Carbon, W %							66.02			
Hydrogen, W %							4.06			
Nitrogen, W %							1.11			
Sulfur, W %	3.04	2.73	3.02	2.48	2.55	2.40	2.50	2.34	2.23	2.27
ASTM Ash, W %	28.07	26.80	24.45	24.06	25.74	24.69	26.61	25.86	25.68	25.60
Coke/Ash Ratio,										
DMF Extraction by Filtration	0.529	0.633	0.671	0.677	0.613	0.613	0.602	0.571	0.586	0.628
DMF Soluble, W %	56.50	59.26	58.44	61.11	58.94	59.02	58.64	60.44	58.04	59.07
Toluene-Extracted Oil										
IBP, °F							7.45			
Distillate to 975°F, W %							2.35			
Filter Cake										
W % of Feed to Vacuum Still	37.1	9.8	3.41	29.0	40.8	32.8	46.7	26.9	12.3	33.0
Toluene-Soluble, W %	31.62	26.49	24.35	28.57	34.34	27.68	28.43	27.45	29.35	29.12
Toluene-Insoluble, W %	25.31	21.87	23.04	24.07	21.74	21.26	23.16	23.39	22.46	24.12
Ash, W %	48.20	55.27	52.01	47.36	43.92	51.06	48.41	49.16	48.19	46.76
Toluene-Insoluble Residues, W %	1.78	4.11	3.30	3.31	2.77	2.96	2.45	2.40	3.28	2.49
Unreacted Coal, W % (Estimated)	23.53	17.76	19.74	20.76	18.97	18.80	20.71	20.99	19.18	21.63
Catalyst Withdrawals										
Withdrawals, Oil-Laden Pounds	8.5		8.31	8.50	8.50		8.25	7.56	8.06	
Oil, W %	27.43		26.51	28.49	26.42		24.65	24.52	25.07	
Molybdenum (Oil Free), W %	6.34		6.19	6.19	6.15		6.56	6.25	6.57	
Estimate Catalyst Content, Lbs.*	4.35		4.20	4.18	4.27		4.53	3.96	4.41	
Hydroclone Feed										
Ash, W %	15.54	19.26	16.64	10.11	14.50	14.99	11.04	10.03	9.73	10.62
Hydroclone Overflow										
Gravity, °API	-16.8	-16.7	-18.0	-15.3	-16.0	15.8	-16.4	-13.9	-15.2	-16.3
Distillation										
IBP, °F	472	457	468	468	484	476	473	495	480	479
10 V %	618	619	612	600	623	613	609	607	610	612
30	727	742	737	714	743	731	748	680	718	725
50	902	889	905	858	912	876	900	815	883	888
70										
EP	975	975	975	975	975	975	975	975	975	975
V % @ 650°F	16	17	15	19	15	17	15	19	17	18
V % @ 975°F	58	58	56	60	57.5	605	57.5	62	59	60.5
W % 975°F+ (Includes Solids)	51.0	50.6	53.0	48.0	51.0	49.0	50.4	46.9	49.8	49.2
Ash, W %	8.44	8.18	8.74	7.78	7.80	7.60	8.04	6.60	7.88	7.94
Hydroclone Underflow										
Ash, W %	17.38	17.24	16.69	14.34	15.73	15.60	17.28	13.98	15.62	15.47
Atmospheric Overhead										
IBP-400°F										
Gravity, °API							41.2			
Sulfur, W %							0.11			
Nitrogen, W %							0.16			
Phenols, V %							5.5			
400°F+										
Gravity, °API							18.8			
Sulfur, W %							0.20			
Nitrogen, W %							0.55			
Atmospheric Still Bottoms										
IBP-650°F										
Gravity, °API							12.5			
Sulfur, W %							0.03			
Nitrogen, W %										
Phenols, V %										
650°F+										
Gravity, °API							2.3			
Sulfur, W %							0.04			
Nitrogen, W %										
Vacuum Still Overhead										
IBP-650°F										
Gravity, °API							8.5			
Sulfur, W %							0.03			
Nitrogen, W %										

* Basis, 9.00% Molybdenum in Fresh Catalyst

PDU RUN 5 (130-82) - ANALYSES (CONTINUED)

Period	9	10	11	12	13	14	15	16	17	18
Vacuum Still Overhead										
650°F+										
Gravity, °API							0.5			
Sulfur, W %							0.16			
Nitrogen, W %										
Vacuum Still Bottoms										
Toluene-Extracted Oil, IBP-975°F										
Gravity, °API							-7.9			
Carbon, W %							90.24			
Hydrogen, W %							6.48			
Sulfur, W %							0.83			
Nitrogen, W %							1.03			
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCT										
Batch Distillation of Filtrate from Filtration of Vacuum Still Feed										
Final Vapor Temperature, °F	490	559	528	521	555	515	505	570	556	569
Pressure, Torr	2.2	2.2	1.4	0.4	1.4	4.2	2.4	2.8	0.8	1.0
Residue, W % of Filtrate	48.9	54.3	46.4	40.4	41.5	48.8	46.7	48.9	50.2	40.6
Analysis of Residue										
Sulfur, W %	0.48		0.56	0.67	0.55	0.50	0.48	1.06	2.17	0.56
IBP, °F							930			
Distillate to 975°F, W %							5.0			
Analysis of 975°F+										
ASTM Ash, W %										
Carbon, W %							89.38			
Hydrogen, W %							5.17			
Sulfur, W %							0.39			
Nitrogen, W %							1.61			
Toluene-Extraction of Residue										
Insolubles (Except Ash), W %	29.27		30.52	30.19	28.88	24.01	28.68	32.20	31.00	35.01
Ash, W %	0.96		0.53	1.76	0.95	0.72	0.72	7.90	23.87	0.84
Batch Distillation of Vacuum Bottoms Slurry Product										
Final Vapor Temperature, °F	385	510	439	512	330	515	508	351	517	490
Pressure, Torr	1.9	1.6	1.8	2.2	2.8		2.0	2.0	2.6	3.0
Distillate, W % of Vacuum Bottoms Slurry	19.1	9.2	6.6	9.3	8.0	7.4	9.0	10.1	10.1	9.5
Vacuum Distillate										
Gravity, °API	-4.7	-4.1	-4.4	-2.3	-3.1	-4.7	-4.0	-4.6	-6.3	-6.5
IBP, °F										
10 V %										
30										
50										
70										
90										
FBP										
V % @ 650°F										
V % @ 975°F										
Residue, W %										
Sulfur, W %							0.05			
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product										
Constitution, W %										
Batch Still Distillate from Slurry Product	15.9	14.1	11.5	14.2	12.7	11.2	14.5	15.9	16.1	15.2
Batch Still Residue from Filtrate	84.1	85.9	88.5	85.8	87.3	88.8	85.5	84.1	83.9	84.8
Composition, W % (Calculated)										
Carbon, W %							89.56			
Hydrogen, W %							5.44			
Nitrogen, W %							1.49			
Sulfur, W %	0.41		0.50	0.58	0.48	0.45	0.41			0.48
Ash, W %	0.81		0.47	1.51	0.85	0.64	0.62			0.71
Calculated Composition of 400°F+ Liquid Product										
Constitution, W %										
Atmospheric Still Overhead, 400°F+	31.4	26.3	25.8	22.0	22.7	23.2	23.2	26.3	29.5	28.8
Atmospheric Still Bottoms	15.3	12.8	16.1	15.0	20.9	19.6	27.2	6.6	8.7	12.8
Vacuum Still Overhead	1.3	0.8	1.3	0.9	-0.6	0.4	6.2	7.0	0.6	0.3
Vacuum Still Bottoms, Solids-Free Oil	52.0	60.0	56.8	62.1	57.0	56.8	55.7	60.2	61.3	58.1
Composition, W %										
Carbon, W %										
Hydrogen, W %							7.32			
Nitrogen, W %							1.03			
Sulfur, W %	0.29		0.35	0.42	0.33	0.31	0.29			0.35
Ash, W %	0.42		0.27	0.94	0.47	0.36	0.34			0.41

PDU RUN 5 (13C-82) - H-COAL OPERATIONS ON BURNING STAR MINE, ILLINOIS NO. 6 COAL (HRI 3944)

CATALYST - AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830) 96.7 LBS DRY INITIAL CHARGE

REACTOR LIQUID PHASE DEPTH 19 FEET, VOLUME 7.49 FT^3

Period	19	20	21	22	23	24	25	26	27
Date, End of Period (1977)	9/23	9/24	9/25	9/26	9/27	9/28	9/29	9/30	10/1
Hours of Run - Beginning	429	453	477	501	525	549	573	597	621
End	453	477	501	525	549	573	597	621	645
Catalyst Inventory, Beginning, Lbs.	98.8	98.8	98.9	98.9	99.6	103.0	101.9	101.6	101.3
Catalyst Added	3.57	4.09	3.75	0.00	4.53	3.38	3.38	1.88	3.92
Catalyst Withdrawn	3.92	4.09	3.67	0.00	3.85	0.00	4.43	0.00	4.22
Catalyst Age (End), Lbs Dry Coal/Lb Catalyst									
Average*	837	857	881	938	953	978	1081	1010	1032
Original Charge**	1088	1143	1200	1257	1315	1370	1426	1480	1534
Catalyst Added, Cumulative, Lbs/Ton Dry Coal	1.05	1.07	1.08	1.03	1.06	1.06	1.07	1.08	1.09
Coal Feed (Dry), Lbs/Hr/Ft^3 Reactor Volume	30.58	30.17	31.28	31.54	32.03	31.79	31.66	30.33	30.35
Moisture, W %	2.26	3.99	2.30	3.11	3.81	5.20	3.63	3.24	4.21
Ash, % (Dry Basis)	10.73	10.92	10.79	10.82	10.85	10.85	10.81	10.69	10.68
Recycle Flows, Lbs/Lb Solids									
Atmospheric Still Bottoms	0.611	0.645	0.571	0.574	0.550	0.510	0.528	0.685	0.527
Vacuum Still Overhead	0.002	0.004	0.000	0.000	0.000	0.000	0.002	0.005	0.000
Inventory Change	-0.020	0.026	-0.008	-0.037	-0.042	-0.098	-0.039	0.064	0.009
Hydroclone Overflow (Oil)	1.058	1.072	1.028	0.988	0.997	1.038	1.060	1.092	1.121
Make-Up Oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	1.691	1.695	1.006	1.598	1.588	1.646	1.628	1.718	1.639
Temperatures, °F									
Coal Preheater Outlet	751	763	736	741	739	739	744	754	754
Reactor Liquid Phase - Average	851	851	850	850	851	851	850	850	851
Maximum	859	860	859	859	860	861	859	858	861
Separator	787	789	787	786	789	788	786	784	792
Hydroclone	578	578	579	580	582	580	580	580	583
Vacuum Still Flash Zone	538	542	542	538	537	536	537	535	535
Pressure in Vacuum Flash, Torr									
Pressure, psig									
Unit Back Pressure	2700	2700	2700	2700	2700	2700	2700	2700	2665
Hydrogen Make-Up	2815	2810	2890	2900	2890	2900	2910	2885	2890
Hydrogen Partial Pressure (Reactor Outlet)	1570	1650	1730	1830	1820	1830	1890	1950	1840
Recycle Gas, MSCF/Ton Dry Coal	38.6	38.8	40.5	41.6	37.8	38.0	38.1	40.4	40.6
Vent Gas, MSCF/Ton Dry Coal	3.31	5.94	6.11	7.80	7.25	7.66	8.12	7.93	7.11
Hydrogen Purity of Recycle Gas & Vent, %	74.5	76.9	79.0	82.8	82.5	84.2	84.6	86.8	84.3
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)	32.4	35.6	38.2	42.5	38.7	40.1	40.7	43.6	41.7
Make-Up Hydrogen + Recycle Hydrogen									
MSCF/Ton Dry Coal	51.0	55.3	58.1	62.0	58.7	60.2	60.1	61.5	61.9
V % of Make-Up & Recycle Gas	83.8	86.0	87.2	89.7	87.9	90.9	91.0	92.0	90.6
Hydrogen Partial Pressure, psig	2370	2430	2530	2610	2620	2650	2660	2670	2630
Hydrogen Consumption***									
MSCF/Ton Dry Coal	18.6	19.7	20.0	19.5	20.4	20.1	19.4	17.9	20.1
W % Dry Coal	4.94	5.23	5.29	5.17	5.41	5.33	5.15	4.75	5.34
Oil Additions									
Make-Up Oil - Lbs/Lb Dry Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lbs/Hr/Ft^3 Reactor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flush Oil, Lbs/Lb Dry Coal	0.0033	0.0034	0.0033	0.0032	0.0032	0.0032	0.0032	0.0034	0.0034

* Average age weighted by proportions of catalyst of various ages in bed

** Age of portion of original catalyst remaining in bed

*** Orifice for fresh hydrogen, meter for product gases with analysis

Period	19	20	21	22	23	24	25	26	27
Collected Product Quantities									
W % of Dry Coal									
Atmospheric Still Overhead	28.28	28.67	28.84	33.32	35.77	41.48	37.48	31.65	38.70
Atmospheric Still Bottoms (1)	5.27	7.93	8.16	2.83	-0.41	-5.60	-4.31	2.39	1.53
Vacuum Still Overhead (1)	0.72	-0.06	-0.51	1.21	0.27	0.19	0.74	1.39	-1.77
Vacuum Still Bottoms	42.16	42.02	40.76	42.74	42.03	43.29	43.94	44.37	40.40
H_2O (2)	12.26	12.69	11.22	12.15	10.90	12.07	10.88	10.70	10.87
C_1-C_3	13.49	13.02	13.26	12.19	11.90	12.27	12.21	11.29	11.52
C_4-C_6	4.74	4.01	3.98	3.89	3.83	4.47	3.58	3.84	4.16
H_2S in Gases	1.93	1.83	1.79	1.89	1.84	1.94	1.95	2.01	1.85
CO_2 & CO	0.50	0.49	0.49	0.57	0.72	0.63	0.55	0.56	0.43
Total	109.35	110.60	107.91	110.79	106.85	106.27	107.02	108.20	107.69
Input Quantities, W % of Dry Coal									
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture in Feed Coal	2.31	4.16	2.35	3.21	3.96	5.49	3.77	3.35	4.40
Make-up Oil Additions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flush Oil	0.33	0.34	0.33	0.32	0.32	0.32	0.32	0.34	0.34
Hydrogen Reacted (7)	4.94	5.23	5.29	5.17	5.41	5.33	5.15	4.75	5.34
Total Used for Normalization	107.58	109.73	107.97	108.70	(5)	111.14	109.24	109.44	110.08
Coal Conversion, W % of M.A.F. Coal (6)	94.9	95.2	95.3	94.6	94.6	95.0	95.1	95.0	95.0
Normalized Net Product Distribution (3)									
W % of Dry Coal									
CO, CO_2	0.49	0.48	0.49	0.56	0.73	0.63	0.56	0.56	0.43
C_1-C_3 Hydrocarbons in Gases	13.22	12.86	13.20	11.91	12.04	12.28	12.43	11.29	11.65
C_4-C_6 Hydrocarbons in Gases	4.64	3.96	3.96	3.80	3.92	4.47	3.65	3.84	4.21
IBP-400°F Naphtha	14.22	14.25	14.16	14.43	15.40	14.76	13.93	13.40	15.42
400-650°F Distillates	24.81	25.67	26.72	26.87	20.83	27.30	25.92	26.40	28.18
650-975°F Distillates					4.67				
975°F+ Residual Oil (4)									
Toluene Soluble	15.07	15.69	15.07	16.60	16.45	15.52	17.32	19.14	17.16
Toluene Insoluble	4.78	5.82	5.00	3.61	4.21	4.67	5.10	4.60	2.09
Unconverted Coal	4.71	4.53	4.40	5.04	5.33	4.85	4.76	4.59	4.78
Ash	10.99	11.31	11.25	11.39	11.65	12.01	11.91	11.30	11.76
H_2O (Net)	9.36	8.02	8.41	8.33	6.10	6.25	6.99	7.03	7.28
NH_3 (Forced Nitrogen)					1.02				
H_2S (Forced Sulfur)	2.65	2.64	2.63	2.62	2.56	2.60	2.57	2.59	2.62
Total (100 + Hydrogen Reacted)	104.94	105.23	105.29	105.16	105.00	105.33	105.14	104.74	105.58

(1) Negative quantities of atmospheric still overhead and vacuum overhead are decreases of inventory of slurry oil holding tank

(2) Includes dissolved NH_3 and H_2S

(3) ASTM distillation cut points

(4) Period 23 based on vacuum distillation of toluene soluble oil in vacuum bottoms

(5) Hydrogen consumption by coal feed and product hydrogen analyses

(6) Based on filtration of product slurry fed to vacuum still, unless otherwise noted

(7) Orifice for fresh hydrogen, meter for product gases with analysis

PDU RUN 5 (130-87) - ANALYSES

Period	19	20	21	22	23	24	25	26	27
Atmospheric Still Overhead									
Gravity, °API	30.1	30.1	2.97	2.82	2.67	2.50	2.49	2.72	2.60
IBP, °F	136	138	128	158	143	141	180	136	152
10 V %	215	228	219	235	231	233	242	221	244
30	308	322	315	341	349	362	365	335	354
50	385	392	394	408	419	445	440	415	430
70	442	450	445	462	476	508	510	484	496
90	512	532	522	538	546	581	592	568	584
FBP	575	570	584	630	642	683	685	660	668
V % @ 400°F	55	54	53	48	46	39	40	46	43
Carbon, W %					88.93				
Hydrogen, W %					10.96				
Nitrogen, W %					0.30				
Sulfur, W %					0.10				
Phenols, V %					9.5				
Atmospheric Still Bottoms									
Gravity, °API	8.3	8.1	8.0	7.2	7.6	6.3	6.2	7.6	7.1
IBP, °F	468	463	463	486	(394)	488	475	465	464
10 V %	512	506	522	525	(487)	550	538	525	522
30	565	558	574	575	(567)	600	600	575	580
50	608	608	618	620	(607)	642	641	625	628
70					(652)				
90					(745)				
FBP					(874)				
V % @ 400°F					(0.5)				
V % @ 650°F	64	66	63	62	(67)	54	54	64	59
Carbon, W %					90.94				
Hydrogen, W %					8.56				
Nitrogen, W %					0.09				
Sulfur, W %					0.04				
Vacuum Still Overhead									
Gravity, °API	0.8	0.9	0.8	0.9	0.8	0.4	0.2	0.6	-0.2
IBP, °F	496		475	510	(448)			538	525
10 V %	575		585	589	(582)			608	613
30					(650)				
50					(700)				
70					(768)				
90					(850)				
FBP					(945)				
V % @ 650°F	28	26	28	26	(30)	23	20	19	17
Carbon, W %					90.65				
Hydrogen, W %					7.62				
Nitrogen, W %					0.79				
Sulfur, W %	0.117	0.124	0.094	0.094	0.072	0.116	0.093	0.092	0.091
Water									
Nitrogen, W %					4.04				
Sulfur, W %					2.63				
Carbon, W %					3.74				
0-5 Liquid									
Gravity, °API	10.4	10.3	9.7	9.7	9.9	10.0	10.0	10.7	10.3
Ash, W %	0.0006	0.0024	0.0010	0.0007	0.0030	0.0009	0.0014	0.0006	0.0024
Vacuum Distillation									
IBP, °F									
10 V %									
30									
50									
70									
90									
FBP									
V % @ 400°F									
V % @ 650°F									
Residue, W %									
0-12 Liquid									
Gravity, °API	12.8	13.3	12.0	13.0	11.6	11.4	11.7	12.1	11.5
Vacuum Distillation									
IBP, °F									
10 V %									
30									
50									
70									
90									
FBP									
V % @ 400°F									
V % @ 650°F									
Residue, W %									

Distillation - All ASTM D-86 except bracketed values from ASTM D-1160 (modified)

POU RUN 5 (130-82) - ANALYSES (CONTINUED)

Period	19	20	21	22	23	24	25	26	27
Vacuum Still Bottoms									
W % of Flows from Vacuum Still	58.0	58.1	59.0	58.8	60.0	60.4	59.5	58.0	59.0
Toluene Soluble, W %	50.37	47.44	48.96	52.19	49.77	50.67	51.66	54.45	55.02
Toluene Insoluble, W %	22.95	24.93	23.16	20.71	22.34	21.97	22.04	20.73	16.82
Ash, W %	26.68	27.63	27.88	27.10	27.89	27.36	26.30	24.82	28.16
Unreacted Coal, W % (Estimated)	11.39	10.91	10.85	12.07	12.48	11.19	10.64	10.35	11.70
Toluene-Insoluble Resid, W % (Estimated)	11.56	14.02	12.31	8.64	9.86	10.78	11.40	10.38	5.12
Carbon, W %					65.02				
Hydrogen, W %					4.01				
Nitrogen, W %					1.21				
Sulfur, W %	2.28	2.31	2.37	2.33	2.43	2.29	2.28	2.26	2.38
ASTM Ash, W %	26.59	27.24	27.71	17.28	27.31	27.72	26.61	25.48	28.80
Coke/Ash Ratio,									
DMF Extraction by Filtration	0.638	0.593	0.547	0.567	0.575	0.536	0.570	0.554	0.508
DMF Soluble, W %	57.38	56.07	56.89	56.92	56.79	57.79	58.86	61.56	57.39
Toluene-Extracted Oil									
IBP, °F					600				
Distillate to 975°F, W %					23.5				
Filter Cake									
W % of Feed to Vacuum Still	35.3	35.8	36.7	15.1	35.8	32.8	32.9	33.5	35.4
Toluene-Soluble, W %	20.95	30.13	28.77	32.07	28.06	30.06	29.45	29.48	27.09
Toluene-Insoluble, W %	22.93	22.31	22.11	22.50	23.88	22.28	22.32	22.46	22.19
Ash, W %	47.12	47.56	49.12	45.43	48.06	47.66	48.23	48.06	50.72
Toluene-Insoluble Residues, W %	2.82	3.53	2.99	2.27	2.38	2.79	2.80	2.41	1.11
Unreacted Coal, W % (Estimated)	20.11	18.78	19.12	20.23	21.50	19.49	19.52	20.05	21.08
Carbon, W %									
Hydrogen, W %									
Sulfur, W %					3.52				
Nitrogen, W %									
Catalyst Withdrawals									
Withdrawals, Oil-Laden Pounds	7.38	8.50	7.69		8.00		9.00	7.81	8.13
Oil, W %	25.51	25.2	25.90		22.75		27.12	26.20	27.07
Molybdenum (Oil-Free), W %	6.42	5.79	5.80		5.61		6.08	6.35	6.40
Estimated Catalyst Content, Lbs.*	3.92	4.09	3.67		3.85		4.43	4.07	4.22
Hydroclone Feed									
Ash, W %	11.04	11.42	12.12	11.27	11.49	11.57	11.36	10.80	11.08
Hydroclone Overflow									
Gravity, °API	-16.4	-16.0	-17.1	-17.1	-17.2	-17.7	-16.1	-15.8	-14.0
Distillation (D-1160)									
IBP, °F	485	473	485	480	495	481	498	485	480
10 V %	605	602	610	610	621	633	633	633	624
30	722	724	730	724	719	732	727	724	753
50	890	902	888	886	904	900	902	876	884
70									
V % @ 650°F	17	17	16	16	15	14	12	13	14.5
V % @ 975°F	41	41	41	40.5	50.5	60	58	58	58
W % 975°F+ (Includes Solids)	50.0	49.4	50.2	50.2	50.0	48.6	50.6	49.0	49.4
Ash, W %	8.10	8.17	8.82	8.79	8.51	8.73	8.53	8.20	9.10
Hydroclone Underflow									
Ash, W %	15.58	16.29	17.33	17.37	17.98	17.58	16.63	15.97	22.06
Atmospheric Overhead									
IBP-400°F									
Gravity, °API					40.9				
Sulfur, W %					0.03				
Nitrogen, W %					0.15				
Phenols, V %					5.5				
400°F+									
Gravity, °API					17.2				
Sulfur, W %					0.09				
Nitrogen, W %					0.42				
Atmospheric Still Bottoms									
IBP-650°F									
Gravity, °API					11.3				
Sulfur, W %					0.04				
Nitrogen, W %									
Phenols, V %									
650°F+									
Gravity, °API									
Sulfur, W %					0.07				
Nitrogen, W %									
Vacuum Still Overhead									
IBP-650°F									
Gravity, °API					8.9				
Sulfur, W %					0.04				
Nitrogen, W %									

* Basis, 9.00% Molybdenum in Fresh Catalyst

PDU RUN 5 (130-82) - ANALYSES (CONTINUED)

Period	19	20	21	22	23	24	25	26	27
650°F+									
Gravity, °API					-2.6				
Sulfur, W %					0.10				
Nitrogen, W %									
Vacuum Still Bottoms									
Toluene-Extracted Oil, IBP-975°F									
Gravity, °API					-8.3				
Carbon, W %					89.53				
Hydrogen, W %					6.66				
Sulfur, W %					.03				
Nitrogen, W %					1.14				
CHARACTERIZATION OF SOLIDS FREE OIL PRODUCT									
Batch Distillation of Filtrate from Filtration of Vacuum Still Feed									
Final Vapor Temperature, °F	562	570	575	533	571	580	566	562	573
Pressure, Torr	1.2	2.4	6.8	0.7	6.6	6.0	1.8	0.4	1.0
Residue, W % of Filtrate	42.5	48.0	48.9	50.8	52.0	51.9	44.4	40.0	41.0
Analysis of Residue									
Sulfur, W %	0.57	0.43	0.47		0.43	0.41	0.46	0.56	0.41
IBP, °F					8.85				
Distillate to 975°F, W %					13.1				
Analyses of 975°F+									
ASTM Ash, W %					1.21				
Carbon, W %					89.34				
Hydrogen, W %					5.28				
Sulfur, W %					0.36				
Nitrogen, W %					1.67				
Toluene-Extraction of Residue									
Insolubles (Except Ash), W %	29.20	27.01	24.47	27.06	23.45	22.04	28.43	31.30	25.86
Ash, W %	0.51	0.53	0.36	21.97	0.97	0.67	0.27	1.45	1.27
Batch Distillation of Vacuum Bottoms Slurry Product									
Final Vapor Temperature, °F	520	485	530	503	540	515		515	520
Pressure, Torr	2.4	8.2	2.5	2.7	3.0	1.8		2.0	2.4
Distillate, W % of Vacuum Bottoms Slurry	11.7	8.1	9.7	9.9	9.9	11.7		8.6	10.0
Vacuum Distillate									
Gravity, °API		-5.7	-6.6	-5.0	-4.5	-8.7	-10.2	-6.6	
IBP, °F					650				
10 V %					755				
30					815				
50					865				
70					910				
90					960				
FBP					975				
V % @ 650°F									
V % @ 975°F					94				
Residue, W %					5.8				
Sulfur, W %					0.13				
Calculated Composition of Solids-Free Oil In Vacuum Bottoms Slurry Product									
Constitution, W %									
Batch Still Distillate from Slurry Product	18.2	13.1	15.8	16.3	16.4	19.2	16.2	13.4	16.8
Batch Still Residue from Filtrate	81.8	86.9	84.2	83.7	83.6	80.8	83.8	86.6	83.2
Composition, W % (Calculated)									
Carbon, W %									
Hydrogen, W %					5.54				
Nitrogen, W %					1.57				
Sulfur, W %	0.47	0.38	0.40		0.36	0.34	0.39	0.38	0.35
Ash, W %	0.42	0.46	0.30		0.81	0.54	0.23	1.26	1.02
Calculated Composition of 400°F+ Liquid Product									
Constitution, W %									
Atmospheric Still Overhead, 400°F+	30.2	29.8	31.1	38.5	45.3	56.3	50.1	36.4	50.0
Atmospheric Still Bottoms	11.6	16.6	17.4	5.9	-0.9	-11.8	-9.1	4.8	3.3
Vacuum Still Overhead	0.8	-0.8	-1.8	1.8	-0.1	-0.3	0.9	2.1	-4.5
Vacuum Still Bottoms, Solids-Free Oil	57.4	54.4	53.3	53.8	55.7	55.7	58.1	56.8	51.2
Composition, W %									
Carbon, W %									
Hydrogen, W %					7.46				
Nitrogen, W %					1.06				
Sulfur, W %	0.29	0.23	0.24		0.23	0.22	0.25	0.24	0.20
Ash, W %	0.24	0.25	0.16		0.45	0.30	0.13	0.71	0.52

POU RUN 5 (130-82) - H-COAL OPERATIONS ON BURNING STAR MINE, ILLINOIS NO. 6 COAL (HRI 3944)

CATALYST - AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830) 96.7 LBS DAY INITIAL CHARGE

REACTOR LIQUID PHASE DEPTH 19 FEET, VOLUME 7.49 FT^3

Period	28	29	30	31A	32A	33A
Date, End of Period (1977)	10/2	10/3	10/4	10/4	10/5	10/5
Hours of Run - Beginning	645	669	693	717	729	741
End	669	693	717	729	741	753
Catalyst Inventory, Beginning, Lbs.	101.3	100.8	100.4	100.4	100.4	100.4
Catalyst Added	0.00	3.75	4.05	-	-	-
Catalyst Withdrawn	0.00	4.26	4.44	-	-	-
Catalyst Age (End), Lbs Dry Coal/Lb Catalyst						
Average*	1086	1102	1113	1134	1149	1154
Original Charge**	1589	1645	1700	1721	1736	1741
Catalyst Added, Cumulative, Lbs/Ton Dry Coal	1.05	1.06	1.07	-	-	-
Coal Feed (Dry), Lbs/Hr/Ft^3 Reactor Volume	30.53	31.46	30.88	23.52	16.46	5.57
Moisture, W %	5.88	3.04	5.14	4.63	5.78	4.42
Ash, % (Dry Basis)	11.00	10.85	10.42	10.55	10.67	10.41
Recycle Flows, Lbs/Lb Solids						
Atmospheric Still Bottoms	0.552	0.552	0.616	0.805	0.870	1.670
Vacuum Still Overhead	0.000	0.000	0.000	0.000	0.479	1.848
Inventory Change	-0.019	-0.005	0.022	0.389	-0.073	-0.618
Hydroclone Overflow (Oil)	1.087	1.041	0.988	1.169	1.653	5.048
Make-Up Oil	0.000	0.000	0.000	0.578	0.061	0.857
Total	1.658	1.598	1.581	2.163	3.136	10.041
Temperatures, °F						
Coal Preheater Outlet	742	741	741	759	786	796
Reactor Liquid Phase - Average	851	851	851	820	800	754
Maximum	860	861	860	826	802	756
Separator	801	801	799	776	733	692
Hydroclone	583	582	582	575	552	521
Vacuum Still Flash Zone	535	539	547	499	486	473
Pressure in Vacuum Flash, Torr	2.1	2.0	2.2	2.1	2.1	2.0
Pressure, psig						
Unit Back Pressure	2700	2700	2700	2700	2700	2700
Hydrogen Make-Up	2930	2950	2970	2855	2750	2750
Hydrogen Partial Pressure (Reactor Outlet)	1930	1920	1890	-	-	-
Recycle Gas, MSCF/Ton Dry Coal	40.9	39.9	40.1	51.0	62.0	18.2
Vent Gas, MSCF/Ton Dry Coal	8.06	7.85	7.38	6.32	4.24	23.5
Hydrogen Purity of Recycle Gas & Vent, %	86.4	85.7	85.1	89.6	89.9	97.5
Total Hydrogen, MSCF/Ton Dry Coal (Reactor Outlet)	44.1	42.4	41.9	53.5	62.3	208
Make-Up Hydrogen + Recycle Hydrogen						
MSCF/Ton Dry Coal	64.0	62.0	62.6	71.1	80.3	245
V % of Make-Up & Recycle Gas	92.0	91.6	91.3	93.1	92.8	98.2
Hydrogen Partial Pressure, psig	2710	2720	2720	2670	2570	2720
Hydrogen Consumption***						
MSCF/Ton Dry Coal	19.9	19.6	20.7	17.6	18.0	37.3
W % Dry Coal	5.27	5.19	5.49	4.67	4.77	9.9
Oil Additions						
Make-Up Oil - Lbs/Lb Dry Coal	0.000	0.000	0.000	0.641	0.067	0.958
Lbs/Hr/Ft^3 Reactor	0.000	0.000	0.000	15.08	1.11	5.34
Flush Oil, Lbs/Lb Dry Coal	0.0033	0.0033	0.0034	0.0044	0.0062	0.0192

* Average age weighed by proportions of catalyst of various ages in bed

** Age of portion of original catalyst remaining in bed

*** Orifice for fresh hydrogen, meter for product gases with analysis

POU RUN 5 (130-82) - OPERATING RESULTS

Period	28	29	30	31A	31B	32A
Collected Product Quantities W % of Dry Coal						
Atmospheric Still Overhead	39.63	35.98	29.58	23.84	29.86	41.60
Atmospheric Still Bottoms (1)	1.87	0.69	8.41	43.92	4.32	30.25
Vacuum Still Overhead (1)	0.18	1.03	-1.35	20.75	1.60	33.64
Vacuum Still Bottoms	42.66	40.45	41.46	52.04	76.06	163.15
H_2O (2)	11.19	10.40	10.89	11.09	11.03	15.57
C_1-C_3	10.89	10.44	10.88	8.08	7.45	4.69
C_4-C_6	4.07	4.05	3.71	2.69	2.29	1.73
H_2S in Gases	2.02	1.89	1.77	2.33	1.72	4.37
CO_2 & CO	0.52	0.52	0.46	0.43	0.27	0.76
Total	100.93	105.45	105.81	165.17	125.96	169.98
Input Quantities, W % of Dry Coal						
Dry Coal	100.00	100.00	100.00	100.00	100.00	100.00
Moisture in Feed Coal	6.25	3.14	5.42	4.85	6.13	4.62
Make-up Oil Additions	0.00	0.00	0.00	64.09	67.60	95.84
Flush Oil	0.35	0.33	0.34	0.44	0.62	1.92
Hydrogen Reacted (8)	5.27	5.19	5.49	4.67	4.77	9.9
Total Used for Normalization	111.85	108.66	111.25	174.05	179.12	216.90
Coal Conversion, W % of M.A.F. Coal (6)	95.0	94.6	94.2	92.1 (7)	91.7 (7)	86.8 (7)
Normalized Net Product Distribution (3) W % of Dry Coal						
CO, CO_2	0.53	0.53	0.48			
C_1-C_3 Hydrocarbons in Gases	11.16	10.63	11.39			
C_4-C_6 Hydrocarbons in Gases	4.17	4.12	3.88			
IBP-400°F Naphtha	15.56	14.21	13.08			
400-650°F Distillates	28.95	22.26	10.37			
650-975°F Distillates		6.48				
975°F+ Residual Oil (4)						
Toluene Soluble	16.57	15.60	16.22	28.88	24.71	38.55
Toluene Insoluble	4.36	3.40	3.58		8.42	
Unconverted Coal	4.63	5.78	6.09	7.08	7.42	11.81
Ash	11.83	11.51	12.09	10.55	10.67	10.41
H_2O (Net)	4.97	6.65	5.74			
NH_3 (Forced Nitrogen)		1.08				
H_2S (Forced Sulfur)	2.54	2.64	2.56			
Total (100 + Hydrogen Reacted)	105.27	104.89 (5)	105.49			

(1) Negative quantities of atmospheric still overhead and vacuum overhead are decreases of inventory of slurry oil holding tank

(2) Includes dissolved NH_3 and H_2S

(3) ASTM Distillation Cut Points

(4) Using vacuum still bottoms batch distillate results below approximate cut point 925°F

(5) Hydrogen consumption by coal feed and product hydrogen analyses

(6) Based on filtration of product slurry fed to vacuum still, unless otherwise stated

(7) Based on dimethylformamid extraction of vacuum bottoms product. Normalized vacuum bottoms flow from ash balance

(8) Orifice for fresh hydrogen, meter for product gases with analysis

PDU RUN 5 (130-82) - ANALYSES

Period	28	29	30	31A	31B	32A
Atmospheric Still Overhead						
Gravity, °API	25.8	25.7	27.7	31.6	28.3	26.8
IBP, °F	149	138	137	136	132	142
10 V %	241	224	225	214	230	242
30	356	346	327	304	342	352
50	433	429	409	376	414	422
70	495	490	475	438	464	470
90	585	574	562	538	534	540
FBP	659	648	637	600	586	586
V % @ 400°F	42	43	46	59	46	45
Carbon, W %		88.84				
Hydrogen, W %		10.97				
Nitrogen, W %		0.43				
Sulfur, W %		0.08				
Phenols, V %		9.5				
Atmospheric Still Bottoms						
Gravity, °API	6.9	7.7	7.6	7.8	9.3	11.6
IBP, °F	474	(421)	506		464	
10 V %	534	(507)	564		524	
30	588	(576)	620		570	
50	636	(618)			610	
70		(687)			650	
90		(796)				
FBP		(891)				
V % @ 400°F						
V % @ 650°F	57	(65)	64		70	
Carbon, W %		88.43				
Hydrogen, W %		8.62				
Nitrogen, W %		0.58				
Sulfur, W %		0.05				
Vacuum Still Overhead	-0.3					
Gravity, °API	0.3	0.2	1.7	2.7	4.4	
IBP, °F	535	449				
10 V %	616	596				
30		(670)				
50		(714)				
70		(766)				
90		(846)				
FBP		(950)				
V % @ 650°F	17	(25)				
Carbon, W %		91.11				
Hydrogen, W %		7.62				
Nitrogen, W %		0.66				
Sulfur, W %	0.07	0.11	0.07		0.94	
Water						
Nitrogen, W %		3.50				
Sulfur, W %		2.03				
Carbon, W %		1.90				
0-5 Liquid						
Gravity, °API	8.7	9.5		12.7	13.4	
Ash, W %	0.0022	0.0020	0.0015			
Vacuum Distillation						
IBP, °F		(352)				
10 V %		(418)				
30		(530)				
50		(590)				
70		(648)				
90		(749)				
FBP		(863)				
V % @ 400°F		(6)				
V % @ 650°F		(71)				
Residue, W %		2.2				
0-12 Liquid						
Gravity, °API	11.6	11.8		11.9	13.4	
Vacuum Distillation						
IBP, °F	(299)					
10 V %	(456)					
30	(527)					
50	(574)					
70	(617)					
90	(676)					
FBP	(755)					
V % @ 400°F	(4)					
V % @ 650°F	(82)					
Residue, W %	1.5					

Distillations - All ASTM D-86 except bracketed values from ASTM D-1160 (modified)

PDU RUN 5 (130-82) - ANALYSES (CONTINUED)

Period	28	29	30	31A	31B	32A
Vacuum Still Bottoms						
W % of Flows from Vacuum Still	59.0	60.2	60.1			
Toluene Soluble, W %	53.45	51.85	49.89		59.18	
Toluene Insoluble, W %	20.56	21.05	22.27		24.39	
Ash, W %	25.99	27.10	27.84		16.43	
Unreacted Coal, W % (Estimated)	10.58	12.13	14.03			
Toluene Insoluble Resid, W % (Estimated)	9.98	8.92	8.24			
Carbon, W %		59.18				
Hydrogen, W %		4.08				
Nitrogen, W %		0.99				
Sulfur, W %		2.32	2.35	2.03	2.01	1.78
ASTM Ash, W %	27.06	27.94	27.86	18.57	16.60	11.34
Coke/Ash Ratio, DMF Extraction by Filtration	0.496	0.530	0.523	0.671	0.695	1.134
DMF Soluble, W %	61.07	58.53	57.37	69.77	72.01	77.41
Toluene-Extracted Oil						
IBP, °F		715				
Distillate to 975°F, W %		24.0				
Filter Cake						
W % of Feed to Vacuum Still						
Toluene-Soluble, W %						
Toluene-Insoluble, W %	22.58	22.17	24.23			
Ash, W %	49.98	43.79	43.54			69.44
Toluene-Insoluble Residues, W %	2.23	2.57	2.28			
Unreacted Coal, W % (Estimated)	20.35	19.60	21.95			
Carbon, W %		49.49				27.91
Hydrogen, W %		3.15				1.16
Sulfur, W %		3.60				5.46
Nitrogen, W %		0.79				0.37
Catalyst Withdrawals						
Withdrawals, Oil-Laden Pounds	0.00	7.69	8.44			
Oil, W %		22.24	25.37			
Molybdenum (Oil-Free), W %		6.41	6.35			
Estimated Catalyst Content, Lbs*		4.46	4.44			
Hydroclone Feed						
Ash, W %	11.10	11.19	11.59	7.24	5.09	2.00
Hydroclone Overflow						
Gravity, °API	-17.2	-17.3	-17.8		-5.2	
Distillation (D-1160)						
IBP, °F	488	498	492		503	
10 V %	633	633	658		616	
30	765	749	778		693	
50	915	932	937		757	
70					940	
EP						
V % @ 650°F	12	13	9.5		10.5	
V % @ 975°F	58	56	54		71.5	
W % 975°F+ (Includes Solids)	50.8	52.8	55.0		33.0	
Ash, W %	9.20	9.50	10.18	5.25	3.25	0.96
Hydroclone Underflow						
Ash, W %	17.45	23.07	22.38	18.22	15.83	7.48
Atmospheric Overhead						
IBP-400°F						
Gravity, °API		40.9				
Sulfur, W %		0.08				
Nitrogen, W %		0.12				
Phenols, V %		7.00				
400°F+						
Gravity, °API		16.4				
Sulfur, W %		0.03				
Nitrogen, W %		0.55				
Atmospheric Still Bottoms						
IBP-650°F						
Gravity, °API		11.2				
Sulfur, W %		0.03				
Nitrogen, W %		0.42				
Phenols, V %						
650°F+						
Gravity, °API		2.8				
Sulfur, W %		0.05				
Nitrogen, W %		0.79				
Vacuum Still Overhead						
IBP-650°F						
Gravity, °API		7.5				
Sulfur, W %		0.03				
Nitrogen, W %		0.57				

* Basis, 9.00% Molybdenum in Fresh Catalyst

PDU RUN 5 (130-82) - ANALYSES (CONTINUED)

Period	28	29	30	31A	31B	32A
Vacuum Still Overhead						
650°F+						
Gravity, °API		2.8				
Sulfur, W %		0.05				
Nitrogen, W %		0.79				
Vacuum Still Bottoms						
Toluene-Extracted Oil, IBP-975°F						
Gravity, °API		6.7				
Carbon, W %		90.24				
Hydrogen, W %		6.91				
Sulfur, W %		0.05				
Nitrogen, W %		0.87				
CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCT						
Batch Distillation of Filtrate from Filtration of Vacuum Still Feed						
Final Vapor Temperature, °F	564		522			
Pressure, Torr	0.8	2.8	2.4			
Residue, W % of Filtrate	44.1	48.3	56.8			
Analysis of Residue						
Sulfur, W %	1.35	0.42	1.75			
IBP, °F		950				
Distillate to 975°F, W %		6.7				
Analysis of 975°F+						
ASTM Ash, W %		0.61				
Carbon, W %		89.77				
Hydrogen, W %		5.59				
Sulfur, W %		0.37				
Nitrogen, W %		1.88				
Toluene-Extraction of Residue						
Insolubles (Except Ash), W %	28.45	24.15	30.77			
Ash, W %	12.83	0.25	17.00			
DMF Extraction of Residue						
Insolubles (Except Ash), W %		8.58				
Ash, W %		0.41				
Batch Distillation of Vacuum Bottoms Slurry Product						
Final Vapor Temperature, °F	516	490	490	514*	514*	538*
Pressure, Torr	3.4	2.0	2.3	0.20	0.28	0.80
Distillate, W % of Vacuum Bottoms Slurry	11.7	10.0	10.1	19.9	20.3	33.8
Vacuum Distillate						
Gravity, °API		-4.9				
IBP, °F		657		754	743	671
10 V %		720		874	850	764
30		755				957
50		811				
70		866				
90		927				
FBP						
V % @ 650°F						
V % @ 975°F		97		19	19.5	30
Residue, W %		5.4		80.1	79.7	66.2
Sulfur, W %		0.10				
Calculated Composition of Solids-Free Oil in Vacuum Bottoms Slurry Product						
Constitution, W %						
Batch Still Distillate from Slurry Product	18.8	16.7	17.4			
Batch Still Residue from Filtrate	81.2	83.3	82.6			
Composition, W % (Calculated)						
Carbon, W %						
Hydrogen, W %						
Nitrogen, W %						
Sulfur, W %		0.35				
Ash, W %		0.21				
Calculated Composition of 400°F+ Liquid Product						
Constitution, W %						
Atmospheric Still Overhead, 400°F+	5.02	46.0	35.7			
Atmospheric Still Bottoms	-3.8	1.5	17.6			
Vacuum Still Overhead	-1.0	1.5	-3.5			
Vacuum Still Bottoms, Solids-Free Oil	54.6	51.0	50.3			
Composition, W %						
Carbon, W %		89.6				
Hydrogen, W %		7.83				
Nitrogen, W %		1.12				
Sulfur, W %		0.22				
Ash, W %		0.11				

* Laboratory Assay to 975°F end point, Residue Percentage based on Vacuum Bottoms Slurry Quanity

PDU RUN 7 - ILLINOIS COAL - FUEL OIL MODE

PDU Run 7 was designed to create emergency situations under controlled conditions and develop the proper responses to re-establish operations with a minimum of disruption. In addition, the study served to train operating personnel to handle emergencies in the H-Coal Pilot Plant and to start up the new equiment which had been installed since the last PDU operations.

The run also generated process optimization data for operations in the fuel oil mode using Illinois No. 6 coal.

COAL FEED ANALYSIS

HRI No.	3944	3944
Feed to Period	As-Received	1-10
Hours of Run		0-240
Moisture, W %		4.81
Proximate Analysis, Dry Basis, W %		
Ash	11.75	10.96
Volatile Matter	35.56	
Fixed Carbon	52.69	
Ultimate Analysis, Dry Basis, W %		
Carbon	71.52	71.00
Hydrogen (organic)	5.05	4.63
Nitrogen	1.36	1.28
Sulfur (LECO)	3.52	3.68
Ash	11.75	10.96
Chlorine	0.10	-
Oxygen (Difference)	6.70	8.44
Screen Size (U.S.S.), W %		
+ 50		8.27
50/70		7.32
70/100		9.64
100/140		11.12
140/200		11.18
200/325		19.99
325/Pan		32.48

POU RUN 7

H-COAL® OPERATIONS ON BURNING STAR MINE ILLINOIS NO. 6 COAL (HRI 3944)

CATALYST - H-COAL STANDARD, 1/16" EXTRUDATES (HRI NO. 3830) 58.72 LB. DRY INITIAL CHARGE

REACTOR LIQUID PHASE DEPTH 20.8 FT, VOL. 4.17 FT^3

Period	1A	1B	2A	2B	3	4A	4B	5	6A	6B
Date at End of Period (1978)	9/9	9/10	9/10	9/11	9/12	9/12	9/13	9/14	9/14	9/15
Hrs. of Run - Beginning	0	12	24	36	48	72	84	96	120	132
- End	12	24	36	48	72	84	96	120	132	144
Catalyst Invent., Beginning, Lbs	50.72	50.72	50.72	50.72	50.72	50.72	50.72	50.72	49.78	49.78
Catalyst Added, Lbs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.65	0.00	0.00
Catalyst Withdr. (est.below), Lbs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00
Catalyst Age (End)Lbs.Dry Coal/ Lb. Catalyst Average*	48	94	146	209	340	410	482	605	683	758
Lbs.Dry Coal/Lb.Catalyst Original Charge**	48	94	146	209	340	410	482	633	711	786
Catalyst Add. Cumulative, Lbs/Ton Coal Fed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.15	0.13
Coal Feed(Dry)Lbs/Hr/Ft^3Reac.,Vol.	58.6	46.0	53.2	63.9	66.5	70.9	72.4	75.0	77.6	74.6
W % Moisture	-	4.01	3.20	-	3.52	-	3.82	3.54	-	2.45
% Ash (Dry Basis)	-	10.74	10.93	-	10.98	-	11.53	11.50	-	11.16
Recycle Flows, Lbs/Lb Solids										
Atmospheric Still Bottoms	0.985	1.392	1.269	1.118	0.921	1.088	1.020	0.953	0.883	0.884
Vacuum Still Overhead	0.000	0.632	0.154	0.146	0.091	0.158	0.127	0.126	0.118	0.120
Inventory Change	-0.232	-0.240	0.129	-0.161	-0.081	0.127	0.038	0.062	0.062	0.000
Hydroclone Overflow (Oil)	0.505	0.880	0.808	0.371	0.788	0.729	0.883	0.923	0.890	0.939
Make-up Oil	0.000	0.000	0.000	0.000	0.013	0.120	0.000	0.000	0.000	0.000
Total (Oil)	1.721	3.143	2.102	1.996	1.893	1.969	1.971	1.940	1.829	1.943
Temperatures, °F										
Coal Preheater (Outlet)	760	745	748	737	728	731	734	753	764	771
Reactor Liquid Phase, Average	789	819	829	823	932	835	838	840	837	839
Maximum	798	828	839	838	847	853	854	856	851	851
Separator,(Ov'hd)(Outlet)	703	738	759	755	765	771	769	761	762	783
Hydroclone Overflow	-	-	-	-	-	-	-	524	551	550
Vacuum Still Flash Zone	355	464	447	405	399	476	539	540	540	540
Pressure in Vac.Flash, Torr	329	281	51	111	20.2	132	132	142	12.7	13.9
Pressure, psig										
Unit Back Pressure	2800	2800	2800	2785	2755	2785	2765	2750	2690	2700
Hydrogen Make-up (Inlet)	2800	2800	2790	2900	2825	2820	2850	2840	2750	2800
Hydrogen Partial P. (Reactor Outlet)	-	-	2105	2199	2982	2091	1953	1977	2038	2189
Recycle Gas, MSCF/Ton Dry Coal(Inlet)	28.92	2736	32.94	24.66	21.88	20.41	20.22	19.58	25.17	43.43
Vent Gas, MSCF/Ton Dry Coal	5.67	4.19	4.04	3.80	5.29	3.47	9.37	6.39	4.84	6.65
H_2 Purity of Recycle Gas&Vent,%(Vent)	-	-	88.4	90.2	85.5	86.9	87.3	87.1	86.5	88.9
Total H_2,MSCF/Ton Dry Coal (Reactor Outlet)	-	-	31.9	28.8	25.8	24.3	24.8	23.8	28.4	27.2
Make-up H_2-Recycle H_2										
MSCF/Ton Dry Coal (Inlet)	-	-	46.4	42.0	40.8	39.1	38.1	36.6	40.7	58.1
V % of Make-up & Recycle Gas	-	-	93.4	94.6	92.8	93.6	93.7	93.6	92.3	92.3
Partial Pressure of H_2,psig(Inlet)	-	-	2619	2661	2634	2653	2684	2670	2551	2598
H_2 Consumption (Orifice for Fresh H_2 Meter for Products&Analysis)										
MSCF/Ton Dry Coal	-	-	14.58	13.21	15.01	14.72	13.30	12.95	12.26	10.93
W % of Dry Coal	-	-	3.97	3.50	3.98	3.90	3.53	3.44	3.25	2.91
Oil Additions										
Make-up Oil Lbs/Lb Dry Coal	0.0000	0.0000	0.0000	0.0000	0.0150	0.1339	0.0000	0.0000	0.0000	0.0000
LBS/Hr/Ft^3 Reactor	0.00	0.00	0.00	0.00	1.00	9.49	0.00	0.00	0.00	0.00
Flush Oil, Lbs/Lb Dry Coal	0.0038	0.0043	0.0039	0.0029	0.0028	0.0026	0.0025	0.0031	0.0025	0.0026
Collected Product Quant.,W% Dry Coal										
Atmospheric Still Overhead	[illegible]	[illegible]	77.29	38.33	30.62(4)	36.02	22.79	26.99	24.82	28.08
Atmospheric Still Bottoms(1)	22.12	-17.58	12.74	-15.11	-8.09	12.68	4.22	6.32	6.27	0.28
Vacuum Still Overhead(1)	0.00	-2.66	21.69	12.89	-0.68	2.00	0.70	1.52	1.05	0.36
Vacuum Still Bottoms	37.81	61.70	58.64	51.89	70.75	59.69	53.29	53.01	57.71	57.76
H_2O(2)	-1.11	-1.13	-0.99	-1.10	9.56(4)	-0.74	4.03	-0.91	-0.58	-0.69
C_1-C_3	-	-	2.22	3.01	4.87	4.52	4.41	4.52	4.79	4.64
C_4-C_6	-	-	2.63	3.43	4.23	3.83	3.49	3.81	3.75	3.62
H_2S in Gases	-	-	0.56	1.38	1.52	1.36	1.36	1.35	1.55	1.76
CO_2 & CO	-	-	0.21	0.36	0.46	0.33	0.48	0.50	0.55	0.64
Total	-	-	126.99	96.08	113.26	119.69	94.77	97.11	99.91	96.44
Input Quantities, W % Dry Coal										
Dry Coal	[illegible]	[illegible]	[illegible]	[illegible]	100.0	100.0	100.0	100.0	100.0	100.0
Moisture in Feed Coal	4.18	4.18	3.30	-	3.65	-	3.97	3.67	-	2.51
Make-up Oil Additions	0.00	0.00	0.00	0.00	0.15	13.39	0.00	0.00	0.00	0.00
Flush Oil	0.38	0.43	0.39	0.29	0.28	0.26	0.25	0.31	0.25	0.26
H_2 Reacted(H_2Orifice Gas Anal.Flow)	-	-	3.87	3.50	3.98	3.90	3.53	3.44	3.25	2.91
Total	-	-	107.56	-	108.06	-	107.75	107.42	-	105.68
Coal Conversion W % of m.a.f. Coal(5)	90.83	90.74	90.56	90.79	93.88	92.19	90.83	92.65	93.31	93.77
Normalized Net Prod.Distribution(3) W % Dry Coal										
CO, CO_2					0.43					
C_1-C_3 Hydrocarbons in Gases					4.60					
C_4-C_6 Hydrocarbons in Gases					4.00					
IBP-400°F Naphtha					10.83					
400-650°F Distillates					13.81					
650-975°F Distillates					17.81					
975°F+ Residual Oil										
Toluene Soluble					18.36					
Toluene Insoluble					10.11					
Unconverted Coal					5.49					
Ash					10.84					
H_2O (Rec)					4.48					
NH_3 (Forced Nitrogen)					0.61					
H_2S (Forced Sulfur)					2.70					
Total (100 + H_2 Reacted)					103.79					

*Average age, weighted by proportion of various ages in bed.
**Age of portion of original catalyst remaining in bed.

(1) Negative Quantities of ASOM & Vac Ov'd are decreases of inventory of Slurry Oil Holding Tank

(2) Water separation for Atmospheric Still Overhead ineffective. Actual gross water quantity is included in Atmospheric Still Overhead quantity, except Periods 3 and 8B Numbers on this line represent wash water injected into vapor line downstream of reactor.

(3) ASTM Distillation Cut Points

(4) Based on actual separation of water from Atmospheric Still Overhead product drums.

(5) Based on filtration of product slurry fed to vacuum still.

POU RUN 7 - ANALYSIS

Period	1A	1B	2A	2B	3	4A	4B	5	6A	6B
Atmospheric Still Overhead										
Gravity, °API		8.2	3.39	26.7	25.4	28.4	30.7	30.8	30.2	28.4
IBP, °F		176	172	182	157	168	145	172	158	148
10 V %		200	236	276	266	249	226	249	240	248
30		212	296	362	374	342	317	315	320	334
50			356	406	422	400	382	388	376	394
70			400	446	463	435	435	424	420	436
90			740	530	554	487	500	476	480	500
FBP			582	646	635	565	568	565	562	564
V % @ 400°F			70	48	40.5	50	56	57	63	63
V % @ 650°F					-	-	-	-	-	-
Carbon, W %					85.38					
Hydrogen, W %					0.71					
Nitrogen, W %					0.24					
Sulfur, W % (H_2S free)					0.04					
Atmospheric Still Bottoms										
Gravity, °API				14.6	12.5		12.6	13.1		12.0
IBP, °F				416	(351)		426	410		416
10 V %				458	(455)		469	475		474
30				488	(494)		509	516		510
50				522	(534)		552	556		558
70				572	(590)		600	608		610
90				-	(694)		-	-		-
FBP				-	(900)		-	-		-
V % @ 400°F				-	(<1)		-	-		-
V % @ 650°F				86	(84)		84	81		80
Carbon, W %					85.36					
Hydrogen, W %					10.74					
Nitrogen, W %					0.39					
Sulfur, W %					<0.03					
Vacuum Still Overhead										
Gravity, °API			6.4		10.9	7.1	6.2	6.0	6.0	5.9
IBP, °F	-	-	-	-	(371)		467	462		462
10 V %					(442)		513	517		538
30					(492)		586	592		606
50					(546)		650	633		-
70					(609)		-	-		-
90					(694)		-	-		-
FBP					(805)		650	633		638
V % @ 650°F					(81)		50	46		44
Carbon, W %					89.06					
Hydrogen, W %					9.38					
Nitrogen, W %					0.36					
Sulfur, W %					0.10		0.11	0.10		0.15
0-5 Liquid										
Gravity, °API	-	-	-	18.0	18.0	16.4	16.7	17.3	15.1	13.1
0-12 Liquid										
Gravity, °API	-	-	16.9	15.2	12.5	-	12.8	13.0	-	-
Catalyst Withdrawals										
Withdrawals, Oil-laden Pounds								6.81		
Oil, W %								31.94		
Molybdenum (oil-free), W %								7.40		
Estimate Catalyst Content, Lbs*								3.59		
Hydroclone Feed										
Ash, W %	-	6.97	-	10.87	11.24	-	8.38	9.00	-	9.01
Hydroclone Overflow										
Gravity, °API		-3.9		-13.1			-11.6	-10.8		-11.1
Vac Distillation										
IBP, °F		372		402			479	460		501
10 V %		514		513			572	577		597
30		615		687			737	713		754
50		753		890			873	860		862
FBP		975		975			975	975		975
V % @ 650°F		38.5		28.5			23	22		19
V % @ 975°F		69.5		59			59	59.5		58
W % 975°F+ (incl. solids)		35.17		49.37			48.05	46.76		48.77
Ash, W %	-	4.92	5.42	7.26	8.34	7.68	6.55	5.66	5.85	5.60
Hydroclone Underflow										
Ash, W %	-	8.41	-	12.43	14.59	-	11.62	12.11	-	14.73

Distillations - All ASTM D-86 Except Bracketed Values from ASTM D-1160 (Modified)
*Basis 9.57 % Molybdenum in Fresh Catalyst

PDU RUN 7 ANALYSIS

CHARACTERIZATION OF SOLIDS-FREE OIL PRODUCT

Period	1A	1B	2A	2B	3	4A	4B	5	6A	6B
Batch Dist'n of Filtrate from Filtration of Vacuum Still Feed										
Final Vapor Temperature, °F				570	548		568	551		570
Pressure, Tor				1.0	2.6		1.6	1.8		1.2
Residue, W % of Filtrate				38.56	61.02		42.44	53.16		46.01
Vacuum Bottom Oil										
Sulfur, W %				0.70	2.24		0.66	2.26		1.12
Toluene Extraction										
Insolubles, W %				30.22	36.60	44.74	43.64		44.93	
Ash, W %				0.58	18.75	0.15	19.65		5.47	
Batch Dist'n of Vacuum Bottoms Slurry Product										
Final Vapor Temperature, °F				490	499			470		440
Pressure, Torr				1.5	1.7			1.6		2.0
Residue, W % of Vac Btms. Slurry				64.99	67.95			87.92		92.09
Vacuum Distillate										
Gravity, °API				4.9	3.5		-3.4			
Vacuum Still Bottoms										
W % of Flows from Vacuum Still	100	46.62	52.74	54.77	82.09	69.35	61.86	47.68	62.62	60.79
Toluene Soluble, W %	81.06	68.83	-	60.52	60.52	-	46.69	47.53	-	47.31
Toluene Insoluble, W %	11.06	18.76	-	23.45	23.30	-	30.13	32.11	-	32.92
Ash, W %	7.88	12.41	-	16.38	16.18	-	20.18	20.36	-	19.77
Unreacted Coal, W % (Est.)	6.19	9.59		11.96	9.20		14.13	11.28		9.88
Toluene Insoluble Resid, W% (Est.)	4.97	9.17		11.49	15.10		16.00	20.84		23.04
Carbon, W %					74.84					
Hydrogen, W %					5.70					
Nitrogen, W %					1.11					
Sulfur, W %					1.72					
ASTM Ash, W %	8.12	12.47	17.66	15.98	16.53	20.43	20.08	19.93	18.55	19.92
Coke/Ash Ratio (DMF Extraction by Filtration)	-	0.6440	-	0.5788	0.5573	-	0.5652	0.6136	-	0.5885
DMF Soluble, W %		79.68		74.36	75.55		69.04	67.34		68.58
Filter Cake										
W % of Feed to Vacuum Still	-	-	-	25.95	8.72	-	26.46	15.14	-	28.07
Toluene Extraction of Cake										
Soluble, W %				28.00	31.72		23.02	19.20		27.04
Insoluble, W %				32.10	26.54		33.74	31.30		27.92
Ash, W %				39.90	41.74		43.24	49.50		45.04
Insoluble Residues, W % (Est.)				2.25	5.84		3.30	3.30		5.58
Unreacted Coal, W % (Est.)				29.85	20.70		30.44	28.00		-2.34
Water										
Ammonia, W %					3.63					
Sulfur, W %					2.77					
Carbon, W %					1.51					

ANALYSIS OF PRODUCT FRACTIONS

Atmospheric Overhead	
IBP-400°F	
Gravity, °API	3.58
400°F+	
Gravity, °API	17.5
Atmospheric Still Bottoms	
IBP-650°F	
Gravity, °API	13.7
650°F+	
Gravity, °API	2.7
Vacuum Still Overhead	
IBP-650°F	
Gravity, °API	13.6
650°F+	
Gravity, °API	3.1

PDU RUN 7

H-COAL® OPERATIONS ON BURNING STAR MINE ILLINOIS NO. 6 COAL (HRI-3944)

CATALYST - H-COAL STANDARD, 1/16" EXTRUDATES (HRI NO. 3830) 50.72 LB. DRY INITIAL CHARGE

REACTOR LIQUID PHASE DEPTH 20.8 FT. VOL. 4.17 FT.^{3}

Period	7A	7B	8A	8B	9A	9B	10A	10B	11A
Date at End of Period (1978)	9/15	9/16	9/16	9/17	9/17	9/18	9/18	9/19	9/19
Hours of Run - Beginning	144	156	168	180	192	204	216	228	240
- End	156	168	180	192	204	216	228	240	248
Catalyst Inventory, Beginning Lbs.	49.78	49.78	49.78	49.68	49.68	49.08	49.08	49.08	49.08
Catalyst Added, Lbs	0.00	0.00	2.26	0.00	0.00	0.00	0.00	0.00	0.00
Catalyst Withdrew (Est. Below), Lbs	0.00	0.00	2.35	0.00	0.60	0.00	0.00	0.00	0.00
Catalyst Age (End), Lbs. Dry Coal/Lb.									
Catalyst Average*	934	908	942	1014	1086	1164	1244	1326	1451
Catalyst Original Charge**	861	936	1011	1084	1155	1234	1313	1395	1451
Catalyst Add., Cumulative, Lbs/Ton Coal Fed	0.12	0.11	0.19	0.18	0.17	0.16	0.15	0.14	0.14
Coal Feed (Dry) Lbs/Hr/Ft^3 Reac., Vol.	75.4	73.8	74.3	72.3	70.2	77.4	78.2	80.5	81.0
W % Moisture	-	1.39	-	1.37	-	2.11	-	0.95	-
[illegible] (Dry Basis)	-	11.71	-	10.52	-	10.97	-	11.06	-
Recycle Flows, Lbs/Lb Solids									
Atmospheric Still Bottoms	0.954	0.886	0.885	0.790	0.898	0.853	0.774	0.768	0.749
Vacuum Still Overhead	0.119	0.152	0.233	0.148	0.144	0.135	0.111	0.110	0.104
Inventory Change	[illegible]	[illegible]	-0.007	-0.022	-0.045	0.063	0.012	0.004	0.014
Hydroclone Overflow (Oil)	0.934	0.918	0.902	0.934	0.938	0.833	0.852	0.811	0.801
Make-up Oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total (Oil)	1.938	1.958	2.127	1.893	2.026	1.778	1.725	1.685	1.640
Temperatures, °F									
Coal Preheater (Outlet)	773	781	793	799	787	780	777	773	751
Reactor Liquid Phase, Average	[illegible]	[illegible]	[illegible]	842	535	844	830	840	807
Maximum	849	852	854	854	849	856	840	852	815
Separator, (Ov'hd) (Outlet)	791	776	776	778	773	775	751	768	735
Hydroclone Overflow	550	541	541	538	516	541	534	541	542
Vacuum Still Flash Zone	578	535	542	540	539	544	542	547	541
Pressure in Vac. Flash, Torr	184	110	114	81	197	101	68	63	51
Pressure, psig									
Unit Back Pressure	[illegible]	2735	2730	2730	2730	2700	2710	2700	2775
Hydrogen Make-up (Inlet)	2805	2805	2800	2810	2820	2805	2815	2800	2895
Hydrogen Partial P. (Reactor Outlet)	2162	2096	2093	2106	2140	2027	2186	2054	2414
Recycle Gas, MSCF/Ton Dry Coal	44.73	28.15	21.85	23.88	27.48	22.56	19.98	19.70	20.40
Vent Gas, MSCF/Ton Dry Coal	7.20	5.19	3.31	9.37	8.18	4.95	4.66	4.74	5.91
H_2 Consumption (Orifice Gas Meter for Products & Analysis)									
MSCF/Ton Dry Coal	11.73	11.26	15.99	11.25	11.69	10.24	10.47	10.47	9.39
W % Dry Coal	3.10	2.99	4.24	2.98	3.10	2.72	2.78	2.78	2.49
Oil Additions									
Make-up Oil Lbs/Lb Dry Coal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Lbs/Hr/Ft^3 Reactor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flush Oil, Lbs/Lb Dry Coal	0.0024	0.0026	0.0025	0.0027	0.0026	0.0024	0.0024	0.0024	0.0024
Collected Product Quant., W% Dry Coal									
Atmospheric Still Overhead	24.46	23.99	31.47	20.12(3)	26.81	21.71	25.40	22.33	20.24
Atmospheric Still Bottoms(1)	7.07	1.14	-0.37	-1.61	-4.16	-4.54	1.31	0.79	1.61
Vacuum Still Overhead(1)	1.10	0.45	0.13	0.02	-0.13	1.04	0.43	0.30	0.41
Vacuum Still Bottoms	55.26	61.84	59.45	62.21	61.16	62.15	64.35	63.54	60.82
H_2O(2)	-0.68	-0.70	-0.65	11.88(3)	-0.78	-0.71	-0.74	-0.60	-0.67
C_1-C_3	5.22	5.93	3.80	6.73	58.5	6.10	3.51	5.22	0.94
C_4-C_6	4.64	4.80	4.58	5.15	4.66	5.16	3.57	4.90	1.21
H_2S in Gases	1.85	1.86	1.80	2.34	1.94	2.27	2.06	2.05	1.14
CO_2 & CO	0.44	0.56	0.40	0.65	0.55	0.58	0.61	0.61	0.40
Total	99.36	99.87	100.41	106.71	95.90	102.84	100.50	99.14	86.10
Input Quantities, W % Dry Coal									
Dry Coal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture in Feed Coal	-	1.41	-	1.39	-	2.16	-	0.87	-
Make-up Oil Additions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flush Oil	0.24	0.26	0.25	0.27	0.26	0.24	0.24	0.24	0.24
H_2 Reacted(H_2Orifice Gas Anal. Flow)	3.10	2.99	4.24	2.98	3.10	2.72	2.78	2.78	2.49
Total	-	104.66	-	104.64	-	105.12	-	103.89	-
Coal Conversion W % of m.a.f. Coal(5)	93.28	92.87	92.06	91.71	91.25	92.55	93.57	93.33	
Normalized Net Prod. Distribution(3) W % Dry Coal									
CO, CO_2			0.32	0.65					
C_1-C_3 Hydrocarbons in Gases			3.98	6.63					
C_4-C_6 Hydrocarbons in Gases			4.74	5.07					
IBP-400°F Naphtha			11.69	11.42					
400-650°F Distillates			8.31	7.12					
650-975°F Distillates			9.37	8.90					
975°F+ Residual Oil									
Toluene Soluble			17.52	16.49					
Toluene Insoluble			16.45	15.78					
Unconverted Coal			6.56	7.28					
Ash			11.87	12.16					
H_2O (Net)			9.80	9.56					
NH_3 (Forces nitrogen)			0.35	0.37					
H_2S (Forces Sulfur)			2.41	2.64					
Total (Lbs + H_2 reacted)			100.47	103.00					

*Average age, weighted by composition of various ages in bed.
**Age of portion of original catalyst remaining in bed.

(1) Negative Quantities of ASOH & Vac Ov'd are decreases of inventory of Slurry Oil Holding Tank

(2) Water separation for Atmospheric Still Overhead ineffective. Actual gross water quantity is included in Atmospheric Still Overhead quantity, except Periods 3 and 8B Numbers on this line represent wash water injected into vapor line down [illegible] of reactor.

(3) ASTM Distillation Cut Points

(4) Based on actual separation of water from Atmospheric Still Overhead product drum.

(5) Based on filtration of product slurry fed to vacuum still.

RUN 130 - 86 ANALYSIS

Period	7A	7B	8A	8B	9A	9B	10A	10B	11A
Atmospheric Still Overhead									
Gravity, °API	28.5	30.1	30.0	30.0	30.4	30.4	30.0	30.0	30.6
IBP, °F	167	150	156	156	155	158	158	148	
10 V %	255	220	247	247	242	242	235	235	227
30	336	315	328	328	321	321	320	320	326
50	386	374	386	386	384	384	382	382	375
70	435	424	432	432	432	432	432	432	427
90	494	480	485	485	489	489	487	487	491
FBP	570	559	556	556	565	565	560	560	565
V % @ 400°F	54	60	60	60	59	59	58	58	60
V % @ 650°F	-	-	-	-	-	-	-	-	
Carbon, W %				84.43					
Hydrogen, W %				11.43					
Nitrogen, W %				0.25					
Sulfur, W %				0.18					
Atmospheric Still Bottoms									
Gravity, °API		12.7		12.5		12.6		12.5	12.9
IBP, °F		415		(376)		427		436	442
10 V %		476		(479)		484		494	487
30		529		(529)		531		543	532
50		574		(565)		574		578	567
70		619		(621)		618		626	610
90		-		(702)		-		-	-
FBP		-		(809)		-		-	-
V % @ 400°F		-		(1)		-		-	-
V % @ 650°F		80		(80)		80		80	84
Carbon, W %				88.80					
Hydrogen, W %				9.54					
Nitrogen, W %				0.40					
Sulfur, W %				0.05					
Vacuum Still Overhead									
Gravity, °API	6.0	6.2	6.1	6.2	6.4	6.4	6.2	6.8	6.3
IBP, °F		480		(397)		476		485	472
10 V %		540		(527)		545		535	532
30		612		(600)		615		600	596
50		-		(660)		-		-	-
70		-		(723)		-		-	-
90		-		(805)		-		-	-
FBP		640		(938)		638		630	627
V % @ 650°F		43		(48)		44		48	48
Carbon, W %				89.50					
Hydrogen, W %				8.74					
Nitrogen, W %				0.49					
Sulfur, W %		0.12		0.14		0.14		0.16	0.17
O-5 Liquid									
Gravity, °API	13.2	14.0	14.3	14.5	14.2	14.5	13.4	14.8	14.8
O-12 Liquid									
Gravity, °API		12.5		12.8	12.9	12.9		12.7	
Catalyst Withdrawals									
Withdrawals, Oil-laden Pounds			5.01		1.30				
Oil, W %			28.61		24.97				
Molybdenum (oil-free), W %			6.30		5.88				
Estimate Catalyst Content, Lbs*			2.36		0.60				
Hydroclone Feed									
Ash, W %	-	7.89	-	-	-	-	-	-	-
Hydroclone Overflow									
Gravity, °API Distillation		-11.8		-12.2		013.8		-14.5	-16.4
IBP, °F		466		474		436		483	488
10 V %		581		581		570		600	600
30		730		724		722		718	750
50		876		865		873		886	975
FBP		940		975		975	-	975	975
V % @ 650°F		22		23.5		24		21	16
V % @ 975°F		60.5		58		58		56.5	51
W % 975°F+ (incl. solids)		46.38		48.06		49.92		51.61	55.82
Ash, W %	5.56	5.47	5.60	5.49	5.47	5.92		6.30	6.28

PDU RUN 7 - ANALYSIS (CONTINUED)

Hydroclone Underflow									
Ash, W %	-	16.57	-	-	-	-	-	-	-
Vacuum Still Bottoms									
W % of Flows from Vacuum Still	59.44	61.25	66.19	59.95	59.44	61.02	64.13	64.39	63.78
Toluene Soluble, W %		45.61		44.15		43.22		40.87	41.80
Toluene Insoluble, W %		36.68		37.68		38.70		42.54	41.38
Ash W %		17.71		18.17		18.08		16.59	16.82
Unreacted Coal, W % (Est.)		26.14		25.79		26.05		33.50	32.46
CARBON, W %				70.94					
Hydrogen, W %				4.73					
Nitrogen, W %				1.52					
Sulfur, W %				2.21					2.06
ASTM Ash, W %		18.35	18.20	19.87	18.39	17.81	17.11	17.47	17.20
Coke/Ash Ratio (DMF Extraction by Filtration		0.6486	-	0.7669	-	0.7268	-	0.7002	0.6980
DMF Soluble, W %		70.11		65.05		69.35		70.23	71.44
Filter Cake									
W % of Feed to Vacuum Still		14.23		29.42	26.46	34.72		28.85	-
Toluene Extraction of Cake									
Soluble, W %		26.36		26.13	24.86	29.90		30.26	
Insoluble, W %		30.91		32.89	33.77	33.35		30.79	
Ash, W %		42.73		40.98	41.37	36.75		38.95	
Insoluble Residues, W %		6.36		6.07	5.73	7.26		10.64	
Unreacted Coal, LW % (Est.)		24.54		26.82	28.04	26.09		20.15	
Water									
Ammonia, W %				3.24					
Sulfur, W %				2.54					
Carbon, W %				1.81					
Atmospheric Overhead									
IBP°-400°F Gravity, °API				37.3					
Atmospheric Still Bottoms									
IBP-650°F Gravity, °API				14.4					
650°F+ Gravity, °API				1.7					
Batch Dist'n of Filtrate from Filtration of Vacuum Still Feed									
Final Vapor Temperature, °F		570		570	570	551		535	
Pressure, Torr		4.0		2.8	2.0	2.0		1.8	
Residue, W % of Filtrate		45.31		38.85	46.42	44.62		49.75	
Vacuum Bottom Oil									
Sulfur, W %		0.96		1.04	0.82	1.07		0.84	
Toluene Extraction									
Insolubles, W %		42.61		39.55	56.00	45.71		47.42	
Ash, W %		1.05		1.81	0.50	4.22		0.16	
Batch Dist'n of Vacuum Bottoms Slurry Product									
Final Vapor Temperature, °F		489		480	491	481		489	
Pressure, Torr		1.5		1.2	0.5	1.2		1.2	
Residue, W % Vac. Btms. Slurry		90.00		34.97	91.13	88.78		87.93	
Vacuum Distillate									
Gravity, °API		-2.5		-3.1		-4.1		-4.0	

PDU RUN 8 - ILLINOIS COAL - DUAL MODE OPERATION

PDU 8 successfully operated in two modes with no interruption during transition. The first phase of the run operated in a fuel oil mode to produce hydroclone underflow. Forty drums of this material were manufactured for further tests designed to establish the most favorable Pilot Plant operating conditions for the solvent precipitation system.

In the second phase of the run, during operations in an intermediate mode, a new solvent precipitation system was placed on-line in the PDU and operated satisfactorily with 0.01% ash in the overflow product.

The reactor and separator were free of deposits when they were inspected following the run, thus verifying that the PDU design can handle solids without any buildup in the system.

The achievements of this run were:

- Operation of the PDU first in a fuel oil mode and then gradually changing over to an intermediate mode was accomplished.
- Forty drums of hydroclone underflow were produced for further testing by Lummus.
- The solvent precipitation system achieved a 0.01 ash in the overflow product showing the feasibility of the operation.
- Catalyst replacement was maintained for the duration of the run.

ANALYSIS OF ILLINOIS NO. 6 BURNING STAR MINE COAL FOR PDU RUN 8 (RUN 130-88)

HRI No.	4004	4004	4004/4062
Feed to Period	1-6	7-15	16-23
Hours on Stream	0-107	107-290	290-462
Moisture, W %	3.36	4.96	2.76
Proximate, Dry Basis, W %			
Ash	11.16	11.30	11.41
Volatile Matter	37.57	37.40	37.54
Fixed Carbon	51.27	51.30	51.05
Ultimate, Dry Basis, W %			
Carbon	68.27	68.66	68.37
Hydrogen	4.39	4.53	4.31
Nitrogen	1.14	1.19	1.42
Sulfur (LECO)	3.41	3.50	3.41
Ash	11.16	11.30	11.41
Oxygen (Difference)	11.63	10.82	11.08
Sulfur in Ash, W %	3.07	3.60	3.54
Heating Value, Btu/Lb	11921	11896	12157
Sieve Analysis, Screen Size (U.S.S.)			
+50	2.12	5.52	9.42
50/70	2.69	6.59	9.12
70/100	5.30	9.29	11.71
100/140	8.38	9.69	11.39
140/200	9.20	11.83	8.75
100/325	22.07	17.67	18.57
-325	50.23	39.41	31.04

UNIT 130 - H-COAL OPERATIONS ON ILLINOIS # 6 (HRI 4004)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830)
REACTOR VOLUME: 4.17 CUBIC FEET
RUN NUMBER 130- 68

PERIOD	4 A	4 B	5 A	5 B	6 A	7 A
DATE (END OF PERIOD), 1979	7/ 5	7/ 5	7/ 6	7/ 6	7/ 7	7/12
HOURS OF RUN - BEGINNING	52.00	64.00	76.00	88.00	100.00	107.00
END	64.00	76.00	88.00	100.00	107.00	117.00
CATALYST INVENTORY, END, LBS	50.45	50.45	50.20	50.20	50.09	50.09
CATALYST ADDED, LBS	4.36	0.00	4.28	0.00	2.12	0.00
CATLYST WITHDRAWN, LBS *	4.72	0.00	4.53	0.00	2.22	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	323.4	399.4	437.9	514.0	536.1	586.6
ORIGINAL CHARGE (BASIS)	364.0	440.0	517.3	593.4	638.5	689.0
CATALYST ADDED, CUMULATIVE**						
LBS/TON DRY COAL	.90	.75	.96	.84	.91	.85
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	9.40	0.00	9.22	0.00	4.55	0.00
OIL, W %	28.74	0.00	27.27	0.00	26.87	0.00
MOLYDENUM (OIL FREE), W % *	7.01	0.00	6.72	0.00	6.65	0.00
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	76.08	76.63	77.24	76.35	77.45	60.55
MOISTURE W % (COAL SAMPLE)	3.72	3.94	3.93	3.92	3.92	4.11
ASH,W% (DRY COAL)	0.00	10.17	10.62	10.99	0.00	0.00
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.61	.49	.42	.52	.51	.42
VACUUM STILL OVERHEAD	.35	.35	.35	.32	.40	0.00
INVENTORY CHANGE	-.04	-.07	-.08	-.00	-.07	.01
HYDROCLONE OVERFLOW (OIL)	.90	.91	.90	1.01	.90	.83
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.89	1.82	1.75	1.84	1.89	1.24
TEMPERATURE, °F						
COAL PREHEATER OUTLET	737.	740.	740.	747.	681.	799.
REACTOR LIQUID PHASE, AVG.	845.	846.	845.	845.	765.	793.
MAX.	861.	862.	860.	858.	775.	798.
SEPARATOR-2" (@ 12" SKIN)	830.	830.	829.	828.	753.	759.
HYDROCLONE OVERFLOW	510.	512.	513.	458.	474.	494.
VACUUM STILL FLASH ZONE	525.	523.	530.	529.	519.	457.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2662.	2645.	2631.	2617.	2594.	2614.
HYDROGEN MAKE-UP, PSIG	2790.	2795.	2781.	2717.	2705.	2721.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1789.	1772.	1755.	1843.	1844.	1958.
VACUUM FLASH, TORR	4.	4.	3.	3.	3.	0.

* 9.95 W% MOLYBDENUM IN FRESH CATALYST.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

PERIOD	4 A	4 B	5 A	5 B	6 A	7 A
RECYCLE GAS, MSCF/TON DRY COAL	21.45	22.61	22.30	21.90	21.70	24.14
VENT GAS, MSCF/TON DRY COAL	4.31	4.20	4.37	4.48	4.96	3.60
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	89.22	87.57	85.97	91.68	90.00	81.90
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	24.94	25.52	24.94	26.48	26.27	25.27
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	36.77	37.20	36.58	37.53	36.68	32.07
PARTIAL PRESSURE, PSIG(INLET)	2639.	2612.	2575.	2605.	2568.	2408.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	11.83	11.68	11.64	11.05	10.41	6.80
W % DRY COAL	3.14	3.10	3.09	2.93	2.76	1.80
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.002	.003	.003	.003	.002	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	16.58	27.32	21.74	21.05	18.18	5.74
ATMOSPHERIC STILL BOTTOMS (2)	4.01	5.43	.07	3.27	-3.06	13.27
VACUUM STILL OVERHEAD (2)	-1.19	-2.72	-3.65	.19	-3.47	0.00
VACUUM STILL BOTTOMS	61.12	60.13	62.02	64.92	65.58	74.62
HYDROCLONE UNDERFLOW	0.00	0.00	0.00	0.00	0.00	0.00
H2O	9.62	7.70	9.57	12.88	9.84	-.27
C1-C3	0.00	5.31	0.00	4.91	0.00	0.00
C4-C7	0.00	2.96	0.00	2.61	0.00	0.00
H2S IN GASES	0.00	2.16	0.00	2.07	0.00	0.00
CO2 & CO	0.00	.79	0.00	.73	0.00	0.00
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	3.86	4.10	4.09	4.08	4.08	4.29
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.24	.27	.27	.26	.24	.30
HYDROGEN REACTED (1)	3.14	3.10	3.09	2.93	2.76	1.80
TOTAL	107.24	107.47	107.45	107.27	107.08	106.39
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	0.00	94.31	0.00	91.97	0.00	0.00
DMF CONVERSION (4)	0.00	92.35	0.00	91.61	0.00	0.00

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	4 A	4 B	5 A	5 B	6 A	7 A
NORMALIZED NET PRODUCT DISTRIBUTION*!$						
W % OF DRY COAL						
CO, CO2	0.00	.82	.75	.75	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	0.00	5.49	5.03	5.03	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	0.00	3.04	2.67	2.67	0.00	0.00
IBP-400 °F NAPHTHA	0.00	13.25	11.44	11.44	0.00	0.00
400-650 °F DISTILLATES	0.00	10.97	10.47	10.47	0.00	0.00
650-975 °F DISTILLATES	0.00	10.25	9.19	9.19	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	0.00	23.85	27.40	27.40	0.00	0.00
TOLUENE INSOLUBLE	0.00	11.02	8.62	8.82	0.00	0.00
UNCONVERTED COAL	0.00	6.21	7.61	7.61	0.00	0.00
ASH	0.00	12.49	11.71	11.71	0.00	0.00
H2O (NET)	0.00	4.29	6.47	6.47	0.00	0.00
NH3 (FORCED NITROGEN)	0.00	.26	.24	.24	0.00	0.00
H2S (FORCED SULFUR)	0.00	2.02	1.97	1.97	0.00	0.00
TOTAL (100 + HYDROGEN REACTED)	0.00	103.97	103.78	103.78	0.00	0.00
FILTERED LIQUID**						
GRAVITY, °API	0.0	-8.0	0.0	-9.3	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	0.	645.	0.	659.	0.	0.
10 V %	0.	686.	0.	677.	0.	0.
30 V %	0.	749.	0.	762.	0.	0.
50 V %	0.	853.	0.	953.	0.	0.
70 V %	0.	0.	0.	0.	0.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	0.	975.	0.	975.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	4.90	0.00	7.00	0.00	0.00
V % AT 975 °F	0.00	60.00	0.00	62.00	0.00	0.00
SULFUR, W %	0.00	.29	0.00	.47	0.00	0.00
W % 975 °F+	0.00	43.11	0.00	43.18	0.00	0.00
W % SULFUR IN 975 °F+	0.00	.68	0.00	.79	0.00	0.00
W % NITROGEN IN 975 °F+	0.00	0.00	0.00	0.00	0.00	0.00

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 14 TO 22 FILTRATION OF HYDROCLONE UNDERFLOW WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS FROM RUN 130-82-16A AS PUSHER (TWO WEIGHTS OF HYDROCLONE UNDERFLOW PER ONE WEIGHT OF ATMOSPHERIC STILL BOTTOMS). DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. GRAVITY, SULFUR, AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HYDROCLONE UNDERFLOW.

! PERIODS 3AB, 11B, 17B, AND 19B ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

$ IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	4 A	4 B	5 A	5 B	6 A	7 A
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	33.7	29.7	28.9	28.9	29.6	28.0
IBP, °F (ASTM D-86)	130.	126.	134.	134.	144.	152.
10 V %	206.	210.	220.	220.	234.	252.
30 V %	280.	310.	328.	328.	330.	334.
50 V %	344.	382.	396.	396.	388.	386.
70 V %	396.	420.	436.	436.	436.	428.
90 V %	454.	476.	500.	500.	508.	486.
FBP	506.	520.	534.	534.	546.	542.
V % @ 400 °F	72.00	61.00	55.00	55.00	56.00	65.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	100.00
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR (H2S FREE), W %	0.00	0.00	0.00	0.00	0.00	0.00
IBP-400 °F						
GRAVITY, °API	39.3	37.0	37.1	37.1	35.4	37.4
SULFUR (H2S FREE), W %	0.00	0.00	0.00	0.00	0.00	0.00
400 °F+						
GRAVITY, °API	19.8	19.3	19.0	19.0	19.1	17.9
SULFUR (H2S FREE), W %	0.00	0.00	0.00	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.2	10.5	10.2	10.2	10.4	8.5
IBP, °F (ASTM D-86)	0.	460.	0.	466.	475.	0.
10 V %	0.	494.	0.	514.	506.	0.
30 V %	0.	526.	0.	546.	534.	0.
50 V %	0.	560.	0.	578.	572.	0.
70 V %	0.	604.	0.	616.	608.	0.
90 V %	0.	0.	0.	718.	690.	0.
FBP	0.	0.	0.	764.	760.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	83.00	0.00	80.00	85.00	0.00
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	.02	0.00	.04	0.00	0.00
IBP-650 °F						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	4 A	4 B	5 A	5 B	6 A	7 A
WATER						
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
AMMONIA, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	0.00	0.00	0.00	0.00	0.00
CLEAN OIL TANK						
GRAVITY, °API	0.0	8.0	0.0	7.2	0.0	0.0
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	0.0	284.0	0.0	366.0	0.0	0.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	4.5	4.3	3.9	3.7	4.3	0.0
IBP, °F (ASTM D-1160 MODIFIED)	0.	0.	0.	0.	492.	0.
10 V %	0.	0.	0.	0.	535.	0.
30 V %	0.	0.	0.	0.	582.	0.
50 V %	0.	0.	0.	0.	618.	0.
70 V %	0.	0.	0.	0.	0.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	0.	0.	0.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	0.00	0.00	0.00	63.00	0.00
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	.04	0.00	.10	0.00	0.00
IBP-650 °F						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	4 A	4 B	5 A	5 B	6 A	7 A
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	60.96	60.65	61.40	64.45	59.49	100.00
TOLUENE SOLUBLE, W %	0.00	52.62	0.00	56.73	0.00	0.00
NON-ASH TOLUENE INSOLUBLE, W %	0.00	27.47	0.00	25.26	0.00	0.00
ASH, W %	0.00	19.91	0.00	18.01	0.00	0.00
UNREACTED COAL, W % (EST.)	0.00	10.01	0.00	11.71	0.00	0.00
TOLUENE INSOL. RESID. W % (EST.)	0.00	17.46	0.00	13.55	0.00	0.00
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	2.19	0.00	2.19	0.00	0.00
ASTM ASH, W %	0.00	19.64	0.00	20.71	0.00	0.00
COKE/ASH RATIO (DMF EXTR.)	0.00	.68	0.00	.68	0.00	0.00
DMF-SOLUBLE, W %	0.00	67.71	0.00	68.96	0.00	0.00
VISCOSITY, CP @ 500 °F *	0.0	500.0	0.0	680.0	0.0	0.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	0.	0.	0.	0.	0.	0.
DISTILLATE TO 975 °F, W %	0.00	0.00	0.00	0.00	0.00	0.00
IBP-975 °F						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0
HYDROCLONE OVERFLOW						
GRAVITY, °API	0.0	-13.0	0.0	-14.8	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	0.	481.	0.	498.	0.	0.
10 V %	0.	585.	0.	600.	0.	0.
30 V %	0.	727.	0.	712.	0.	0.
50 V %	0.	884.	0.	821.	0.	0.
70 V %	0.	0.	0.	0.	0.	0.
END POINT	0.00	975.00	0.00	975.00	0.00	0.00
V % @ 650 °F	0.00	22.80	0.00	20.00	0.00	0.00
V % @ END POINT	0.00	56.30	0.00	58.00	0.00	0.00
ASH, W %	0.00	5.88	0.00	8.46	0.00	0.00
RESIDUE AND SOLIDS, W %	0.00	48.28	0.00	49.86	0.00	0.00
HYDROCLONE UNDERFLOW, ASH, W %	0.00	11.54	0.00	12.64	0.00	0.00
HYDROCLONE FEED, ASH W %	0.00	10.53	0.00	0.00	0.00	0.00
FILTER CAKE						
W % OF FEED TO FILTER	0.00	26.59	0.00	24.68	0.00	0.00
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	0.00	30.18	0.00	31.34	0.00	0.00
NON-ASH INSOLUBLE, W %	0.00	26.34	0.00	29.35	0.00	0.00
ASH, W %	0.00	43.48	0.00	39.31	0.00	0.00
INSOLUBLE RESID., W %	0.00	4.49	0.00	3.80	0.00	0.00
UNREACTED COAL, W % (EST.)	0.00	21.85	0.00	25.55	0.00	0.00
DMF - EXTRACTED CAKE						
ASH (OIL FREE), W %	0.00	69.68	0.00	69.64	0.00	0.00
O - 5 LIQUID						
GRAVITY, °API	13.7	13.5	12.1	12.6	12.0	11.3
O - 12 LIQUID						
GRAVITY, °API	0.0	14.9	0.0	13.6	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES

PERIOD	4 A	4 B	5 A	5 B	6 A	7 A
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	0.00	390.00	0.00	485.00	0.00	0.00
PRESSURE, TORR	0.00	3.00	0.00	2.60	0.00	0.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	0.00	10.81	0.00	12.27	0.00	0.00
SULFUR, W %	0.00	.16	0.00	.22	0.00	0.00
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	0.00	15.97	0.00	17.79	0.00	0.00
BATCH STILL RESID. FROM FILTRATE	0.00	84.03	0.00	82.21	0.00	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	0.00	.37	0.00	.45	0.00	0.00
CALCULATED COMPOSITION OF * 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD	0.00	42.40	0.00	34.90	0.00	0.00
ATMOSPHERIC STILL BOTTOMS	0.00	19.50	0.00	10.60	0.00	0.00
NET VACUUM STILL OVERHEAD	0.00	-9.80	0.00	.60	0.00	0.00
VACUUM STILL BOTTOMS, SOLIDS FREE OIL: IBP-975 °F	0.00	3.60	0.00	5.40	0.00	0.00
975 °F+	0.00	44.30	0.00	48.50	0.00	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	0.00	.40	0.00	.46	0.00	0.00
SULFUR (ACTUAL), W %	0.00	0.00	0.00	0.00	0.00	0.00
VISCOSITY (ACTUAL), SSU @ 250 °F	0.00	0.00	0.00	0.00	0.00	0.00

* THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.6 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.16 W% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-88
COAL ILLINOIS #6 (HRI 4004)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	4 A	4 B	5 A	5 B	6 A	7 A
OPERATING CONDITIONS						
HOURS OF RUN - BEGINNING	52.00	64.00	76.00	88.00	100.00	107.00
END	64.00	76.00	88.00	100.00	107.00	117.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	323.4	399.4	437.9	514.0	536.1	586.6
CATALYST ADDED, CUMULATIVE LBS/TON DRY COAL	.90	.75	.96	.84	.91	.85
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	76.08	76.63	77.24	76.35	77.45	60.55
AVERAGE REACTOR TEMPERATURE, °F	845.	846.	845.	845.	765.	793.
UNIT BACKPRESSURE (UNIT BP), PSIG	2662.	2645.	2631.	2617.	2594.	2614.
H2 PARTIAL PRESSURE, PSIG	1789.	1772.	1755.	1843.	1844.	1958.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.89	1.82	1.75	1.84	1.89	1.24
H2 INLET RATE, MSCF/TON DRY COAL	36.77	37.20	36.58	37.53	36.68	32.07
RECYCLE GAS, MSCF/TON DRY COAL	21.45	22.61	22.30	21.90	21.70	24.14
YIELDS, WT% OF DRY COAL						
CO,CO2	0.00	.82	.75	.75	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	0.00	5.49	5.03	5.03	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	0.00	3.04	2.67	2.67	0.00	0.00
IBP-400 °F NAPHTHA	0.00	13.25	11.44	11.44	0.00	0.00
400-650 °F DISTILLATES	0.00	10.97	10.47	10.47	0.00	0.00
650-975 °F DISTILLATES	0.00	10.25	9.19	9.19	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	0.00	23.85	27.40	27.40	0.00	0.00
TOLUENE INSOLUBLE	0.00	11.02	8.82	8.82	0.00	0.00
UNCONVERTED COAL	0.00	6.21	7.61	7.61	0.00	0.00
ASH	0.00	12.49	11.71	11.71	0.00	0.00
H2O (NET)	0.00	4.29	6.47	6.47	0.00	0.00
NH3 (FORCED NITROGEN)	0.00	.26	.24	.24	0.00	0.00
H2S (FORCED SULFUR)	0.00	2.02	1.97	1.97	0.00	0.00
TOTAL	0.00	103.97	103.78	103.78	0.00	0.00
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
COMPOSITION OF 400 °F+ FUEL OIL, WT%**						
ATMOSPHERIC STILL OVERHEAD	0.00	42.40	0.00	34.90	0.00	0.00
ATMOSPHERIC STILL BOTTOMS	0.00	19.50	0.00	10.60	0.00	0.00
NET VACUUM STILL OVERHEAD	0.00	-9.80	0.00	.60	0.00	0.00
VACUUM STILL BOTTOMS, SOLID FREE OIL: IBP-975 °F	0.00	3.60	0.00	5.40	0.00	0.00
975 °F+	0.00	44.30	0.00	48.50	0.00	0.00
SULFUR, WT%	0.00	0.00	0.00	0.00	0.00	0.00
VISCOSITY, SSU @ 250 °F	0.00	0.00	0.00	0.00	0.00	0.00

** THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 WT% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

UNIT 130 - H-COAL OPERATIONS ON ILLINOIS # 6 (HRI 4004)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830)
REACTOR VOLUME: 4.17 CUBIC FEET
RUN NUMBER 130- 88

PERIOD	7 B	8 A	8 B	9 A	10 A	10 B
DATE (END OF PERIOD), 1979	7/13	7/13	7/14	7/15	7/15	7/ 7
HOURS OF RUN - BEGINNING	117.00	129.00	141.00	153.00	163.00	166.00
END	129.00	141.00	153.00	163.00	166.00	178.00
CATALYST INVENTORY, END, LBS	50.09	51.01	51.01	51.09	51.09	51.09
CATALYST ADDED, LBS	0.00	6.97	0.00	5.16	0.00	0.00
CATLYST WITHDRAWN, LBS *	0.00	6.05	0.00	5.08	0.00	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	658.7	639.2	714.1	698.5	706.7	767.5
ORIGINAL CHARGE (BASIS)	761.1	837.0	911.9	972.5	980.7	1041.5
CATALYST ADDED, CUMULATIVE**						
LBS/TON DRY COAL	.77	1.03	.94	1.10	1.09	1.02
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	13.02	0.00	10.11	0.00	0.00
OIL, W %	0.00	25.10	0.00	25.45	0.00	0.00
MOLYDENUM (OIL FREE), W % *	0.00	6.17	0.00	6.70	0.00	0.00
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	72.14	75.24	76.40	73.49	33.40	62.09
MOISTURE W % (COAL SAMPLE)	4.11	4.13	4.14	4.14	4.60	4.60
ASH,W% (DRY COAL)	11.05	0.00	11.18	0.00	0.00	10.75
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.74	.68	.67	0.00	0.00	0.00
VACUUM STILL OVERHEAD	.23	.20	.17	0.00	0.00	0.00
INVENTORY CHANGE	-.10	.11	.03	0.00	0.00	0.00
HYDROCLONE OVERFLOW (OIL)	.64	.82	.83	0.00	0.00	0.00
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.72	1.59	1.64	0.00	0.00	0.00
TEMPERATURE, °F						
COAL PREHEATER OUTLET	787.	783.	785.	792.	795.	795.
REACTOR LIQUID PHASE, AVG.	846.	850.	849.	847.	786.	825.
MAX.	856.	859.	858.	856.	790.	833.
SEPARATOR-2" (@ 12" SKIN)	821.	827.	824.	828.	753.	797.
HYDROCLONE OVERFLOW	491.	495.	498.	496.	488.	487.
VACUUM STILL FLASH ZONE	507.	530.	519.	511.	468.	498.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2604.	2650.	2518.	2592.	2700.	2600.
HYDROGEN MAKE-UP, PSIG	2752.	2812.	2743.	2760.	2775.	2705.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1719.	1683.	1551.	1661.	2214.	2099.
VACUUM FLASH, TORR	3.	2.	3.	3.	0.	3.

* 9.95 W% MOLYBDENUM IN FRESH CATALYST.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

PERIOD	7 B	8 A	8 B	9 A	10 A	10 B
RECYCLE GAS, MSCF/TON DRY COAL	23.26	22.01	21.64	23.20	50.99	28.51
VENT GAS, MSCF/TON DRY COAL	5.01	3.52	3.60	2.95	5.42	4.05
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	81.91	88.27	84.66	87.40	94.10	94.09
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	25.68	25.00	22.98	26.35	61.33	35.56
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	37.15	36.23	35.46	38.47	76.62	46.55
PARTIAL PRESSURE, PSIG(INLET)	2485.	2639.	2522.	2579.	2684.	2625.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	11.47	11.22	12.48	12.12	15.29	10.99
W % DRY COAL	3.04	2.98	3.31	3.22	4.06	2.92
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.002	.002	.003	.006	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	26.27	13.98	19.15	27.64	17.68	25.11
ATMOSPHERIC STILL BOTTOMS (2)	-8.53	10.28	3.20	-7.01	94.62	-14.01
VACUUM STILL OVERHEAD (2)	-2.38	3.19	.95	-2.23	15.43	-6.42
VACUUM STILL BOTTOMS	72.61	52.44	60.70	67.25	0.00	84.35
HYDROCLONE UNDERFLOW	0.00	0.00	0.00	0.00	0.00	0.00
H2O	2.62	14.51	7.39	6.67	3.60	1.65
C1-C3	4.65	0.00	4.65	0.00	0.00	0.00
C4-C7	1.04	0.00	1.04	0.00	0.00	0.00
H2S IN GASES	1.33	0.00	1.33	0.00	0.00	0.00
CO2 & CO	.89	0.00	.89	0.00	0.00	0.00
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	4.29	4.31	4.32	4.32	4.82	4.82
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.26	.24	.24	.26	.64	.30
HYDROGEN REACTED (1)	3.04	2.98	3.31	3.22	4.06	2.92
TOTAL	107.59	107.53	107.87	107.80	109.52	108.04
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	92.78	0.00	92.34	0.00	0.00	92.41
DMF CONVERSION (4)	91.22	0.00	91.57	0.00	0.00	92.14

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	7 B	8 A	8 B	9 A	10 A	10 B
NORMALIZED NET PRODUCT DISTRIBUTION*!$						
W % OF DRY COAL						
CO, CO2	0.00	0.00	0.00	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	0.00	0.00	0.00	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	0.00	0.00	0.00	0.00	0.00	0.00
IBP-400 °F NAPHTHA	0.00	0.00	0.00	0.00	0.00	0.00
400-650 °F DISTILLATES	0.00	0.00	0.00	0.00	0.00	0.00
650-975 °F DISTILLATES	0.00	0.00	0.00	0.00	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	0.00	0.00	0.00	0.00	0.00	0.00
TOLUENE INSOLUBLE	0.00	0.00	0.00	0.00	0.00	0.00
UNCONVERTED COAL	0.00	0.00	0.00	0.00	0.00	0.00
ASH	0.00	0.00	0.00	0.00	0.00	0.00
H2O (NET)	0.00	0.00	0.00	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	0.00	0.00	0.00	0.00	0.00	0.00
H2S (FORCED SULFUR)	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL (100 + HYDROGEN REACTED)	0.00	0.00	0.00	0.00	0.00	0.00
FILTERED LIQUID**						
GRAVITY, °API	-11.7	0.0	-12.8	0.0	0.0	-11.9
IBP, °F (ASTM D-1160 MODIFIED)	574.	0.	557.	0.	0.	566.
10 V %	679.	0.	699.	0.	0.	642.
30 V %	793.	0.	796.	0.	0.	735.
50 V %	975.	0.	975.	0.	0.	905.
70 V %	0.	0.	0.	0.	0.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	975.	0.	975.	0.	0.	975.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	6.00	0.00	6.00	0.00	0.00	12.00
V % AT 975 °F	50.00	0.00	50.00	0.00	0.00	55.00
SULFUR, W %	.32	0.00	.55	0.00	0.00	.56
W % 975 °F+	53.77	0.00	53.19	0.00	0.00	48.29
W % SULFUR IN 975 °F+	.88	0.00	.79	0.00	0.00	.98
W % NITROGEN IN 975 °F+	0.00	0.00	0.00	0.00	0.00	0.00

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 14 TO 22 FILTRATION OF HYDROCLONE UNDERFLOW WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS FROM RUN 130-82-16A AS PUSHER (TWO WEIGHTS OF HYDROCLONE UNDERFLOW PER ONE WEIGHT OF ATMOSPHERIC STILL BOTTOMS). DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. GRAVITY, SULFUR, AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HYDROCLONE UNDERFLOW.

! PERIODS 3AB, 11B, 17B, AND 19B ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

$ IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	7 B	8 A	8 B	9 A	10 A	10 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	28.0	31.2	31.2	28.7	0.0	26.0
IBP, °F (ASTM D-86)	152.	132.	132.	160.	0.	142.
10 V %	252.	208.	208.	224.	0.	248.
30 V %	334.	288.	288.	326.	0.	340.
50 V %	386.	352.	352.	382.	0.	392.
70 V %	428.	400.	400.	424.	0.	426.
90 V %	486.	466.	466.	496.	0.	466.
FBP	642.	606.	606.	658.	0.	613.
V % @ 400 °F	65.00	70.00	70.00	69.00	0.00	54.00
V % @ 650 °F	100.00	100.00	100.00	100.00	0.00	102.00
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR (H2S FREE), W %	0.00	0.00	0.00	0.00	0.00	0.00
IBP-400 °F						
GRAVITY, °API	37.4	36.7	36.7	36.8	0.0	35.2
SULFUR (H2S FREE), W %	0.00	0.00	0.00	0.00	0.00	0.00
400 °F+						
GRAVITY, °API	17.9	18.3	18.3	19.3	0.0	16.9
SULFUR (H2S FREE), W %	0.00	0.00	0.00	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	9.4	10.1	10.1	10.1	8.9	8.9
IBP, °F (ASTM D-86)	438.	0.	430.	0.	0.	390.
10 V %	468.	0.	476.	0.	0.	464.
30 V %	500.	0.	512.	0.	0.	496.
50 V %	534.	0.	550.	0.	0.	530.
70 V %	582.	0.	600.	0.	0.	570.
90 V %	696.	0.	720.	0.	0.	644.
FBP	718.	0.	760.	0.	0.	710.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	86.00	0.00	83.00	0.00	0.00	91.00
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	.10	0.00	.08	0.00	0.00	.06
IBP-650 °F						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	7 B	8 A	8 B	9 A	10 A	10 B
WATER						
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
AMMONIA, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	0.00	0.00	0.00	0.00	0.00
CLEAN OIL TANK						
GRAVITY, °API	7.6	0.0	8.4	0.0	0.0	6.5
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	325.0	0.0	1660.0	0.0	0.0	153.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	3.4	2.7	2.8	0.0	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	0.	0.	0.	0.	0.	0.
10 V %	0.	0.	0.	0.	0.	0.
30 V %	0.	0.	0.	0.	0.	0.
50 V %	0.	0.	0.	0.	0.	0.
70 V %	0.	0.	0.	0.	0.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	0.	0.	0.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	0.00	0.00	0.00	0.00	0.00
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	.16	0.00	.16	0.00	0.00	.18
IBP-650 °F						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	7 B	8 A	8 B	9 A	10 A	10 B
VACUUM STILL BOTTOMS						
W.% OF VACUUM STILL FEED	73.64	68.99	75.05	73.84	0.00	69.00
TOLUENE SOLUBLE, W %	57.91	0.00	50.68	0.00	0.00	57.76
NON-ASH TOLUENE INSOLUBLE, W %	25.60	0.00	29.27	0.00	0.00	26.34
ASH, W %	16.49	0.00	20.05	0.00	0.00	15.90
UNREACTED COAL, W % (EST.)	9.59	0.00	12.21	0.00	0.00	10.02
TOLUENE INSOL. RESID. W % (EST.)	16.01	0.00	17.06	0.00	0.00	16.32
CARBON, W %	0.00	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	2.10	0.00	2.32	0.00	0.00	2.33
ASTM ASH, W %	16.67	0.00	20.26	0.00	0.00	16.41
COKE/ASH RATIO (DMF EXTR.)	.71	0.00	.67	0.00	0.00	.65
DMF-SOLUBLE, W %	71.55	0.00	66.70	0.00	0.00	73.72
VISCOSITY, CP @ 600 °F *	288.0	0.0	1460.0	0.0	0.0	946.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	0.	0.	0.	0.	0.	0.
DISTILLATE TO 975 °F, W %	0.00	0.00	0.00	0.00	0.00	0.00
IBP-975 °F						
GRAVITY, °API	0.0	0.0	0.0	0.0	0.0	0.0
HYDROCLONE OVERFLOW						
GRAVITY, °API	-16.0	0.0	-20.6	-17.7	0.0	-14.2
IBP, °F (ASTM D-1160 MODIFIED)	472.	0.	469.	0.	0.	482.
10 V %	569.	0.	607.	0.	0.	580.
30 V %	710.	0.	794.	0.	0.	680.
50 V %	0.	0.	0.	0.	0.	865.
70 V %	0.	0.	0.	0.	0.	0.
END POINT	975.00	0.00	975.00	0.00	0.00	975.00
V % @ 650 °F	22.00	0.00	15.00	0.00	0.00	24.00
V % @ END POINT	51.50	0.00	45.75	0.00	0.00	59.60
ASH, W %	7.83	0.00	10.37	0.00	0.00	6.94
RESIDUE AND SOLIDS, W %	55.10	0.00	62.41	0.00	0.00	50.56
HYDROCLONE UNDERFLOW, ASH, W %	12.92	0.00	13.89	0.00	0.00	8.19
HYDROCLONE FEED, ASH W %	11.05	0.00	13.30	0.00	0.00	8.47
FILTER CAKE						
W % OF FEED TO FILTER	29.00	0.00	33.20	0.00	0.00	27.81
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	24.73	0.00	24.01	0.00	0.00	31.82
NON-ASH INSOLUBLE, W %	30.35	0.00	31.79	0.00	0.00	29.46
ASH, W %	44.92	0.00	44.20	0.00	0.00	38.72
INSOLUBLE RESID., W %	4.23	0.00	4.88	0.00	0.00	5.06
UNREACTED COAL, W % (EST.)	26.12	0.00	26.91	0.00	0.00	24.40
DMF - EXTRACTED CAKE						
ASH (OIL FREE), W %	58.59	0.00	59.88	0.00	0.00	60.50
O - 5 LIQUID						
GRAVITY, °API	11.7	11.3	11.5	11.5	11.6	11.6
O - 12 LIQUID						
GRAVITY, °API	0.0	12.3	0.0	0.0	0.0	10.8

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	7 B	8 A	8 B	9 A	10 A	10 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	470.00	0.00	440.00	0.00	0.00	415.00
PRESSURE, TORR	2.60	0.00	2.00	0.00	0.00	2.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	5.66	0.00	9.55	0.00	0.00	9.14
SULFUR, W %	.30	0.00	.29	0.00	0.00	.39
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	7.91	0.00	14.32	0.00	0.00	12.40
BATCH STILL RESID. FROM FILTRATE	92.09	0.00	85.68	0.00	0.00	87.60
CALCULATED COMPOSITION, W %						
SULFUR, W %	.85	0.00	.72	0.00	0.00	.91
CALCULATED COMPOSITION OF * 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD	0.00	0.00	30.36	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS	0.00	0.00	15.56	0.00	0.00	0.00
NET VACUUM STILL OVERHEAD	0.00	0.00	3.34	0.00	0.00	0.00
VACUUM STILL BOTTOMS, SOLIDS FREE OIL: IBP-975 °F	0.00	0.00	0.00	0.00	0.00	0.00
975 °F+	0.00	0.00	50.74	0.00	0.00	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	0.00	0.00	.46	0.00	0.00	0.00
SULFUR (ACTUAL), W %	0.00	0.00	0.00	0.00	0.00	0.00
VISCOSITY (ACTUAL), SSU @ 250 °F	0.00	0.00	0.00	0.00	0.00	0.00

* THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 W% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-88
COAL ILLINOIS #6 (HRI 4004)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	7 B	8 A	8 B	9 A	10 A	10 B
OPERATING CONDITIONS						
HOURS OF RUN - BEGINNING	117.00	129.00	141.00	153.00	163.00	166.00
END	129.00	141.00	153.00	163.00	166.00	178.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	658.7	639.2	714.1	698.5	706.7	767.5
CATALYST ADDED, CUMULATIVE LBS/TON DRY COAL	.77	1.03	.94	1.10	1.09	1.02
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	72.14	75.24	76.40	73.49	33.40	62.09
AVERAGE REACTOR TEMPERATURE, °F	846.	850.	849.	847.	786.	825.
UNIT BACKPRESSURE (UNIT BP), PSIG	2604.	2650.	2518.	2592.	2700.	2600.
H2 PARTIAL PRESSURE, PSIG	1719.	1683.	1551.	1661.	2214.	2099.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.72	1.59	1.64	0.00	0.00	0.00
H2 INLET RATE, MSCF/TON DRY COAL	37.15	36.23	35.46	38.47	76.62	46.55
RECYCLE GAS, MSCF/TON DRY COAL	23.26	22.01	21.64	23.20	50.99	28.51
YIELDS, WT% OF DRY COAL						
CO,CO2	0.00	0.00	0.00	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	0.00	0.00	0.00	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	0.00	0.00	0.00	0.00	0.00	0.00
IBP-400 °F NAPHTHA	0.00	0.00	0.00	0.00	0.00	0.00
400-650 °F DISTILLATES	0.00	0.00	0.00	0.00	0.00	0.00
650-975 °F DISTILLATES	0.00	0.00	0.00	0.00	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	0.00	0.00	0.00	0.00	0.00	0.00
TOLUENE INSOLUBLE	0.00	0.00	0.00	0.00	0.00	0.00
UNCONVERTED COAL	0.00	0.00	0.00	0.00	0.00	0.00
ASH	0.00	0.00	0.00	0.00	0.00	0.00
H2O (NET)	0.00	0.00	0.00	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	0.00	0.00	0.00	0.00	0.00	0.00
H2S (FORCED SULFUR)	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
COMPOSITION OF 400 °F+ FUEL OIL, WT%**						
ATMOSPHERIC STILL OVERHEAD	0.00	0.00	30.36	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS	0.00	0.00	15.56	0.00	0.00	0.00
NET VACUUM STILL OVERHEAD	0.00	0.00	3.34	0.00	0.00	0.00
VACUUM STILL BOTTOMS, SOLID FREE OIL: IBP-975 °F	0.00	0.00	0.00	0.00	0.00	0.00
975 °F+	0.00	0.00	50.74	0.00	0.00	0.00
SULFUR, WT%	0.00	0.00	0.00	0.00	0.00	0.00
VISCOSITY, SSU @ 250 °F	0.00	0.00	0.00	0.00	0.00	0.00

** THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 WT% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

UNIT 130 - H-COAL OPERATIONS ON ILLINOIS # 6 (HRI 4004)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830)
REACTOR VOLUME: 4.17 CUBIC FEET
RUN NUMBER 130- 88

PERIOD	11 A	11 B	12 A	12 B	13 A	13 B
DATE (END OF PERIOD), 1979	7/16	7/17	7/17	7/18	7/18	7/19
HOURS OF RUN - BEGINNING	178.00	190.00	202.00	214.00	226.00	238.00
END	190.00	202.00	214.00	226.00	238.00	250.00
CATALYST INVENTORY, END, LBS	51.27	51.27	53.59	53.59	44.37	44.37
CATALYST ADDED, LBS	3.19	0.00	2.32	0.00	0.00	0.00
CATLYST WITHDRAWN, LBS *	3.01	0.00	0.00	0.00	9.22	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	791.9	867.6	901.6	973.3	1052.0	1140.8
ORIGINAL CHARGE (BASIS)	1117.3	1193.0	1267.3	1339.1	1417.8	1506.6
CATALYST ADDED, CUMULATIVE**						
LBS/TON DRY COAL	1.07	1.00	1.01	.95	.90	.85
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	6.67	0.00	0.00	0.00	19.85	0.00
OIL, W %	30.17	0.00	0.00	0.00	22.85	0.00
MOLYDENUM (OIL FREE), W % *	6.43	0.00	0.00	0.00	6.17	0.00
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	76.88	77.51	76.57	76.85	77.57	78.75
MOISTURE W % (COAL SAMPLE)	4.54	4.48	4.33	4.18	6.24	6.30
ASH,W% (DRY COAL)	0.00	10.87	0.00	11.29	0.00	11.40
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.62	.62	.56	.53	.58	.56
VACUUM STILL OVERHEAD	.36	.33	.29	.23	.09	.12
INVENTORY CHANGE	.07	-.05	-.04	.04	-.09	-.08
HYDROCLONE OVERFLOW (OIL)	.78	.88	.76	.77	.79	.79
MAKE-UP OIL	0.00	0.60	0.00	0.00	0.00	0.00
TOTAL	1.69	1.77	1.66	1.48	1.55	1.56
TEMPERATURE, °F						
COAL PREHEATER OUTLET	803.	788.	783.	773.	777.	784.
REACTOR LIQUID PHASE, AVG.	840.	845.	849.	849.	848.	847.
MAX.	846.	857.	857.	858.	857.	855.
SEPARATOR-2" (@ 12" SKIN)	816.	829.	829.	816.	816.	810.
HYDROCLONE OVERFLOW	503.	506.	509.	504.	506.	504.
VACUUM STILL FLASH ZONE	507.	514.	511.	533.	525.	522.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2604.	2584.	2683.	2628.	2623.	2622.
HYDROGEN MAKE-UP, PSIG	2736.	2727.	2825.	2831.	2823.	2807.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1858.	1744.	1895.	1650.	1562.	1566.
VACUUM FLASH, TORR	1.	3.	2.	20.	80.	79.

* 9.95 W% MOLYBDENUM IN FRESH CATALYST.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

PERIOD	11 A	11 B	12 A	12 B	13 A	13 B
RECYCLE GAS, MSCF/TON DRY COAL	19.58	20.90	21.26	20.95	21.70	22.31
VENT GAS, MSCF/TON DRY COAL	3.06	3.89	4.44	5.02	4.67	4.72
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	92.94	88.06	89.64	81.23	80.68	80.70
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	25.42	24.16	25.61	21.97	22.03	22.71
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	34.90	35.60	36.87	33.59	33.85	34.04
PARTIAL PRESSURE, PSIG(INLET)	2646.	2562.	2680.	2547.	2525.	2505.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	9.48	11.44	11.26	11.62	11.82	11.33
W % DRY COAL	2.52	3.04	2.99	3.08	3.14	3.01
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.002	.002	.002	.002	.002	.002
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	13.84	14.89	15.94	17.92	14.72	16.53
ATMOSPHERIC STILL BOTTOMS (2)	5.34	7.27	-.95	3.41	-8.86	-7.89
VACUUM STILL OVERHEAD (2)	3.15	-2.13	-1.37	1.65	-1.19	-1.48
VACUUM STILL BOTTOMS	68.27	66.84	63.65	60.74	76.60	77.18
HYDROCLONE UNDERFLOW	0.00	0.00	0.00	0.00	0.00	0.00
H2O	7.72	9.43	9.56	11.04	10.14	10.99
C1-C3	4.16	5.28	4.79	5.99	6.81	0.00
C4-C7	2.29	2.34	2.40	2.56	2.91	0.00
H2S IN GASES	2.16	2.24	2.14	2.32	2.60	0.00
CO2 & CO	.89	.84	.83	.91	1.04	0.00
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	4.76	4.69	4.53	4.36	5.53	6.72
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.24	.25	.24	.24	.24	.23
HYDROGEN REACTED (1)	2.52	3.04	2.99	3.08	3.14	3.01
TOTAL	107.52	107.98	107.76	107.68	108.91	109.96
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	0.00	92.89	0.00	92.81	0.00	92.24
DMF CONVERSION (4)	0.00	89.72	0.00	88.89	0.00	89.37

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	11 A	11 B	12 A	12 B	13 A	13 B
NORMALIZED NET PRODUCT DISTRIBUTION*‡						
W % OF DRY COAL						
CO, CO2	0.00	.84	0.00	0.00	.34	.34
C1-C3 HYDROCARBONS IN GASES	0.00	5.37	0.00	0.00	7.11	7.11
C4-C7 HYDROCARBONS IN GASES	0.00	2.40	0.00	0.00	3.02	3.02
IBP-400 °F NAPHTHA	0.00	9.95	0.00	0.00	10.32	10.32
400-650 °F DISTILLATES	0.00	10.24	0.00	0.00	-1.64	-1.64
650-975 °F DISTILLATES	0.00	7.21	0.00	0.00	17.07	17.07
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	0.00	25.63	0.00	0.00	29.91	29.91
TOLUENE INSOLUBLE	0.00	15.21	0.00	0.00	10.50	10.50
UNCONVERTED COAL	0.00	7.31	0.00	0.00	7.50	7.50
ASH	0.00	12.65	0.00	0.00	12.62	12.62
H2O (NET)	0.00	4.35	0.00	0.00	4.44	4.44
NH3 (FORCED NITROGEN)	0.00	.21	0.00	0.00	.10	.10
H2S (FORCED SULFUR)	0.00	1.89	0.00	0.00	1.77	1.77
TOTAL (100 + HYDROGEN REACTED)	0.00	103.16	0.00	0.00	102.96	102.96
FILTERED LIQUID**						
GRAVITY, °API	0.0	-11.7	0.0	-13.4	0.0	-13.6
IBP, °F (ASTM D-1160 MODIFIED)	0.	520.	0.	558.	0.	681.
10 V %	0.	619.	0.	707.	0.	677.
30 V %	0.	718.	0.	821.	0.	792.
50 V %	0.	905.	0.	0.	0.	0.
70 V %	0.	0.	0.	0.	0.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	0.	975.	0.	975.	0.	975.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	15.00	0.00	5.00	0.00	6.00
V % AT 975 °F	0.00	55.00	0.00	45.00	0.00	46.00
SULFUR, W %	0.00	.60	0.00	.60	0.00	.63
W % 975 °F+	0.00	45.74	0.00	59.10	0.00	58.50
W % SULFUR IN 975 °F+	0.00	1.03	0.00	.83	0.00	.90
W % NITROGEN IN 975 °F+	0.00	1.55	0.00	0.00	0.00	0.00

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 14 TO 22 FILTRATION OF HYDROCLONE UNDERFLOW WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS FROM RUN 130-82-16A AS PUSHER (TWO WEIGHTS OF HYDROCLONE UNDERFLOW PER ONE WEIGHT OF ATMOSPHERIC STILL BOTTOMS). DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. GRAVITY, SULFUR, AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HYDROCLONE UNDERFLOW.

‡ PERIODS 3AB, 11B, 17B, AND 19B ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	11 A	11 B	12 A	12 B	13 A	13 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	32.1	31.6	32.2	29.2	30.1	30.1
IBP, °F (ASTM D-86)	140.	140.	138.	144.	144.	144.
10 V %	220.	220.	212.	210.	212.	212.
30 V %	288.	288.	286.	310.	304.	304.
50 V %	348.	348.	350.	374.	366.	366.
70 V %	412.	412.	398.	420.	412.	412.
90 V %	480.	480.	462.	498.	482.	482.
FBP	556.	556.	514.	582.	548.	548.
V % @ 400 °F	68.00	68.00	71.00	62.00	66.00	66.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	100.00
CARBON, W %	0.00	85.70	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	11.42	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	.28	0.00	0.00	0.00	0.00
SULFUR (H2S FREE), W %	0.00	.29	0.00	0.00	0.00	0.00
IBP-400 °F						
GRAVITY, °API	39.4	39.8	37.9	37.1	36.8	36.8
SULFUR (H2S FREE), W %	0.00	.24	0.00	0.00	0.00	0.00
400 °F+						
GRAVITY, °API	17.2	18.2	18.4	18.0	18.0	18.0
SULFUR (H2S FREE), W %	0.00	.32	0.00	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.0	9.8	9.8	9.2	9.5	10.2
IBP, °F (ASTM D-86)	0.	409.	0.	454.	0.	446.
10 V %	0.	469.	0.	488.	0.	480.
30 V %	0.	509.	0.	524.	0.	514.
50 V %	0.	552.	0.	562.	0.	548.
70 V %	0.	600.	0.	610.	0.	594.
90 V %	0.	693.	0.	0.	0.	0.
FBP	0.	870.	0.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	83.00	0.00	81.00	0.00	84.00
CARBON, W %	0.00	88.41	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	8.74	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	.55	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	.10	0.00	.14	0.00	.17
IBP-650 °F						
GRAVITY, °API	0.0	11.3	0.0	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	0.0	2.3	0.0	0.0	0.0	0.0

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	11 A	11 B	12 A	12 B	13 A	13 B
WATER						
CARBON, W %	0.00	1.75	0.00	0.00	0.00	0.00
AMMONIA, W %	0.00	2.99	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	2.19	0.00	0.00	0.00	0.00
CLEAN OIL TANK						
GRAVITY, °API	0.0	7.5	0.0	7.3	0.0	10.0
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	0.0	316.0	0.0	3000.0	0.0	2340.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	2.9	3.5	2.6	2.6	8.4	9.6
IBP, °F (ASTM D-1160 MODIFIED)	0.	436.	0.	0.	0.	0.
10 V %	0.	519.	0.	0.	0.	0.
30 V %	0.	588.	0.	0.	0.	0.
50 V %	0.	649.	0.	0.	0.	0.
70 V %	0.	737.	0.	0.	0.	0.
90 V %	0.	790.	0.	0.	0.	0.
FBP	0.	930.	0.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	51.00	0.00	0.00	0.00	0.00
CARBON, W %	0.00	89.07	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	7.96	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	.71	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	.17	0.00	.23	0.00	.18
IBP-650 °F						
GRAVITY, °API	0.0	8.4	0.0	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	0.0	.5	0.0	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	11 A	11 B	12 A	12 B	13 A	13 B
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	63.16	64.26	64.73	69.41	86.97	83.86
TOLUENE SOLUBLE, W %	0.00	48.40	0.00	45.32	0.00	61.97
NON-ASH TOLUENE INSOLUBLE, W %	0.00	33.14	0.00	37.53	0.00	22.43
ASH, W %	0.00	18.46	0.00	17.15	0.00	15.60
UNREACTED COAL, W % (EST.)	0.00	10.76	0.00	9.69	0.00	9.41
TOLUENE INSOL. RESID. W % (EST.)	0.00	22.38	0.00	27.84	0.00	13.02
CARBON, W %	0.00	70.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	0.00	4.57	0.00	0.00	0.00	0.00
NITROGEN, W %	0.00	1.65	0.00	0.00	0.00	0.00
SULFUR, W %	0.00	2.22	0.00	2.15	0.00	2.04
ASTM ASH, W %	0.00	17.90	0.00	17.46	0.00	15.81
COKE/ASH RATIO (DMF EXTR.)	0.00	.84	0.00	.92	0.00	.83
DMF-SOLUBLE, W %	0.00	67.14	0.00	67.59	0.00	71.51
VISCOSITY, CP @ 500 °F *	0.0	3430.0	0.0	680.0	0.0	120.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	0.	751.	0.	0.	0.	0.
DISTILLATE TO 975 °F, W %	0.00	9.30	0.00	0.00	0.00	0.00
IBP-975 °F						
GRAVITY, °API	0.0	-8.5	0.0	0.0	0.0	0.0
HYDROCLONE OVERFLOW						
GRAVITY, °API	0.0	-16.5	0.0	-19.5	0.0	-19.3
IBP, °F (ASTM D-1160 MODIFIED)	0.	451.	0.	472.	0.	450.
10 V %	0.	574.	0.	581.	0.	565.
30 V %	0.	729.	0.	771.	0.	758.
50 V %	0.	0.	0.	0.	0.	0.
70 V %	0.	0.	0.	0.	0.	0.
END POINT	0.00	975.00	0.00	975.00	0.00	975.00
V % @ 650 °F	0.00	21.00	0.00	20.00	0.00	21.00
V % @ END POINT	0.00	49.75	0.00	49.25	0.00	48.75
ASH, W %	0.00	6.49	0.00	8.23	0.00	9.02
RESIDUE AND SOLIDS, W %	0.00	54.57	0.00	58.25	0.00	60.07
HYDROCLONE UNDERFLOW, ASH, W %	0.00	10.93	0.00	13.63	0.00	13.93
HYDROCLONE FEED, ASH W %	0.00	9.74	0.00	11.58	0.00	11.59
FILTER CAKE						
W % OF FEED TO FILTER	0.00	25.52	0.00	29.05	0.00	30.70
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	0.00	28.19	0.00	21.35	0.00	27.84
NON-ASH INSOLUBLE, W %	0.00	30.28	0.00	32.65	0.00	29.93
ASH, W %	0.00	41.53	0.00	46.00	0.00	42.23
INSOLUBLE RESID., W %	0.00	6.06	0.00	6.65	0.00	4.46
UNREACTED COAL, W % (EST.)	0.00	24.22	0.00	26.00	0.00	25.47
DMF - EXTRACTED CAKE						
ASH (OIL FREE), W %	0.00	54.26	0.00	52.02	0.00	54.76
O - 5 LIQUID						
GRAVITY, °API	11.7	11.8	12.0	11.9	11.7	11.5
O - 12 LIQUID						
GRAVITY, °API	0.0	12.0	0.0	12.5	0.0	10.9

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	11 A	11 B	12 A	12 B	13 A	13 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	0.00	445.00	0.00	475.00	0.00	475.00
PRESSURE, TORR	0.00	2.00	0.00	2.00	0.00	2.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	0.00	8.66	0.00	23.32	0.00	20.34
SULFUR, W %	0.00	.42	0.00	.30	0.00	.39
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	0.00	12.75	0.00	34.50	0.00	28.44
BATCH STILL RESID. FROM FILTRATE	0.00	87.25	0.00	65.50	0.00	71.56
CALCULATED COMPOSITION, W %						
SULFUR, W %	0.00	.95	0.00	.65	0.00	.76
CALCULATED COMPOSITION OF * 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD	0.00	20.00	0.00	31.02	0.00	32.77
ATMOSPHERIC STILL BOTTOMS	0.00	26.10	0.00	14.16	0.00	-41.31
NET VACUUM STILL OVERHEAD	0.00	-5.77	0.00	6.87	0.00	-7.77
VACUUM STILL BOTTOMS, SOLIDS FREE OIL: IBP-975 °F	0.00	0.00	0.00	34.37	0.00	47.59
975 °F+	0.00	59.67	0.00	13.58	0.00	68.72
CALCULATED COMPOSITION, W %						
SULFUR, W %	0.00	.68	0.00	.33	0.00	.80
SULFUR (ACTUAL), W %	0.00	.63	0.00	0.00	0.00	0.00
VISCOSITY (ACTUAL), SSU @ 250 °F	0.00	0.00	0.00	0.00	0.00	0.00

* THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 W% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-88
COAL ILLINOIS #6 (HRI 4004)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	11 A	11 B	12 A	12 B	13 A	13 B
OPERATING CONDITIONS						
HOURS OF RUN - BEGINNING	178.00	190.00	202.00	214.00	226.00	238.00
END	190.00	202.00	214.00	226.00	238.00	250.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	791.9	867.6	901.5	973.3	1052.0	1140.8
CATALYST ADDED, CUMULATIVE LBS/TON DRY COAL	1.07	1 00	1.01	.95	.90	.85
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	76.88	77 51	76.57	76.85	77.57	78.75
AVERAGE REACTOR TEMPERATURE, °F	840.	849.	849.	849.	848.	847.
UNIT BACKPRESSURE (UNIT BP), PSIG	2604.	2584.	2683.	2628.	2623.	2622.
H2 PARTIAL PRESSURE, PSIG	1858.	1744.	1895.	1650.	1662.	1666.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.69	1.77	1.66	1.48	1.55	1.56
H2 INLET RATE, MSCF/TON DRY COAL	34.90	35.60	36.87	33.59	33.85	34.04
RECYCLE GAS, MSCF/TON DRY COAL	19.58	20.90	21.26	20.95	21.70	22.31
YIELDS, WT% OF DRY COAL						
CO,CO2	0.00	.84	0.00	0.00	.34	.34
C1-C3 HYDROCARBONS IN GASES	0.00	5.37	0.00	0.00	7.11	7.11
C4-C7 HYDROCARBONS IN GASES	0.00	2.40	0.00	0.00	3.02	3.02
IBP-400 °F NAPHTHA	0.00	9.95	0.00	0.00	10.32	10.32
400-650 °F DISTILLATES	0.00	10.24	0.00	0.00	-1.64	-1.64
650-975 °F DISTILLATES	0.00	7.21	0.00	0.00	17.07	17.07
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	0.00	25.63	0.00	0.00	29.91	29.91
TOLUENE INSOLUBLE	0.00	15.21	0.00	0.00	10.50	10.50
UNCONVERTED COAL	0.00	7.31	0.00	0.00	7.50	7.50
ASH	0.00	12.55	0.00	0.00	12.52	12.52
H2O (NET)	0.00	4.35	0.00	0.00	4.44	4.44
NH3 (FORCED NITROGEN)	0.00	.21	0.00	0.00	.10	.10
H2S (FORCED SULFUR)	0.00	1.89	0.00	0.00	1.77	1.77
TOTAL	0.00	103.16	0.00	0.00	102.96	102.96
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	0.00	11.90	0.00	0.00	0.00	0.00
COMPOSITION OF 400 °F+ FUEL OIL, WT%**						
ATMOSPHERIC STILL OVERHEAD	0.00	26.00	0.00	31.02	0.00	32.77
ATMOSPHERIC STILL BOTTOMS	0.00	26.10	0.00	14.16	0.00	-41.31
NET VACUUM STILL OVERHEAD	0.00	-5.77	0.00	6.87	0.00	-7.77
VACUUM STILL BOTTOMS, SOLID FREE OIL: IBP-975 °F	0.00	0.00	0.00	34.37	0.00	47.59
975 °F+	0.00	59.67	0.00	13.58	0.00	68.72
SULFUR, WT%	0.00	.63	0.00	0.00	0.00	0.00
VISCOSITY, SSU @ 250 °F	0.00	0.00	0.00	0.00	0.00	0.00

** THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 W% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

UNIT 130 - H-COAL OPERATIONS ON ILLINOIS # 6 (HRI 4004)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830)
REACTOR VOLUME: 4.17 CUBIC FEET
RUN NUMBER 130- 88

PERIOD	14 A	14 B	14 AB	15 A	15 B	16 A
DATE (END OF PERIOD), 1979	7/19	7/20	7/20	7/20	7/20	7/21
HOURS OF RUN - BEGINNING	250.00	262.00	250.00	274.00	286.00	290.00
END	262.00	274.00	274.00	286.00	290.00	294.00
CATALYST INVENTORY, END, LBS	44.37	44.37	44.37	54.60	54.60	54.31
CATALYST ADDED, LBS	0.00	0.00	0.00	10.23	0.00	4.40
CATLYST WITHDRAWN, LBS *	0.00	0.00	0.00	0.00	0.00	4.69
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	1226.4	1313.1	1313.1	1127.0	1147.3	1065.9
ORIGINAL CHARGE (BASIS)	1592.2	1673.9	1678.9	1761.1	1771.4	1784.8
CATALYST ADDED, CUMULATIVE**						
LBS/TON DRY COAL	.81	.78	.79	.98	.97	1.06
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	0.00	0.00	0.00	0.00	9.48
OIL, W %	25.45	0.00	0.00	0.00	0.00	22.68
MOLYDENUM (OIL FREE), W % *	6.70	0.00	0.00	0.00	0.00	6.37
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	76.94	76.84	76.39	66.31	66.59	41.47
MOISTURE W % (COAL SAMPLE)	5.54	4.91	5.23	4.91	4.91	2.30
ASH,W% (DRY COAL)	0.00	11.09	11.09	0.00	11.09	0.00
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.64	.55	.60	.66	.72	1.07
VACUUM STILL OVERHEAD	.11	.09	.10	.13	.17	.76
INVENTORY CHANGE	.02	.03	.02	-.06	-.07	.58
HYDROCLONE OVERFLOW (OIL)	.72	.75	.74	.96	.86	1.35
MAKE-UP OIL	.09	0.00	.05	.11	0.00	0.00
TOTAL	1.55	1.37	1.46	1.92	1.81	2.60
TEMPERATURE, °F						
COAL PREHEATER OUTLET	787.	774.	780.	785.	767.	809.
REACTOR LIQUID PHASE, AVG.	849.	849.	849.	848.	772.	773.
MAX.	857.	859.	858.	852.	775.	775.
SEPARATOR-2" (@ 12" SKIN)	821.	805.	813.	806.	743.	742.
HYDROCLONE OVERFLOW	508.	502.	505.	506.	505.	475.
VACUUM STILL FLASH ZONE	521.	526.	523.	528.	524.	498.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2659.	2618.	2638.	2560.	2665.	2650.
HYDROGEN MAKE-UP, PSIG	2813.	2819.	2816.	2738.	2790.	2716.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1638.	1572.	1605.	1561.	1765.	1933.
VACUUM FLASH, TORR	69.	47.	58.	42.	47.	4.

* 9.95 W% MOLYBDENUM IN FRESH CATALYST.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

PERIOD	14 A	14 B	14 AB	15 A	15 B	16 A
RECYCLE GAS, MSCF/TON DRY COAL	23.31	21.16	22.24	27.45	27.98	40.20
VENT GAS, MSCF/TON DRY COAL	4.85	4.92	4.89	5.77	4.78	8.35
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	83.30	81.71	82.51	80.23	88.47	88.90
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	24.57	22.37	23.47	28.04	31.06	46.87
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	36.54	34.13	35.33	41.55	44.10	57.32
PARTIAL PRESSURE, PSIG(INLET)	2555.	2545.	2550.	2435.	2613.	2533.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	11.98	11.76	11.87	13.50	13.04	10.45
W % DRY COAL	3.18	3.12	3.15	3.58	3.46	2.77
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	.11	0.00	.05	.13	0.00	0.00
LBS/HR/CU FT REACTOR	8.33	0.00	4.17	8.63	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.002	.002	.002	.003	.003	.006
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	15.77	16.06	15.91	21.08	56.87	27.96
ATMOSPHERIC STILL BOTTOMS (2)	8.68	3.28	2.98	-5.42	-5.49	42.21
VACUUM STILL OVERHEAD (2)	.72	.68	.70	-.94	-1.25	30.35
VACUUM STILL BOTTOMS	73.92	63.02	68.47	82.42	97.72	75.75
HYDROCLONE UNDERFLOW	0.00	0.00	0.00	0.00	0.00	0.00
H2O	10.35	11.64	10.99	8.98	10.15	15.90
C1-C3	6.27	6.98	6.62	8.75	6.02	0.00
C4-C7	3.14	3.09	3.12	3.33	3.09	0.00
H2S IN GASES	8.88	2.48	2.68	2.88	2.69	0.00
CO2 & CO	1.11	1.13	1.12	1.43	.76	0.00
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	5.86	5.16	5.51	5.16	5.16	2.35
MAKE-UP OIL ADDITIONS	10.97	0.00	5.49	13.22	0.00	0.00
FLUSH OIL	.24	.24	.24	.29	.28	.56
HYDROGEN REACTED (1)	3.18	3.12	3.15	3.58	3.46	2.77
TOTAL	120.25	108.52	114.10	122.25	108.90	105.68
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	0.00	93.09	93.07	0.00	0.00	0.00
DMF CONVERSION (4)	0.00	89.77	89.77	0.00	90.62	0.00

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	14 A	14 B	14 AB	15 A	15 B	16 A
NORMALIZED NET PRODUCT DISTRIBUTION*!#						
W % OF DRY COAL						
CO, CO2	1.15	1.15	1.15	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	6.81	6.81	6.81	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	3.19	3.19	3.19	0.00	0.00	0.00
IBP-400 °F NAPHTHA	10.21	10.21	10.21	0.00	0.00	0.00
400-650 °F DISTILLATES	6.53	6.53	6.53	0.00	0.00	0.00
650-975 °F DISTILLATES	15.28	15.28	15.28	0.00	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	22.35	22.35	22.35	0.00	0.00	0.00
TOLUENE INSOLUBLE	12.59	12.59	12.59	0.00	0.00	0.00
UNCONVERTED COAL	6.73	6.73	6.73	0.00	0.00	0.00
ASH	12.11	12.11	12.11	0.00	0.00	0.00
H2O (NET)	5.28	5.28	5.28	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	.21	.21	.21	0.00	0.00	0.00
H2S (FORCED SULFUR)	1.87	1.87	1.87	0.00	0.00	0.00
TOTAL (100 + HYDROGEN REACTED)	103.31	103.31	103.31	0.00	0.00	0.00
FILTERED LIQUID**						
GRAVITY, °API	0.0	-12.1	-12.1	0.0	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	0.	527.	527.	0.	0.	0.
10 V %	0.	625.	625.	0.	0.	0.
30 V %	0.	700.	700.	0.	0.	0.
50 V %	0.	795.	795.	0.	0.	0.
70 V %	0.	0.	0.	0.	0.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	0.	975.	975.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	17.00	17.00	0.00	0.00	0.00
V % AT 975 °F	0.00	68.00	68.00	0.00	0.00	0.00
SULFUR, W %	0.00	.64	.64	0.00	0.00	0.00
W % 975 °F+	0.00	57.70	57.70	0.00	0.00	0.00
W % SULFUR IN 975 °F+	0.00	.70	.70	0.00	0.00	0.00
W % NITROGEN IN 975 °F+	0.00	1.37	1.87	0.00	0.00	0.00

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 14 TO 22 FILTRATION OF HYDROCLONE UNDERFLOW WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS FROM RUN 130-82-16A AS FLUSHER (TWO WEIGHTS OF HYDROCLONE UNDERFLOW PER ONE WEIGHT OF ATMOSPHERIC STILL BOTTOMS). DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. GRAVITY, SULFUR, AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HYDROCLONE UNDERFLOW.

! PERIODS 3AB,11B,17B,AND 19B ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	14 A	14 B	14 AB	15 A	15 B	16 A
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	29.7	29.7	29.7	29.2	29.2	25.1
IBP, °F (ASTM D-86)	140.	140.	140.	154.	154.	138.
10 V %	214.	214.	214.	232.	232.	280.
30 V %	310.	310.	310.	322.	322.	376.
50 V %	370.	370.	370.	376.	376.	420.
70 V %	410.	410.	410.	418.	418.	452.
90 V %	466.	466.	466.	468.	468.	492.
FBP	520.	520.	520.	520.	520.	540.
V % @ 400 °F	65.00	65.00	65.00	62.00	62.00	40.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	100.00
CARBON, W %	83.43	83.43	83.43	0.00	0.00	0.00
HYDROGEN, W %	11.12	11.12	11.12	0.00	0.00	0.00
NITROGEN, W %	.28	.28	.28	0.00	0.00	0.00
SULFUR (H2S FREE), W %	.27	.27	.30	0.00	0.00	0.00
IBP-400 °F						
GRAVITY, °API	0.0	36.4	36.4	36.1	36.1	34.9
SULFUR (H2S FREE), W %	.26	.26	.26	0.00	0.00	0.00
400 °F+						
GRAVITY, °API	0.0	18.8	18.8	18.9	18.9	19.0
SULFUR (H2S FREE), W %	.37	.37	.37	.20	.20	0.00
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.1	10.9	10.9	11.3	12.6	13.0
IBP, °F (ASTM D-86)	0.	444.	433.	0.	480.	0.
10 V %	0.	482.	469.	0.	504.	0.
30 V %	0.	516.	510.	0.	524.	0.
50 V %	0.	546.	543.	0.	546.	0.
70 V %	0.	590.	586.	0.	578.	0.
90 V %	0.	0.	704.	0.	674.	0.
FBP	0.	0.	905.	0.	730.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	85.00	87.00	0.00	88.00	0.00
CARBON, W %	0.00	100.00	87.03	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	9.07	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	.47	0.00	0.00	0.00
SULFUR, W %	0.00	.14	.19	0.00	.04	0.00
IBP-650 °F						
GRAVITY, °API	12.7	12.7	12.7	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	1.7	1.7	2.2	0.0	0.0	0.0

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	14 A	14 B	14 AB	15 A	15 B	16 A
WATER						
CARBON, W %	2.02	2.02	2.02	0.00	0.00	0.00
AMMONIA, W %	2.51	2.51	2.51	0.00	0.00	0.00
SULFUR, W %	1.65	1.65	1.65	0.00	0.00	0.00
CLEAN OIL TANK						
GRAVITY, °API	0.0	10.6	10.6	0.0	0.0	0.0
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	0.0	0.0	0.0	0.0	0.0	0.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	9.8	9.1	9.5	8.7	10.3	8.6
IBP, °F (ASTM D-1160 MODIFIED)	413.	0.	413.	0.	0.	0.
10 V %	480.	0.	480.	0.	0.	0.
30 V %	532.	0.	532.	0.	0.	0.
50 V %	569.	0.	569.	0.	0.	0.
70 V %	610.	0.	610.	0.	0.	0.
90 V %	680.	0.	680.	0.	0.	0.
FBP	750.	0.	750.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	87.00	0.00	87.00	0.00	0.00	0.00
CARBON, W %	86.91	0.00	86.91	0.00	0.00	0.00
HYDROGEN, W %	8.75	0.00	8.75	0.00	0.00	0.00
NITROGEN, W %	.56	0.00	.56	0.00	0.00	0.00
SULFUR, W %	.18	.18	.18	0.00	.09	0.00
IBP-650 °F						
GRAVITY, °API	10.6	10.6	10.6	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	2.9	2.9	2.9	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	14 A	14 B	14 AB	15 A	15 B	16 A
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	83.63	84.03	83.35	84.09	84.15	44.48
TOLUENE SOLUBLE, W %	0.00	55.35	55.35	0.00	0.00	0.00
NON-ASH TOLUENE INSOLUBLE, W %	0.00	27.45	27.45	0.00	0.00	0.00
ASH, W %	0.00	17.20	17.20	0.00	0.00	0.00
UNREACTED COAL, W % (EST.)	0.00	9.53	9.56	0.00	0.00	0.00
TOLUENE INSOL. RESID. W % (EST.)	0.00	17.92	17.89	0.00	0.00	0.00
CARBON, W %	71.04	71.04	71.04	0.00	0.00	0.00
HYDROGEN, W %	4.66	4.66	4.66	0.00	0.00	0.00
NITROGEN, W %	1.31	1.31	1.31	0.00	0.00	0.00
SULFUR, W %	2.17	2.17	2.18	0.00	2.12	0.00
ASTM ASH, W %	0.00	18.01	18.01	0.00	18.01	0.00
COKE/ASH RATIO (DMF EXTR.)	0.00	.82	.82	0.00	.75	0.00
DMF-SOLUBLE, W %	0.00	68.44	68.44	0.00	69.00	0.00
VISCOSITY, CP @ 500 °F *	0.0	0.0	0.0	0.0	0.0	0.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	623.	623.	623.	0.	0.	0.
DISTILLATE TO 975 °F, W %	23.60	23.60	22.60	0.00	0.00	0.00
IBP-975 °F						
GRAVITY, °API	-4.3	-4.3	-4.3	0.0	0.0	0.0
HYDROCLONE OVERFLOW						
GRAVITY, °API	-17.7	-22.2	-22.2	0.0	-9.9	0.0
IBP, °F (ASTM D-1160 MODIFIED)	0.	453.	453.	0.	470.	0.
10 V %	0.	572.	572.	0.	640.	0.
30 V %	0.	813.	813.	0.	612.	0.
50 V %	0.	0.	0.	0.	761.	0.
70 V %	0.	0.	0.	0.	0.	0.
END POINT	0.00	975.00	975.00	0.00	975.00	0.00
V % @ 650 °F	0.00	19.00	19.00	0.00	39.00	0.00
V % @ END POINT	0.00	42.00	42.00	0.00	66.00	0.00
ASH, W %	0.00	11.49	11.49	0.00	5.03	0.00
RESIDUE AND SOLIDS, W %	0.00	65.86	65.86	0.00	43.10	0.00
HYDROCLONE UNDERFLOW, ASH, W %	0.00	15.78	15.78	0.00	4.55	0.00
HYDROCLONE FEED, ASH W %	0.00	13.72	13.72	0.00	0.00	0.00
FILTER CAKE						
W % OF FEED TO FILTER	0.00	28.93	28.93	0.00	0.00	0.00
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	0.00	24.09	24.09	0.00	0.00	0.00
NON-ASH INSOLUBLE, W %	0.00	30.80	30.80	0.00	0.00	0.00
ASH, W %	0.00	45.11	45.11	0.00	0.00	0.00
INSOLUBLE RESID., W %	0.00	5.81	25.07	0.00	0.00	0.00
UNREACTED COAL, W % (EST.)	0.00	24.99	5.73	0.00	0.00	0.00
DMF - EXTRACTED CAKE						
ASH (OIL FREE), W %	0.00	54.94	54.94	0.00	0.00	0.00
0 - 5 LIQUID						
GRAVITY, °API	122.0	12.6	12.3	12.3	12.9	14.1
0 - 12 LIQUID						
GRAVITY, °API	0.0	12.9	9.4	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-88
COAL ILLINOIS #6 (HRI 4004)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	14 A	14 B	14 AB	15 A	15 B	16 A
OPERATING CONDITIONS						
HOURS OF RUN - BEGINNING	250.00	262.00	250.00	274.00	286.00	290.00
END	262.00	274.00	274.00	286.00	290.00	294.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	1226.4	1313.1	1313.1	1127.0	1147.3	1065.9
CATALYST ADDED, CUMULATIVE LBS/TON DRY COAL	.81	.78	.79	.98	.97	1.06
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	75.94	76.84	76.39	65.31	66.59	41.47
AVERAGE REACTOR TEMPERATURE, °F	849.	849.	849.	848.	772.	773.
UNIT BACKPRESSURE (UNIT BP), PSIG	2659.	2613.	2638.	2560.	2665.	2650.
H2 PARTIAL PRESSURE, PSIG	1638.	1572.	1605.	1561.	1765.	1933.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.55	1.37	1.46	1.92	1.81	2.60
H2 INLET RATE, MSCF/TON DRY COAL	36.54	34.13	35.33	41.55	44.10	57.32
RECYCLE GAS, MSCF/TON DRY COAL	23.31	21.16	22.24	27.45	27.98	40.20
YIELDS, WT% OF DRY COAL						
CO,CO2	1.15	1.15	1.15	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	6.81	6.81	6.81	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	3.19	3.19	3.19	0.00	0.00	0.00
IBP-400 °F NAPHTHA	10.21	10.21	10.21	0.00	0.00	0.00
400-650 °F DISTILLATES	5.53	5.53	5.53	0.00	0.00	0.00
650-975 °F DISTILLATES	15.28	15.28	15.28	0.00	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	22.35	22.35	22.35	0.00	0.00	0.00
TOLUENE INSOLUBLE	12.59	12.59	12.59	0.00	0.00	0.00
UNCONVERTED COAL	6.73	6.73	6.73	0.00	0.00	0.00
ASH	12.11	12.11	12.11	0.00	0.00	0.00
H2O (NET)	5.28	5.28	5.28	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	.21	.21	.21	0.00	0.00	0.00
H2S (FORCED SULFUR)	1.87	1.87	1.87	0.00	0.00	0.00
TOTAL	103.31	103.31	103.31	0.00	0.00	0.00
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	0.00	0.00	12.46	0.00	0.00	0.00
COMPOSITION OF 400 °F+ FUEL OIL, WT%**						
ATMOSPHERIC STILL OVERHEAD	18.20	18.20	18.20	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS	0.00	0.00	12.00	0.00	0.00	0.00
NET VACUUM STILL OVERHEAD	0.00	0.00	0.00	0.00	0.00	0.00
VACUUM STILL BOTTOMS, SOLID FREE OIL: IBP-975 °F	24.95	24.95	24.95	0.00	0.00	0.00
975 °F+	44.85	44.85	44.85	0.00	0.00	0.00
SULFUR, WT%	.54	.54	.54	0.00	0.00	0.00
VISCOSITY, SSU @ 250 °F	350.00	350.00	350.00	0.00	0.00	0.00

** THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 WT% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

UNIT 130 - H-COAL OPERATIONS ON ILLINOIS # 6 (HRI 4004)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830)
REACTOR VOLUME: 4.17 CUBIC FEET
RUN NUMBER 130- 88

PERIOD	16 B	17 A	17 B	18 A	18 B	19 A
DATE (END OF PERIOD), 1979	7/21	7/22	7/23	7/23	7/24	7/24
HOURS OF RUN - BEGINNING	294.00	306.00	318.00	330.00	342.00	354.00
END	306.00	318.00	330.00	342.00	354.00	366.00
CATALYST INVENTORY, END, LBS	54.31	54.06	54.06	54.86	54.86	54.73
CATALYST ADDED, LBS	0.00	2.98	0.00	4.21	0.00	3.06
CATLYST WITHDRAWN, LBS *	0.00	3.23	0.00	3.41	0.00	3.20
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	1124.1	1121.0	1181.6	1150.0	1201.1	1173.7
ORIGINAL CHARGE (BASIS)	1843.0	1903.2	1963.8	2026.7	2077.8	2119.4
CATALYST ADDED, CUMULATIVE**						
LBS/TON DRY COAL	1.03	1.05	1.02	1.07	1.04	2.76
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	6.42	0.00	6.89	0.00	6.59
OIL, W %	0.00	25.84	0.00	23.38	0.00	23.05
MOLYDENUM (OIL FREE), W % *	0.00	6.74	0.00	6.43	0.00	6.27
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	63.11	64.84	65.51	66.22	55.98	44.42
MOISTURE W % (COAL SAMPLE)	2.27	2.16	2.05	2.02	2.00	2.17
ASH,W% (DRY COAL)	11.40	0.00	11.00	0.00	11.20	0.00
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.68	.64	.55	.50	.47	.41
VACUUM STILL OVERHEAD	.19	.05	.19	.17	.28	.44
INVENTORY CHANGE	.09	-.07	.00	-.07	-.04	.05
HYDROCLONE OVERFLOW (OIL)	.86	.86	.90	.91	.97	1.08
MAKE-UP OIL	0.00	.00	.01	.00	.04	.02
TOTAL	1.65	1.63	1.64	1.64	1.79	1.89
TEMPERATURE, °F						
COAL PREHEATER OUTLET	804.	785.	803.	791.	797.	801.
REACTOR LIQUID PHASE, AVG.	839.	848.	847.	849.	841.	825.
MAX.	845.	856.	853.	855.	845.	830.
SEPARATOR-2" (@ 12" SKIN)	811.	810.	823.	805.	801.	791.
HYDROCLONE OVERFLOW	480.	489.	479.	473.	471.	469.
VACUUM STILL FLASH ZONE	510.	518.	506.	510.	522.	509.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2648.	2600.	2631.	2617.	2635.	2612.
HYDROGEN MAKE-UP, PSIG	2761.	2737.	2736.	2748.	2745.	2713.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1808.	1530.	1789.	1739.	1926.	1986.
VACUUM FLASH, TORR	36.	40.	38.	40.	9.	2.

* 9.95 W% MOLYBDENUM IN FRESH CATALYST.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

PERIOD	16 B	17 A	17 B	18 A	18 B	19 A
RECYCLE GAS, MSCF/TON DRY COAL	26.63	25.16	23.02	24.78	31.36	36.63
VENT GAS, MSCF/TON DRY COAL	4.07	3.62	4.36	5.60	7.0E	9.00
HYDROGEN PURITY						
OF RECYCLE GAS AND VENT, %	89.25	84.91	89.63	85.55	88.2E	89.30
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	29.78	26.09	27.09	27.30	35.81	43.28
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	40.76	38.75	38.12	39.55	47.72	56.37
PARTIAL PRESSURE, PSIG(INLET)	2585.	2506.	2589.	2533.	2562.	2550.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	10.99	12.66	11.03	12.25	11.91	13.09
W % DRY COAL	2.92	3.36	2.93	3.25	3.16	3.47
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	:00	.04	.02
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	.14	2.36	.88
FLUSH OIL,LBS/LB DRY COAL	.003	.003	.003	.003	.005	.005
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	18.17	20.24	20.64	17.01	16.92	18.82
ATMOSPHERIC STILL BOTTOMS (2)	8.20	-7.69	.54	-5.64	-2.32	3.32
VACUUM STILL OVERHEAD (2)	2.42	-.53	.29	-1.66	-1.36	3.94
VACUUM STILL BOTTOMS	67.30	63.78	77.12	44.47	68.84	73.87
HYDROCLONE UNDERFLOW	0.00	0.00	0.00	0.00	0.00	0.00
H2O	9.51	9.44	8.70	9.13	5.48	7.67
C1-C3	5.51	6.63	5.30	6.30	6.28	5.34
C4-C7	2.21	3.69	2.70	2.65	2.75	2.67
H2S IN GASES	2.28	3.35	2.49	2.72	2.53	2.29
CO2 & CO	.64	.91	.70	.88	.86	.70
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	2.32	2.21	2.09	2.06	2.04	2.22
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	.21	4.21	1.98
FLUSH OIL	.31	.30	.30	.29	.46	.48
HYDROGEN REACTED (1)	2.92	3.36	2.93	3.25	3.16	3.47
TOTAL	105.55	105.87	105.32	105.81	109.87	108.16
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	94.03	0.00	105.32	0.00	90.00	0.00
DMF CONVERSION (4)	90.13	0.00	90.18	0.00	89.47	0.00

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	16 B	17 A	17 B	18 A	18 B	19 A
NORMALIZED NET PRODUCT DISTRIBUTION*‡						
W % OF DRY COAL						
CO, CO2	0.00	0.00	.63	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	0.00	0.00	4.77	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	0.00	0.00	2.43	0.00	0.00	0.00
IBP-400 °F NAPHTHA	0.00	0.00	9.93	0.00	0.00	0.00
400-650 °F DISTILLATES	0.00	0.00	10.86	0.00	0.00	0.00
650-975 °F DISTILLATES	0.00	0.00	15.31	0.00	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	0.00	0.00	21.68	0.00	0.00	0.00
TOLUENE INSOLUBLE	0.00	0.00	12.43	0.00	0.00	0.00
UNCONVERTED COAL	0.00	0.00	6.78	0.00	0.00	0.00
ASH	0.00	0.00	10.71	0.00	0.00	0.00
H2O (NET)	0.00	0.00	5.23	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	0.00	0.00	.59	0.00	0.00	0.00
H2S (FORCED SULFUR)	0.00	0.00	2.22	0.00	0.00	0.00
TOTAL (100 + HYDROGEN REACTED)	0.00	0.00	103.56	0.00	0.00	0.00
FILTERED LIQUID**						
GRAVITY, °API	-11.9	0.0	-12.3	0.0	-7.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	546.	0.	567.	0.	444.	0.
10 V %	637.	0.	610.	0.	542.	0.
30 V %	699.	0.	677.	0.	696.	0.
50 V %	785.	0.	770.	0.	767.	0.
70 V %	0.	0.	963.	0.	859.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	975.	0.	975.	0.	975.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	14.00	0.00	22.00	0.00	43.00	0.00
V % AT 975 °F	70.00	0.00	71.00	0.00	80.00	0.00
SULFUR, W %	.60	0.00	.48	0.00	.56	0.00
W % 975 °F+	55.10	0.00	53.00	0.00	45.00	0.00
W % SULFUR IN 975 °F+	.75	0.00	.78	0.00	.83	0.00
W % NITROGEN IN 975 °F+	0.00	0.00	1.98	0.00	0.00	0.00

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 14 TO 22 FILTRATION OF HYDROCLONE UNDERFLOW WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS FROM RUN 130-82-16A AS PUSHER (TWO WEIGHTS OF HYDROCLONE UNDERFLOW PER ONE WEIGHT OF ATMOSPHERIC STILL BOTTOMS). DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. GRAVITY, SULFUR, AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HYDROCLONE UNDERFLOW.

‡ PERIODS 3AB,11B,17B,AND 19B ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	16 B	17 A	17 B	18 A	18 B	19 A
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	25.1	29.1	29.1	28.7	25.8	24.4
IBP, °F (ASTM D-86)	138.	150.	150.	148.	168.	164.
10 V %	280.	230.	230.	234.	292.	334.
30 V %	376.	326.	326.	336.	366.	384.
50 V %	420.	380.	380.	390.	402.	412.
70 V %	452.	430.	430.	430.	434.	444.
90 V %	492.	486.	486.	482.	486.	494.
FBP	540.	534.	534.	536.	540.	550.
V % @ 400 °F	40.00	56.00	56.00	55.00	49.00	40.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	100.00
CARBON, W %	0.00	0.00	86.11	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	11.19	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	.30	0.00	0.00	0.00
SULFUR (H2S FREE), W %	0.00	0.00	.23	0.00	0.00	0.00
IBP-400 °F						
GRAVITY, °API	34.9	0.0	35.6	37.6	33.0	31.4
SULFUR (H2S FREE), W %	0.00	0.00	0.00	0.00	0.00	0.00
400 °F+						
GRAVITY, °API	19.0	0.0	19.4	19.4	19.6	20.0
SULFUR (H2S FREE), W %	0.00	0.00	0.00	.13	.15	.14
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	12.5	11.2	12.4	11.5	12.3	12.5
IBP, °F (ASTM D-86)	462.	0.	476.	0.	486.	0.
10 V %	498.	0.	502.	0.	516.	0.
30 V %	526.	0.	528.	0.	542.	0.
50 V %	554.	0.	554.	0.	566.	0.
70 V %	592.	0.	588.	0.	602.	0.
90 V %	698.	0.	720.	0.	0.	0.
FBP	718.	0.	862.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	84.00	0.00	87.00	0.00	84.00	0.00
CARBON, W %	0.00	0.00	90.11	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	9.58	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	.48	0.00	0.00	0.00
SULFUR, W %	.02	0.00	.09	0.00	.10	0.00
IBP-650 °F						
GRAVITY, °API	0.0	0.0	13.7	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	0.0	0.0	4.6	0.0	0.0	0.0

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	16 B	17 A	17 B	18 A	18 B	19 A
WATER						
CARBON, W %	0.00	0.03	2.47	0.00	0.00	0.00
AMMONIA, W %	0.00	0.03	3.40	0.00	0.00	0.00
SULFUR, W %	0.00	0.03	2.27	0.00	0.00	0.00
CLEAN OIL TANK						
GRAVITY, °API	11.8	0.0	11.9	0.0	10.5	0.0
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	0.0	0.0	3470.0	0.0	435.0	0.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	7.3	8.0	9.8	9.9	7.7	8.5
IBP, °F (ASTM D-1160 MODIFIED)	0.	0.	442.	0.	0.	0.
10 V %	0.	0.	506.	0.	0.	0.
30 V %	0.	0.	541.	0.	0.	0.
50 V %	0.	0.	573.	0.	0.	0.
70 V %	0.	0.	612.	0.	0.	0.
90 V %	0.	0.	700.	0.	0.	0.
FBP	0.	0.	780.	0.	0.	0.
V % @ 400 °F	0.00	0.03	0.00	0.00	0.00	0.00
V % @ 650 °F	0.00	0.03	84.00	0.00	0.00	0.00
CARBON, W %	0.00	0.03	89.97	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.03	9.09	0.00	0.00	0.00
NITROGEN, W %	0.00	0.03	.47	0.00	0.00	0.00
SULFUR, W %	.03	0.03	.09	0.00	.18	0.00
IBP-650 °F						
GRAVITY, °API	0.0	0.0	11.1	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	0.0	0.0	5.1	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	16 B	17 A	17 B	18 A	18 B	19 A
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	74.90	90.96	78.05	69.78	68.32	58.34
TOLUENE SOLUBLE, W %	52.27	0.00	56.86	0.00	53.21	0.00
NON-ASH TOLUENE INSOLUBLE, W %	30.86	0.00	27.70	0.00	29.46	0.00
ASH, W %	16.87	0.00	15.44	0.00	17.33	0.00
UNREACTED COAL, W % (EST.)	7.83	0.00	9.78	0.00	13.74	0.00
TOLUENE INSOL. RESID. W % (EST.)	23.03	0.00	17.92	0.00	15.72	0.00
CARBON, W %	0.00	0.00	74.44	0.00	0.00	0.00
HYDROGEN, W %	0.00	0.00	5.22	0.00	0.00	0.00
NITROGEN, W %	0.00	0.00	1.26	0.00	0.00	0.00
SULFUR, W %	1.98	0.00	1.85	0.00	1.95	0.00
ASTM ASH. W %	17.30	0.00	15.95	0.00	18.23	0.00
COKE/ASH RATIO (DMF EXTR.)	.77	0.00	.79	0.00	.84	0.00
DMF-SOLUBLE, W %	71.52	0.00	72.15	0.00	67.56	0.00
VISCOSITY, CP @ 500 °F *	0.0	0.0	163.0	0.0	0.0	0.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	0.	0.	625.	0.	0.	0.
DISTILLATE TO 975 °F, W %	0.00	0.00	25.00	0.00	0.00	0.00
IBP-975 °F						
GRAVITY, °API	0.0	0.0	-1.9	0.0	0.0	0.0
HYDROCLONE OVERFLOW						
GRAVITY, °API	-14.0	0.0	-14.9	0.0	-12.3	0.0
IBP, °F (ASTM D-1160 MODIFIED)	497.	0.	487.	0.	494.	0.
10 V %	577.	0.	564.	0.	557.	0.
30 V %	673.	0.	677.	0.	642.	0.
50 V %	914.	0.	935.	0.	831.	0.
70 V %	0.	0.	0.	0.	0.	0.
END POINT	975.00	0.00	975.00	0.00	975.00	0.00
V % @ 650 °F	26.00	0.00	27.90	0.00	31.50	0.00
V % @ END POINT	56.00	0.00	54.90	0.00	59.90	0.00
ASH, W %	6.96	0.00	7.17	0.00	6.50	0.00
RESIDUE AND SOLIDS, W %	52.18	0.00	54.72	0.00	49.45	0.00
HYDROCLONE UNDERFLOW, ASH, W %	12.93	0.00	12.30	0.00	15.36	0.00
HYDROCLONE FEED, ASH W %	11.44	0.00	10.60	0.00	10.69	0.00
FILTER CAKE						
W % OF FEED TO FILTER	28.15	0.00	29.64	0.00	25.78	0.00
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	28.60	0.00	33.90	0.00	40.90	0.00
NON-ASH INSOLUBLE, W %	27.88	0.00	30.01	0.00	29.74	0.00
ASH, W %	43.52	0.00	36.09	0.00	29.36	0.00
INSOLUBLE RESID., W %	7.68	0.00	7.15	0.00	6.45	0.00
UNREACTED COAL, W % (EST.)	20.20	0.00	22.86	0.00	23.29	0.00
DMF - EXTRACTED CAKE						
ASH (OIL FREE), W %	56.60	0.00	55.73	0.00	54.50	0.00
O - 5 LIQUID						
GRAVITY, °API	13.2	12.5	13.2	13.7	13.8	14.3
O - 12 LIQUID						
GRAVITY, °API	16.3	0.0	15.7	0.0	18.5	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	16 B	17 A	17 B	18 A	18 B	19 A
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	465.00	0.00	495.00	0.00	490.00	0.00
PRESSURE, TORR	2.00	0.00	2.50	0.00	3.00	0.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	34.37	0.00	22.29	0.00	8.39	0.00
SULFUR, W %	.20	0.00	.36	0.00	.38	0.00
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	48.06	0.00	34.65	0.00	12.42	0.00
BATCH STILL RESID. FROM FILTRATE	51.94	0.00	65.35	0.00	87.58	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	.49	0.00	.63	0.00	.77	0.00
CALCULATED COMPOSITION OF * 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD	26.80	0.00	21.30	0.00	36.80	0.00
ATMOSPHERIC STILL BOTTOMS	20.00	0.00	1.90	0.00	-16.80	0.00
NET VACUUM STILL OVERHEAD	5.89	0.00	0.00	0.00	-6.20	0.00
VACUUM STILL BOTTOMS, SOLIDS FREE OIL: IBP-975 °F	42.43	0.00	38.30	0.00	56.20	0.00
975 °F+	4.88	0.00	38.50	0.00	30.00	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	.13	0.00	.46	0.00	.44	0.00
SULFUR (ACTUAL), W %	0.00	0.00	.39	0.00	0.00	0.00
VISCOSITY (ACTUAL), SSU @ 250 °F	0.00	0.00	220.00	0.00	0.00	0.00

* THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 W% FOR CASES WHERE SULFUR ANALYSIS I NOT AVAILABLE.

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-88
COAL ILLINOIS #6 (HRI 4004)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	16 B	17 A	17 B	18 A	18 B	19 A
OPERATING CONDITIONS						
HOURS OF RUN - BEGINNING	294.00	306.00	318.00	330.00	342.00	354.00
END	306.00	318.00	330.00	342.00	354.00	366.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	1124.1	1121.0	1181.6	1150.0	1201.1	1173.7
CATALYST ADDED, CUMULATIVE* LBS/TON DRY COAL	1.03	1.05	1.02	1.07	1.04	2.76
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	63.11	64.84	65.61	66.22	65.98	44.42
AVERAGE REACTOR TEMPERATURE, °F	839.	848.	847.	849.	841.	825.
UNIT BACKPRESSURE (UNIT BP), PSIG	2648.	2600.	2631.	2617.	2635.	2612.
H2 PARTIAL PRESSURE, PSIG	1808.	1530.	1789.	1739.	1926.	1986.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.65	1.63	1.64	1.64	1.79	1.89
H2 INLET RATE, MSCF/TON DRY COAL	40.76	38.75	38.12	39.55	47.72	66.37
RECYCLE GAS, MSCF/TON DRY COAL	26.53	25.16	23.02	24.78	31.36	36.63
YIELDS, WT% OF DRY COAL						
CO,CO2	0.00	0.00	.63	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	0.00	0.00	4.77	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	0.00	0.00	2.43	0.00	0.00	0.00
IBP-400 °F NAPHTHA	0.00	0.00	9.93	0.00	0.00	0.00
400-650 °F DISTILLATES	0.00	0.00	10.86	0.00	0.00	0.00
650-975 °F DISTILLATES	0.00	0.00	15.31	0.00	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	0.00	0.00	21.68	0.00	0.00	0.00
TOLUENE INSOLUBLE	0.00	0.00	12.43	0.00	0.00	0.00
UNCONVERTED COAL	0.00	0.00	6.78	0.00	0.00	0.00
ASH	0.00	0.00	10.71	0.00	0.00	0.00
H2O (NET)	0.00	0.00	5.23	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	0.00	0.00	.59	0.00	0.00	0.00
H2S (FORCED SULFUR)	0.00	0.00	2.22	0.00	0.00	0.00
TOTAL	0.00	0.00	103.56	0.00	0.00	0.00
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	0.00	0.00	13.42	0.00	0.00	0.00
COMPOSITION OF 400 °F+ FUEL OIL, WT%						
ATMOSPHERIC STILL OVERHEAD	26.80	0.00	21.30	0.00	36.80	0.00
ATMOSPHERIC STILL BOTTOMS	20.00	0.00	1.90	0.00	-16.80	0.00
NET VACUUM STILL OVERHEAD	5.89	0.00	0.00	0.00	-6.20	0.00
VACUUM STILL BOTTOMS, SOLID FREE OIL: IBP-975 °F	42.43	0.00	38.30	0.00	56.20	0.00
975 °F+	4.88	0.00	38.50	0.00	30.00	0.00
SULFUR, WT%	0.00	0.00	.39	0.00	0.00	0.00
VISCOSITY, SSU @ 250 °F	0.00	0.00	220.00	0.00	0.00	0.00

* CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

** THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 WX FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

UNIT 130 - H-COAL OPERATIONS ON ILLINOIS # 6 (HRI 4004)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3836)
REACTOR VOLUME: 4.17 CUBIC FEET
RUN NUMBER 130- 88

PERIOD	19 B	20 A	20 B	20 AB	21 A	21 B
DATE (END OF PERIOD), 1979	7/25	7/25	7/26	7/26	7/26	7/27
HOURS OF RUN - BEGINNING	366.00	378.00	390.00	378.00	402.00	414.00
END	378.00	390.00	402.00	402.00	414.00	426.00
CATALYST INVENTORY, END, LBS	54.73	48.89	48.89	48.89	53.21	53.21
CATALYST ADDED, LBS	0.00	0.00	0.00	0.00	6.34	0.00
CATLYST WITHDRAWN, LBS *	0.00	5.84	0.00	5.84	7.13	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	1221.6	1270.9	1320.2	1320.2	1096.2	1141.2
ORIGINAL CHARGE (BASIS)	2167.3	2216.6	2265.9	2265.9	2314.5	2359.5
CATALYST ADDED, CUMULATIVE**						
LBS/TON DRY COAL	1.26	.83	.63	.63	2.37	1.98
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	10.86	0.00	10.86	13.72	0.00
OIL, W %	0.00	23.24	0.00	23.24	21.98	0.00
MOLYDENUM (OIL FREE), W % *	0.00	6.97	0.00	6.97	6.63	0.00
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	52.40	50.32	48.18	49.25	49.32	47.80
MOISTURE W % (COAL SAMPLE)	2.35	2.06	1.98	2.02	1.84	1.71
ASH,W% (DRY COAL)	11.26	0.00	10.87	10.87	0.00	11.42
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.48	.39	.30	.34	.34	.40
VACUUM STILL OVERHEAD	.33	.31	.31	.31	.30	.37
INVENTORY CHANGE	.10	.00	-.01	-.01	-.04	.09
HYDROCLONE OVERFLOW (OIL)	.97	1.03	1.06	1.04	1.21	1.11
MAKE-UP OIL	.01	.02	.02	.02	.01	.06
TOTAL	1.69	1.75	1.70	1.72	1.90	1.85
TEMPERATURE, °F						
COAL PREHEATER OUTLET	798.	799.	796.	798.	794.	800.
REACTOR LIQUID PHASE, AVG.	848.	851.	848.	850.	848.	846.
MAX.	856.	857.	855.	856.	855.	853.
SEPARATOR-2" (@ 12" SKIN)	817.	810.	789.	800.	808.	814.
HYDROCLONE OVERFLOW	468.	469.	468.	468.	473.	470.
VACUUM STILL FLASH ZONE	527.	537.	531.	534.	523.	542.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2650.	2642.	2620.	2631.	2628.	2607.
HYDROGEN MAKE-UP, PSIG	2772.	2742.	2735.	2738.	2763.	2732.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1855.	1779.	1856.	1818.	1722.	1938.
VACUUM FLASH, TORR	3.	2.	3.	2.	3.	4.

* 9.95 W% MOLYBDENUM IN FRESH CATALYST.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

PERIOD	19 B	20 A	20 B	20 AB	21 A	21 B
RECYCLE GAS, MSCF/TON DRY COAL	30.74	32.89	34.06	33.47	34.09	34.68
VENT GAS, MSCF/TON DRY COAL	5.58	5.37	6.77	6.07	6.00	7.22
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	90.27	88.40	88.30	88.35	84.50	91.73
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	34.91	35.82	37.94	36.88	35.73	40.80
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	47.59	49.74	51.65	50.69	50.84	54.87
PARTIAL PRESSURE, PSIG(INLET)	2622.	2560.	2553.	2557.	2516.	2610.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	12.68	13.92	13.71	13.81	15.11	14.07
W % DRY COAL	3.36	3.69	3.64	3.67	4.01	3.74
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	.01	.02	.02	.02	.01	.07
LBS/HR/CU FT REACTOR	.72	.90	.98	.94	.58	3.43
FLUSH OIL,LBS/LB DRY COAL	.003	.004	.004	.004	.004	.005
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	19.25	27.27	30.79	29.03	21.08	14.97
ATMOSPHERIC STILL BOTTOMS (2)	7.57	.66	-.25	.21	.42	5.90
VACUUM STILL OVERHEAD (2)	5.12	.93	-.37	.28	1.92	5.54
VACUUM STILL BOTTOMS	55.68	52.82	54.66	53.74	62.27	57.11
HYDROCLONE UNDERFLOW	0.00	0.00	0.00	0.00	0.00	0.00
H2O	9.38	11.82	8.23	10.02	9.25	8.85
C1-C3	5.68	6.56	6.67	6.61	7.96	5.89
C4-C7	3.10	3.64	3.44	3.54	3.71	3.35
H2S IN GASES	2.94	2.94	2.86	2.90	2.90	2.66
CO2 & CO	.76	.78	.81	.80	.94	.48
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	2.41	2.10	2.02	2.06	1.87	1.74
MAKE-UP OIL ADDITIONS	1.37	1.79	2.03	1.91	1.17	7.17
FLUSH OIL	.34	.37	.41	.39	.39	.48
HYDROGEN REACTED (1)	3.36	3.69	3.64	3.67	4.01	3.74
TOTAL	107.48	107.92	108.06	108.01	107.44	113.13
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	91.91	0.00	94.63	94.63	0.00	93.01
DMF CONVERSION (4)	89.57	0.00	89.48	89.48	0.00	91.02

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	19 B	20 A	20 B	20 AB	21 A	21 B
NORMALIZED NET PRODUCT DISTRIBUTION*!$						
W % OF DRY COAL						
CO, CO2	.75	.83	.83	.82	.73	.73
C1-C3 HYDROCARBONS IN GASES	6.65	6.76	6.76	6.74	7.12	7.12
C4-C7 HYDROCARBONS IN GASES	3.07	3.69	3.69	3.68	3.62	3.62
IBP-400 °F NAPHTHA	7.34	12.95	12.95	12.93	7.32	7.32
400-650 °F DISTILLATES	20.31	16.99	16.99	16.92	13.85	13.85
650-975 °F DISTILLATES	8.29	3.86	3.86	3.99	7.43	7.43
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	16.85	21.83	21.83	21.68	22.93	22.93
TOLUENE INSOLUBLE	15.29	11.17	11.17	11.14	11.61	11.61
UNCONVERTED COAL	6.68	4.85	4.85	4.84	6.84	6.84
ASH	10.48	11.02	11.02	10.99	12.46	12.46
H2O (NET)	6.24	7.43	7.43	7.65	7.01	7.01
NH3 (FORCED NITROGEN)	.53	.58	.58	.59	.63	.63
H2S (FORCED SULFUR)	2.36	2.39	2.39	2.39	2.28	2.28
TOTAL (100 + HYDROGEN REACTED)	103.84	104.23	104.23	104.27	103.84	103.84
FILTERED LIQUID**						
GRAVITY, °API	-9.3	0.0	-9.4	-9.4	0.0	-6.4
IBP, °F (ASTM D-1160 MODIFIED)	481.	0.	454.	454.	0.	430.
10 V %	551.	0.	543.	543.	0.	538.
30 V %	613.	0.	615.	615.	0.	610.
50 V %	761.	0.	740.	740.	0.	713.
70 V %	920.	0.	910.	910.	0.	811.
90 V %	0.	0.	0.	0.	0.	0.
FBP	975.	0.	975.	975.	0.	975.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	33.00	0.00	40.50	40.50	0.00	41.00
V % AT 975 °F	75.00	0.00	76.00	76.00	0.00	80.00
SULFUR, W %	.55	0.00	.51	.51	0.00	.48
W % 975 °F+	49.86	0.00	48.70	48.70	0.00	39.14
W % SULFUR IN 975 °F+	.73	0.00	.70	.70	0.00	.68
W % NITROGEN IN 975 °F+	1.95	0.00	1.98	0.00	0.00	0.00

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 14 TO 22 FILTRATION OF HYDROCLONE UNDERFLOW WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS FROM RUN 130-82-16A AS PUSHER (TWO WEIGHTS OF HYDROCLONE UNDERFLOW PER ONE WEIGHT OF ATMOSPHERIC STILL BOTTOMS). DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. GRAVITY, SULFUR, AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HYDROCLONE UNDERFLOW.

! PERIODS 3AB,11B,17B,AND 19B ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

$ IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	19 B	20 A	20 B	20 AB	21 A	21 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	23.9	24.4	28.1	26.2	27.1	25.6
IBP, °F (ASTM D-86)	164.	166.	146.	156.	160.	154.
10 V %	334.	326.	236.	281.	244.	270.
30 V %	384.	386.	334.	360.	352.	366.
50 V %	412.	416.	406.	411.	418.	422.
70 V %	444.	454.	476.	465.	478.	476.
90 V %	494.	524.	550.	537.	560.	582.
FBP	550.	604.	638.	621.	634.	660.
V % @ 400 °F	40.00	39.00	47.00	43.00	44.00	41.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	97.00
CARBON, W %	86.06	0.00	86.66	86.66	86.88	86.88
HYDROGEN, W %	10.75	0.00	11.07	11.07	10.98	10.98
NITROGEN, W %	.37	0.00	.38	.38	.27	.27
SULFUR (H2S FREE), W %	.28	0.00	.26	.26	.22	.22
IBP-400 °F						
GRAVITY, °API	30.6	32.0	39.2	35.6	38.3	36.3
SULFUR (H2S FREE), W %	.25	0.00	.24	.24	0.00	0.00
400 °F+						
GRAVITY, °API	20.2	19.9	18.0	19.0	18.0	18.4
SULFUR (H2S FREE), W %	.02	.13	.14	.13	.16	.12
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	12.6	11.7	10.9	10.9	10.9	12.3
IBP, °F (ASTM D-86)	454.	0.	442.	442.	407.	407.
10 V %	501.	0.	508.	508.	489.	489.
30 V %	540.	0.	553.	553.	538.	538.
50 V %	576.	0.	596.	595.	576.	576.
70 V %	627.	0.	645.	645.	627.	627.
90 V %	781.	0.	774.	774.	766.	766.
FBP	893.	0.	928.	928.	890.	890.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	77.00	0.00	71.00	71.00	77.00	77.00
CARBON, W %	89.13	0.00	88.92	88.92	89.48	89.48
HYDROGEN, W %	9.37	0.00	9.21	9.21	9.48	9.48
NITROGEN, W %	.54	0.00	.57	.57	.56	.56
SULFUR, W %	.07	0.00	.14	.14	.13	.13
IBP-650 °F						
GRAVITY, °API	14.2	0.0	13.5	13.5	14.0	14.0
650 °F+						
GRAVITY, °API	6.4	0.0	4.7	4.7	1.9	1.9

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	19 B	20 A	20 B	20 AB	21 A	21 B
WATER						
CARBON, W %	1.83	0.00	1.95	1.95	1.93	1.93
AMMONIA, W %	3.47	0.00	2.61	2.61	3.60	3.60
SULFUR, W %	2.84	0.00	1.61	1.61	1.63	1.63
CLEAN OIL TANK						
GRAVITY, °API	10.4	0.0	8.4	8.4	0.0	8.2
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	309.0	0.0	0.0	0.0	0.0	0.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	7.3	0.0	17.3	6.0	5.3	5.7
IBP, °F (ASTM D-1160 MODIFIED)	450.	0.	450.	450.	446.	446.
10 V %	531.	0.	537.	5.	531.	531.
30 V %	578.	0.	600.	600.	590.	590.
50 V %	628.	0.	706.	706.	650.	650.
70 V %	740.	0.	768.	768.	777.	777.
90 V %	803.	0.	865.	865.	849.	849.
FBP	969.	0.	1000.	1000.	1030.	1030.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	57.00	0.00	48.00	48.00	50.00	50.00
CARBON, W %	89.09	0.00	89.37	89.37	89.57	89.57
HYDROGEN, W %	8.71	0.00	8.60	8.60	8.70	8.70
NITROGEN, W %	.65	0.00	.62	.62	.73	.73
SULFUR, W %	.15	0.00	.17	.16	.14	.14
IBP-650 °F						
GRAVITY, °API	11.7	0.0	11.1	11.1	10.9	10.9
650 °F+						
GRAVITY, °API	3.4	0.0	2.0	4.7	-1.9	-1.9

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	19 B	20 A	20 B	20 AB	21 A	21 B
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	62.05	58.14	59.30	59.30	61.47	56.82
TOLUENE SOLUBLE, W %	41.33	0.00	50.71	50.71	0.00	49.71
NON-ASH TOLUENE INSOLUBLE, W %	39.70	0.00	29.20	29.20	0.00	30.00
ASH, W %	18.97	0.00	20.09	20.09	0.00	20.29
UNREACTED COAL, W % (EST.)	12.09	0.00	8.84	8.84	0.00	11.00
TOLUENE INSOL. RESID. W % (EST.)	27.61	0.00	20.36	20.36	0.00	19.00
CARBON, W %	70.25	0.00	70.42	70.42	72.28	72.28
HYDROGEN, W %	4.61	0.00	4.49	4.49	4.63	4.63
NITROGEN, W %	1.52	0.00	1.50	1.50	1.34	1.34
SULFUR, W %	2.03	0.00	1.99	1.99	1.98	1.98
ASTM ASH, W %	19.63	0.00	20.80	20.80	0.00	20.53
COKE/ASH RATIO (DMF EXTR.)	.82	0.00	.86	.86	0.00	.70
DMF-SOLUBLE, W %	65.16	0.00	62.50	62.50	0.00	65.83
VISCOSITY, CP @ 500 °F *	0.0	0.0	0.0	0.0	0.0	0.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	738.	0.	714.	714.	723.	723.
DISTILLATE TO 975 °F, W %	9.10	0.00	10.70	11.10	12.45	12.45
IBP-975 °F						
GRAVITY, °API	-6.6	0.0	-3.7	-3.7	-8.4	-8.4
HYDROCLONE OVERFLOW						
GRAVITY, °API	-13.7	0.0	-14.9	-14.9	0.0	-12.8
IBP, °F (ASTM D-1160 MODIFIED)	469.	0.	462.	462.	0.	464.
10 V %	559.	0.	574.	574.	0.	572.
30 V %	664.	0.	690.	690.	0.	702.
50 V %	871.	0.	878.	878.	0.	855.
70 V %	0.	0.	0.	0.	0.	0.
END POINT	975.00	0.00	975.00	975.00	0.00	975.00
V % @ 650 °F	28.00	0.00	24.00	24.00	0.00	24.00
V % @ END POINT	58.20	0.00	57.75	57.75	0.00	61.00
ASH, W %	6.56	0.00	7.06	7.06	0.00	6.19
RESIDUE AND SOLIDS, W %	50.50	0.00	51.30	51.30	0.00	46.77
HYDROCLONE UNDERFLOW, ASH, W %	12.77	0.00	14.05	14.05	0.00	11.77
HYDROCLONE FEED, ASH W %	11.58	0.00	11.54	11.54	0.00	11.45
FILTER CAKE						
W % OF FEED TO FILTER	30.11	0.00	32.66	32.66	0.00	25.82
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	23.66	0.00	23.70	23.70	0.00	26.85
NON-ASH INSOLUBLE, W %	33.61	0.00	26.74	26.74	0.00	28.35
ASH, W %	42.73	0.00	52.82	52.82	0.00	44.80
INSOLUBLE RESID., W %	6.37	0.00	3.49	3.49	0.00	4.06
UNREACTED COAL, W % (EST.)	27.24	0.00	23.25	23.25	0.00	24.29
DMF - EXTRACTED CAKE						
ASH (OIL FREE), W %	54.88	0.00	53.68	53.68	0.00	58.94
O - 5 LIQUID						
GRAVITY, °API	13.9	13.6	13.2	13.4	14.3	14.3
O - 12 LIQUID						
GRAVITY, °API	17.2	6.6	6.0	17.3	0.0	17.6

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	19 B	20 A	20 B	20 AB	21 A	21 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	475.00	0.00	465.00	465.00	0.00	420.00
PRESSURE, TORR	3.00	0.00	3.00	3.00	0.00	3.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	9.35	0.00	7.60	7.60	0.00	5.08
SULFUR, W %	.38	0.00	.34	.34	0.00	.34
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	14.35	0.00	12.16	12.16	0.00	7.72
BATCH STILL RESID. FROM FILTRATE	85.65	0.00	87.84	87.84	0.00	92.28
CALCULATED COMPOSITION, W %						
SULFUR, W %	.68	0.00	.66	.66	0.00	.65
CALCULATED COMPOSITION OF * 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD	25.40	0.00	52.00	52.00	0.00	31.50
ATMOSPHERIC STILL BOTTOMS	22.18	0.00	0.00	0.00	0.00	20.40
NET VACUUM STILL OVERHEAD	15.00	0.00	0.00	0.00	0.00	9.00
VACUUM STILL BOTTOMS, SOLIDS FREE OIL: IBP-975 °F	4.42	0.00	1.60	1.60	0.00	0.00
975 °F+	33.00	0.00	46.40	46.40	0.00	39.10
CALCULATED COMPOSITION, W %						
SULFUR, W %	.33	0.00	.40	.40	0.00	.33
SULFUR (ACTUAL), W %	0.00	0.00	0.00	.36	40.00	.40
VISCOSITY (ACTUAL), SSU @ 250 °F	2500.*	0.00	0.00	0.00	180.00	180.00

* THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 W% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-88
COAL ILLINOIS #6 (HRI 4004)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	19 B	20 A	20 B	20 AB	21 A	21 B
OPERATING CONDITIONS						
HOURS OF RUN - BEGINNING	366.00	378.00	390.00	378.00	402.00	414.00
END	378.00	390.00	402.00	402.00	414.00	426.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	1221.6	1270.9	1320.2	1320.2	1096.2	1141.2
CATALYST ADDED, CUMULATIVE* LBS/TON DRY COAL	1.26	.83	.63	.63	2.37	1.98
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	52.40	50.32	48.18	49.25	49.32	47.80
AVERAGE REACTOR TEMPERATURE, °F	848.	851.	848.	850.	848.	846.
UNIT BACKPRESSURE (UNIT BP), PSIG	2650.	2642.	2620.	2631.	2628.	2607.
H2 PARTIAL PRESSURE, PSIG	1855.	1779.	1856.	1818.	1722.	1938.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.69	1.75	1.70	1.72	1.90	1.85
H2 INLET RATE, MSCF/TON DRY COAL	47.59	49.74	51.65	50.69	50.84	54.87
RECYCLE GAS, MSCF/TON DRY COAL	30.74	32.89	34.06	33.47	34.09	34.68
YIELDS, WT% OF DRY COAL						
CO,CO2	.75	.83	.83	.82	.73	.73
C1-C3 HYDROCARBONS IN GASES	6.65	6.76	6.76	6.74	7.12	7.12
C4-C7 HYDROCARBONS IN GASES	3.07	3.69	3.69	3.68	3.62	3.62
IBP-400 °F NAPHTHA	7.34	12.95	12.95	12.93	7.32	7.32
400-650 °F DISTILLATES	20.31	16.99	16.99	16.92	13.85	13.85
650-975 °F DISTILLATES	8.29	3.86	3.86	3.99	7.43	7.43
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	16.85	21.83	21.83	21.68	22.93	22.93
TOLUENE INSOLUBLE	15.29	11.17	11.17	11.14	11.61	11.61
UNCONVERTED COAL	6.68	4.85	4.85	4.84	6.84	6.84
ASH	10.48	11.02	11.02	10.99	12.46	12.46
H2O (NET)	6.24	7.43	7.43	7.65	7.01	7.01
NH3 (FORCED NITROGEN)	.53	.58	.58	.59	.63	.63
H2S (FORCED SULFUR)	2.36	2.39	2.39	2.39	2.28	2.28
TOTAL	103.84	104.23	104.23	104.27	103.84	103.84
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	14.48	0.00	0.00	16.10	0.00	0.00
COMPOSITION OF 400 °F+ FUEL OIL, WT%**						
ATMOSPHERIC STILL OVERHEAD	25.40	0.00	52.00	52.00	0.00	31.50
ATMOSPHERIC STILL BOTTOMS	22.18	0.00	0.00	0.00	0.00	20.40
NET VACUUM STILL OVERHEAD	15.00	0.00	0.00	0.00	0.00	9.00
VACUUM STILL BOTTOMS, SOLID FREE OIL: IBP-975 °F	4.42	0.00	1.60	1.60	0.00	0.00
975 °F+	33.00	0.00	46.40	46.40	0.00	39.10
SULFUR, WT%	0.00	0.00	0.00	.36	40.00	.40
VISCOSITY, SSU @ 250 °F	2500.*	0.00	0.00	0.00	180.00	180.00

* CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

** THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 WT% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

UNIT 130 - H-COAL OPERATIONS ON ILLINOIS # 6 (HRI 4004)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830)
REACTOR VOLUME: 4.17 CUBIC FEET
RUN NUMBER 130- 88

PERIOD	21 AB	22 A	22 B	23 A		
DATE (END OF PERIOD), 1979	7/27	7/27	7/28	7/28	0/ 0	0/ 0
HOURS OF RUN - BEGINNING	402.00	426.00	438.00	450.00	0.00	0.00
END	426.00	438.00	450.00	462.00	0.00	0.00
CATALYST INVENTORY, END, LBS	53.26	52.99	52.99	52.99	0.00	0.00
CATALYST ADDED, LBS	6.34	3.21	0.00	0.00	0.00	0.00
CATLYST WITHDRAWN, LBS *	7.13	3.43	0.00	0.00	0.00	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	1141.2	1115.6	1163.0	1210.1	0.0	0.0
ORIGINAL CHARGE (BASIS)	2359.5	2404.3	2451.7	2498.8	0.0	0.0
CATALYST ADDED, CUMULATIVE**						
LBS/TON DRY COAL	2.17	2.09	1.82	1.61	0.00	0.00
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	13.72	6.91	0.00	0.00	0.00	0.00
OIL, W %	21.98	24.16	0.00	23.51	0.00	0.00
MOLYDENUM (OIL FREE), W % *	6.63	6.51	0.00	0.00	0.00	0.00
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	48.56	47.13	50.18	49.86	0.00	0.00
MOISTURE W % (COAL SAMPLE)	1.78	2.51	2.72	2.72	0.00	0.00
ASH,W% (DRY COAL)	11.42	0.00	11.20	0.00	0.00	0.00
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.37	.40	.46	.51	0.00	0.00
VACUUM STILL OVERHEAD	.33	.16	0.00	0.00	0.00	0.00
INVENTORY CHANGE	.02	.21	.10	-.01	0.00	0.00
HYDROCLONE OVERFLOW (OIL)	1.16	1.14	1.00	1.05	0.00	0.00
MAKE-UP OIL	.04	.49	.23	.24	0.00	0.00
TOTAL	1.88	1.98	1.60	1.82	0.00	0.00
TEMPERATURE, °F						
COAL PREHEATER OUTLET	797.	781.	782.	772.	0.	0.
REACTOR LIQUID PHASE, AVG.	847.	847.	848.	848.	0.	0.
MAX.	854.	856.	858.	857.	0.	0.
SEPARATOR-2" (@ 12" SKIN)	811.	801.	786.	798.	0.	0.
HYDROCLONE OVERFLOW	471.	470.	467.	466.	0.	0.
VACUUM STILL FLASH ZONE	532.	512.	519.	520.	0.	0.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2617.	2618.	2637.	2629.	0.	0.
HYDROGEN MAKE-UP, PSIG	2747.	2761.	2772.	2753.	0.	0.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1830.	1895.	1912.	1770.	0.	0.
VACUUM FLASH, TORR	3.	278.	55.	99.	0.	0.

* 9.95 W% MOLYBDENUM IN FRESH CATALYST.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

PERIOD	21 AB	22 A	22 B	23 A		
RECYCLE GAS, MSCF/TON DRY COAL	34.39	35.91	34.37	33.19	0.00	0.00
VENT GAS, MSCF/TON DRY COAL	6.61	7.00	6.91	6.23	0.00	0.00
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	88.12	89.34	90.27	87.25	0.00	0.00
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	38.27	40.15	39.03	36.00	0.00	0.00
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	52.86	55.63	53.62	51.63	0.00	0.00
PARTIAL PRESSURE, PSIG(INLET)	2563.	2597.	2623.	2558.	0.	0.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	14.59	15.49	14.59	15.63	0.00	0.00
W % DRY COAL	3.87	4.11	3.87	4.15	0.00	0.00
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	.04	.58	.27	.28	0.00	0.00
LBS/HR/CU FT REACTOR	2.00	27.31	13.55	14.09	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.004	.004	.004	.004	0.000	0.000
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	18.02	30.65	27.54	27.63	0.00	0.00
ATMOSPHERIC STILL BOTTOMS (2)	3.16	18.11	11.99	-.98	0.00	0.00
VACUUM STILL OVERHEAD (2)	3.73	0.00	0.00	0.00	0.00	0.00
VACUUM STILL BOTTOMS	59.69	0.00	0.00	0.00	0.00	0.00
HYDROCLONE UNDERFLOW	0.00	94.93	73.16	82.24	0.00	0.00
H2O	9.05	7.87	8.76	12.57	0.00	0.00
C1-C3	6.92	6.25	6.66	6.92	0.00	0.00
C4-C7	3.63	3.62	3.33	3.77	0.00	0.00
H2S IN GASES	2.78	2.81	2.87	3.08	0.00	0.00
CO2 & CO	.71	.74	.75	.92	0.00	0.00
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.81	2.67	2.80	2.80	0.00	0.00
MAKE-UP OIL ADDITIONS	4.17	57.95	27.00	28.25	0.00	0.00
FLUSH OIL	.44	.40	.37	.36	0.00	0.00
HYDROGEN REACTED (1)	3.87	4.11	3.87	4.15	0.00	0.00
TOTAL	110.25	165.03	134.04	135.56	0.00	0.00
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	92.93	0.00	92.35	0.00	0.00	0.00
DMF CONVERSION (4)	91.02	0.00	91.05	0.00	0.00	0.00

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	21 AB	22 A	22 B	23 A		
NORMALIZED NET PRODUCT DISTRIBUTION*!$						
W % OF DRY COAL						
CO, CO2	.73	0.00	0.00	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	7.12	0.00	0.00	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	3.62	0.00	0.00	0.00	0.00	0.00
IBP-400 °F NAPHTHA	7.32	0.00	0.00	0.00	0.00	0.00
400-650 °F DISTILLATES	13.85	0.00	0.00	0.00	0.00	0.00
650-975 °F DISTILLATES	7.43	0.00	0.00	0.00	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	22.93	0.00	0.00	0.00	0.00	0.00
TOLUENE INSOLUBLE	11.61	0.00	0.00	0.00	0.00	0.00
UNCONVERTED COAL	6.84	0.00	0.00	0.00	0.00	0.00
ASH	12.46	0.00	0.00	0.00	0.00	0.00
H2O (NET)	7.01	0.00	0.00	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	.63	0.00	0.00	0.00	0.00	0.00
H2S (FORCED SULFUR)	2.28	0.00	0.00	0.00	0.00	0.00
TOTAL (100 + HYDROGEN REACTED)	103.84	0.00	0.00	0.00	0.00	0.00
FILTERED LIQUID**						
GRAVITY, °API	-6.4	0.0	-12.7	0.0	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	430.	0.	481.	0.	0.	0.
10 V %	638.	0.	649.	0.	0.	0.
30 V %	610.	0.	620.	0.	0.	0.
50 V %	713.	0.	750.	0.	0.	0.
70 V %	811.	0.	939.	0.	0.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	975.	0.	975.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	41.00	0.00	33.00	0.00	0.00	0.00
V % AT 975 °F	80.00	0.00	73.00	0.00	0.00	0.00
SULFUR, W %	.48	0.00	.40	0.00	0.00	0.00
W % 975 °F+	39.14	0.00	52.25	0.00	0.00	0.00
W % SULFUR IN 975 °F+	.68	0.00	.59	0.00	0.00	0.00
W % NITROGEN IN 975 °F+	1.94	0.00	0.00	0.00	0.00	0.00

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 14 TO 22 FILTRATION OF HYDROCLONE UNDERFLOW WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS FROM RUN 130-82-16A AS PUSHER (TWO WEIGHTS OF HYDROCLONE UNDERFLOW PER ONE WEIGHT OF ATMOSPHERIC STILL BOTTOMS). DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. GRAVITY, SULFUR, AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HYDROCLONE UNDERFLOW.

! PERIODS 3AB,11B,17B,AND 19B ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

$ IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	21 AB	22 A	22 B	23 A		
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	25.8	27.0	27.0	25.9	0.0	0.0
IBP, °F (ASTM D-86)	157.	170.	170.	162.	0.	0.
10 V %	257.	256.	256.	254.	0.	0.
30 V %	359.	332.	332.	334.	0.	0.
50 V %	420.	394.	394.	394.	0.	0.
70 V %	477.	454.	454.	436.	0.	0.
90 V %	671.	662.	662.	622.	0.	0.
FBP	647.	626.	626.	602.	0.	0.
V % @ 400 °F	42.50	52.00	52.00	53.00	0.00	0.00
V % @ 650 °F	98.50	100.00	100.00	100.00	0.00	0.00
CARBON, W %	86.08	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	10.98	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	.27	0.00	0.00	0.00	0.00	0.00
SULFUR (H2S FREE), W %	.22	0.00	0.00	0.00	0.00	0.00
IBP-400 °F						
GRAVITY, °API	37.3	36.2	36.2	35.4	0.0	0.0
SULFUR (H2S FREE), W %	0.00	0.00	0.00	0.00	0.00	0.00
400 °F+						
GRAVITY, °API	18.2	16.6	16.6	16.3	0.0	0.0
SULFUR (H2S FREE), W %	.14	.13	.13	.18	0.00	0.00
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	11.5	9.6	9.3	8.4	0.0	0.0
IBP, °F (ASTM D-86)	407.	0.	450.	0.	0.	0.
10 V %	489.	0.	478.	0.	0.	0.
30 V %	538.	0.	512.	0.	0.	0.
50 V %	576.	0.	550.	0.	0.	0.
70 V %	627.	0.	602.	0.	0.	0.
90 V %	766.	0.	0.	0.	0.	0.
FBP	890.	0.	0.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	77.00	0.00	81.00	0.00	0.00	0.00
CARBON, W %	89.48	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	9.48	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	.56	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	.13	0.00	.15	.06	0.00	0.00
IBP-650 °F						
GRAVITY, °API	14.0	0.0	0.0	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	1.9	0.0	0.0	0.0	0.0	0.0

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	21 AB	22 A	22 B	23 A		
WATER						
CARBON, W %	1.93	0.00	0.00	0.00	0.00	0.00
AMMONIA, W %	3.60	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	1.63	0.00	0.00	0.00	0.00	0.00
CLEAN OIL TANK						
GRAVITY, °API	8.2	0.0	2.6	0.0	0.0	0.0
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	0.0	0.0	0.0	0.0	0.0	0.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	0.0	5.9	5.4	29.2	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	446.	0.	0.	0.	0.	0.
10 V %	531.	0.	0.	0.	0.	0.
30 V %	590.	0.	0.	0.	0.	0.
50 V %	650.	0.	0.	0.	0.	0.
70 V %	770.	0.	0.	0.	0.	0.
90 V %	849.	0.	0.	0.	0.	0.
FBP	1030.	0.	0.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	50.00	0.00	0.00	0.00	0.00	0.00
CARBON, W %	89.97	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	9.09	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	.47	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	.14	0.00	.19	.06	0.00	0.00
IBP-650 °F						
GRAVITY, °API	10.9	0.0	0.0	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	-1.9	0.0	0.0	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	21 AB	22 A	22 B	23 A		
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	58.53	50.79	57.54	71.97	0.00	0.00
TOLUENE SOLUBLE, W %	49.71	0.00	55.02	0.00	0.00	0.00
NON-ASH TOLUENE INSOLUBLE, W %	30.00	0.00	23.89	0.00	0.00	0.00
ASH, W %	20.29	0.00	21.09	0.00	0.00	0.00
UNREACTED COAL, W % (EST.)	11.13	0.00	12.79	0.00	0.00	0.00
TOLUENE INSOL. RESID. W % (EST.)	18.87	0.00	11.10	0.00	0.00	0.00
CARBON, W %	72.28	0.00	0.00	0.00	0.00	0.00
HYDROGEN, W %	4.63	0.00	0.00	0.00	0.00	0.00
NITROGEN, W %	1.34	0.00	0.00	0.00	0.00	0.00
SULFUR, W %	1.96	0.00	2.09	0.00	0.00	0.00
ASTM ASH, W %	20.53	0.00	21.78	0.00	0.00	0.00
COKE/ASH RATIO (DMF EXTR.)	.70	0.00	.71	0.00	0.00	0.00
DMF-SOLUBLE, W %	65.83	0.00	63.81	0.00	0.00	0.00
VISCOSITY, CP @ 500 °F *	0.0	0.0	0.0	0.0	0.0	0.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	723.	0.	0.	0.	0.	0.
DISTILLATE TO 975 °F, W %	12.00	0.00	0.00	0.00	0.00	0.00
IBP-975 °F						
GRAVITY, °API	-8.4	0.0	0.0	0.0	0.0	0.0
HYDROCLONE OVERFLOW						
GRAVITY, °API	-12.8	0.0	-14.9	0.0	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	464.	0.	454.	0.	0.	0.
10 V %	572.	0.	553.	0.	0.	0.
30 V %	702.	0.	666.	0.	0.	0.
50 V %	855.	0.	856.	0.	0.	0.
70 V %	0.	0.	0.	0.	0.	0.
END POINT	975.00	0.00	975.00	0.00	0.00	0.00
V % @ 650 °F	24.00	0.00	27.90	0.00	0.00	0.00
V % @ END POINT	61.00	0.00	59.40	0.00	0.00	0.00
ASH, W %	6.19	0.00	7.20	0.00	0.00	0.00
RESIDUE AND SOLIDS, W %	46.77	0.00	48.95	0.00	0.00	0.00
HYDROCLONE UNDERFLOW, ASH, W %	11.77	0.00	13.76	0.00	0.00	0.00
HYDROCLONE FEED, ASH W %	11.45	0.00	10.38	0.00	0.00	0.00
FILTER CAKE						
W % OF FEED TO FILTER	0.00	0.00	27.79	0.00	0.00	0.00
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	26.85	0.00	25.92	0.00	0.00	0.00
NON-ASH INSOLUBLE, W %	28.35	0.00	29.36	0.00	0.00	0.00
ASH, W %	44.80	0.00	44.72	0.00	0.00	0.00
INSOLUBLE RESID., W %	3.77	0.00	2.23	0.00	0.00	0.00
UNREACTED COAL, W % (EST.)	24.58	0.00	27.13	0.00	0.00	0.00
DMF - EXTRACTED CAKE						
ASH (OIL FREE), W %	58.94	0.00	58.50	0.00	0.00	0.00
O - 5 LIQUID						
GRAVITY, °API	14.3	12.2	11.8	10.7	0.0	0.0
O - 12 LIQUID						
GRAVITY, °API	5.6	0.0	15.0	13.6	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	21 AB	22 A	22 B	23 A		
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	420.00	0.00	430.00	0.00	0.00	0.00
PRESSURE, TORR	3.00	0.00	2.50	0.00	0.00	0.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	5.08	0.00	6.44	0.00	0.00	0.00
SULFUR, W %	.34	0.00	.29	0.00	0.00	0.00
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	18.23	0.00	10.09	0.00	0.00	0.00
BATCH STILL RESID. FROM FILTRATE	81.77	0.00	89.91	0.00	0.00	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	.62	0.00	.56	0.00	0.00	0.00
CALCULATED COMPOSITION OF * 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD	39.50	0.00	0.00	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS	11.30	0.00	0.00	0.00	0.00	0.00
NET VACUUM STILL OVERHEAD	6.60	0.00	0.00	0.00	0.00	0.00
VACUUM STILL BOTTOMS, SOLIDS FREE OIL: IBP-975 °F	0.00	0.00	0.00	0.00	0.00	0.00
975 °F+	42.60	0.00	0.00	0.00	0.00	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	.36	0.00	0.00	0.00	0.00	0.00
SULFUR (ACTUAL), W %	.40	0.00	0.00	0.00	0.00	0.00
VISCOSITY (ACTUAL), SSU @ 250 °F	180.00	0.00	0.00	0.00	0.00	0.00

* THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.6 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 W% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-88
COAL ILLINOIS #6 (HRI 4004)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	21 AB	22 A	22 B	23 A
OPERATING CONDITIONS				
HOURS OF RUN - BEGINNING	402.00	426.00	438.00	450.00
END	426.00	438.00	450.00	462.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	1141.2	1115.6	1163.0	1210.1
CATALYST ADDED, CUMULATIVE* LBS/TON DRY COAL	2.17	2.09	1.82	1.61
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	48.56	47.13	50.18	49.86
AVERAGE REACTOR TEMPERATURE, °F	847.	847.	848.	848.
UNIT BACKPRESSURE (UNIT BP), PSIG	2617.	2618.	2637.	2629.
H2 PARTIAL PRESSURE, PSIG	1830.	1895.	1912.	1770.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.88	1.98	1.60	1.82
H2 INLET RATE, MSCF/TON DRY COAL	52.86	55.63	53.62	51.63
RECYCLE GAS, MSCF/TON DRY COAL	34.39	35.91	34.37	33.19
YIELDS, WT% OF DRY COAL				
CO,CO2	.73	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	7.12	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	3.62	0.00	0.00	0.00
IBP-400 °F NAPHTHA	7.32	0.00	0.00	0.00
400-650 °F DISTILLATES	13.85	0.00	0.00	0.00
650-975 °F DISTILLATES	7.43	0.00	0.00	0.00
975 °F+ RESIDUAL OIL				
TOLUENE SOLUBLE	22.93	0.00	0.00	0.00
TOLUENE INSOLUBLE	11.51	0.00	0.00	0.00
UNCONVERTED COAL	6.34	0.00	0.00	0.00
ASH	12.46	0.00	0.00	0.00
H2O (NET)	7.01	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	.63	0.00	0.00	0.00
H2S (FORCED SULFUR)	2.28	0.00	0.00	0.00
TOTAL	103.84	0.00	0.00	0.00
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	14.45	0.00	0.00	0.00
COMPOSITION OF 400 °F+ FUEL OIL, WT%**				
ATMOSPHERIC STILL OVERHEAD	39.50	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS	11.30	0.00	0.00	0.00
NET VACUUM STILL OVERHEAD	6.60	0.00	0.00	0.00
VACUUM STILL BOTTOMS, SOLID FREE OIL: IBP-975 °F	0.00	0.00	0.00	0.00
975 °F+	42.60	0.00	0.00	0.00
SULFUR, WT%	.40	0.00	0.00	0.00
VISCOSITY, SSU @ 250 °F	180.00	0.00	0.00	0.00

* CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

** THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 WX FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

UNIT 130 - H-COAL OPERATIONS ON ILLINOIS # 6 (HRI 4004)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830)
REACTOR VOLUME: 4.17 CUBIC FEET
RUN NUMBER 130- 88

PERIOD	3 AB	11 3	20 AB			
DATE (END OF PERIOD), 1979	7/ 4	7/17	7/26	0/ 0	0/ 0	0/ 0
HOURS OF RUN - BEGINNING	28.00	190.00	378.00	0.00	0.00	0.00
END	52.00	202.00	402.00	0.00	0.00	0.00
CATALYST INVENTORY, END, LBS	50.81	51.27	48.89	0.00	0.00	0.00
CATALYST ADDED, LBS	3.94	0.00	0.00	0.00	0.00	0.00
CATLYST WITHDRAWN, LBS *	4.28	0.00	5.84	0.00	0.00	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	274.2	867.6	1320.2	0.0	0.0	0.0
ORIGINAL CHARGE (BASIS)	288.4	1193.0	2265.9	0.0	0.0	0.0
CATALYST ADDED, CUMULATIVE**						
LBS/TON DRY COAL	.54	1.00	.63	0.00	0.00	0.00
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	8.53	0.00	10.86	0.00	0.00	0.00
OIL, W %	31.21	0.00	23.24	0.00	0.00	0.00
MOLYDENUM (OIL FREE), W % *	7.26	0.00	6.97	0.00	0.00	0.00
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	74.69	77.51	49.25	0.00	0.00	0.00
MOISTURE W % (COAL SAMPLE)	3.60	4.48	2.02	0.00	0.00	0.00
ASH,W% (DRY COAL)	10.84	10.87	10.87	0.00	0.00	0.00
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.76	.52	.34	0.00	0.00	0.00
VACUUM STILL OVERHEAD	.35	.33	.31	0.00	0.00	0.00
INVENTORY CHANGE	.05	-.65	-.01	0.00	0.00	0.00
HYDROCLONE OVERFLOW (OIL)	.86	.88	1.04	0.00	0.00	0.00
MAKE-UP OIL	0.00	0.60	.02	0.00	0.00	0.00
TOTAL	1.92	1.77	1.72	0.00	0.00	0.00
TEMPERATURE, °F						
COAL PREHEATER OUTLET	734.	788.	798.	0.	0.	0.
REACTOR LIQUID PHASE, AVG.	846.	849.	850.	0.	0.	0.
MAX.	860.	857.	856.	0.	0.	0.
SEPARATOR-2" (@ 12" SKIN)	829.	825.	800.	0.	0.	0.
HYDROCLONE OVERFLOW	499.	506.	468.	0.	0.	0.
VACUUM STILL FLASH ZONE	521.	514.	534.	0.	0.	0.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2688.	2584.	2631.	0.	0.	0.
HYDROGEN MAKE-UP, PSIG	2815.	2727.	2738.	0.	0.	0.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1750.	1744.	1818.	0.	0.	0.
VACUUM FLASH, TORR	4.	3.	2.	0.	0.	0.

* 9.95 W% MOLYBDENUM IN FRESH CATALYST.

** CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

PERIOD	3 AB	11 B	20 AB			
RECYCLE GAS, MSCF/TON DRY COAL	21.60	20.90	33.47	0.00	0.00	0.00
VENT GAS, MSCF/TON DRY COAL	4.39	3.89	6.07	0.00	0.00	0.00
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	85.99	88.06	88.35	0.00	0.00	0.00
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	24.29	24.16	36.88	0.00	0.00	0.00
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	36.56	35.60	50.69	0.00	0.00	0.00
PARTIAL PRESSURE, PSIG(INLET)	2614.	2552.	2557.	0.	0.	0.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	12.26	11.44	13.81	0.00	0.00	0.00
W % DRY COAL	3.26	3.04	3.67	0.00	0.00	0.00
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	.02	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	.94	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.002	.002	.004	0.000	0.000	0.000
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	20.04	14.89	29.03	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS (2)	4.36	7.27	.21	0.00	0.00	0.00
VACUUM STILL OVERHEAD (2)	2.26	-2.13	.28	0.00	0.00	0.00
VACUUM STILL BOTTOMS	58.11	66.84	53.74	0.00	0.00	0.00
HYDROCLONE UNDERFLOW	0.00	0.00	0.00	0.00	0.00	0.00
H2O	10.42	9.43	10.02	0.00	0.00	0.00
C1-C3	6.47	5.28	6.61	0.00	0.00	0.00
C4-C7	2.88	2.34	3.54	0.00	0.00	0.00
H2S IN GASES	2.32	2.24	2.90	0.00	0.00	0.00
CO2 & CO	.78	.84	.80	0.00	0.00	0.00
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	3.73	4.69	2.06	0.00	0.00	0.00
MAKE-UP OIL ADDITIONS	0.00	0.00	1.91	0.00	0.00	0.00
FLUSH OIL	.25	.25	.39	0.00	0.00	0.00
HYDROGEN REACTED (1)	3.26	3.04	3.67	0.00	0.00	0.00
TOTAL	107.24	107.98	108.01	0.00	0.00	0.00
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	93.17	92.89	94.63	0.00	0.00	0.00
DMF CONVERSION (4)	91.78	89.72	89.48	0.00	0.00	0.00

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	3 AB	11 B	20 AB			
NORMALIZED NET PRODUCT DISTRIBUTION*!#						
W % OF DRY COAL						
CO, CO2	.79	.84	.82	0.00	0.00	0.00
C1-C3 HYDROCARBONS IN GASES	6.66	5.37	6.74	0.00	0.00	0.00
C4-C7 HYDROCARBONS IN GASES	2.92	2.40	3.68	0.00	0.00	0.00
IBP-400 °F NAPHTHA	13.69	9.95	12.93	0.00	0.00	0.00
400-650 °F DISTILLATES	11.68	10.24	16.92	0.00	0.00	0.00
650-975 °F DISTILLATES	10.08	7.21	3.99	0.00	0.00	0.00
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	23.98	25.63	21.68	0.00	0.00	0.00
TOLUENE INSOLUBLE	8.09	15.21	11.14	0.00	0.00	0.00
UNCONVERTED COAL	6.58	7.31	4.84	0.00	0.00	0.00
ASH	11.67	12.55	10.99	0.00	0.00	0.00
H2O (NET)	5.96	4.35	7.65	0.00	0.00	0.00
NH3 (FORCED NITROGEN)	.29	.21	.59	0.00	0.00	0.00
H2S (FORCED SULFUR)	2.03	1.89	2.39	0.00	0.00	0.00
TOTAL (100 + HYDROGEN REACTED)	104.21	103.16	104.27	0.00	0.00	0.00
FILTERED LIQUID**						
GRAVITY, °API	-8.5	-11.7	-9.4	0.0	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	518.	520.	454.	0.	0.	0.
10 V %	642.	619.	543.	0.	0.	0.
30 V %	723.	718.	615.	0.	0.	0.
50 V %	860.	905.	740.	0.	0.	0.
70 V %	0.	0.	910.	0.	0.	0.
90 V %	0.	0.	0.	0.	0.	0.
FBP	975.	975.	975.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	12.00	15.00	40.50	0.00	0.00	0.00
V % AT 975 °F	60.00	56.00	76.00	0.00	0.00	0.00
SULFUR, W %	.27	.60	.51	0.00	0.00	0.00
W % 975 °F+	43.65	46.74	48.70	0.00	0.00	0.00
W % SULFUR IN 975 °F+	.59	1.03	.70	0.00	0.00	0.00
W % NITROGEN IN 975 °F+	1.86	1.55	0.00	0.00	0.00	0.00

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 14 TO 22 FILTRATION OF HYDROCLONE UNDERFLOW WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS FROM RUN 130-82-16A AS PUSHER (TWO WEIGHTS OF HYDROCLONE UNDERFLOW PER ONE WEIGHT OF ATMOSPHERIC STILL BOTTOMS). DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. GRAVITY, SULFUR, AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HYDROCLONE UNDERFLOW.

! PERIODS 3AB,11B,17B,AND 19B ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	3 AB	11 B	20 AB			
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	32.6	31.6	26.2	0.0	0.0	0.0
IBP, °F (ASTM D-86)	139.	140.	156.	0.	0.	0.
10 V %	214.	220.	281.	0.	0.	0.
30 V %	288.	288.	360.	0.	0.	0.
50 V %	352.	348.	411.	0.	0.	0.
70 V %	404.	412.	465.	0.	0.	0.
90 V %	446.	480.	537.	0.	0.	0.
FBP	621.	656.	621.	0.	0.	0.
V % @ 400 °F	69.00	68.00	43.00	0.00	0.00	0.00
V % @ 650 °F	100.00	100.00	100.00	0.00	0.00	0.00
CARBON, W %	87.66	85.70	86.66	0.00	0.00	0.00
HYDROGEN, W %	11.73	11.42	11.07	0.00	0.00	0.00
NITROGEN, W %	.24	.28	.38	0.00	0.00	0.00
SULFUR (H2S FREE), W %	.13	.29	.26	0.00	0.00	0.00
IBP-400 °F						
GRAVITY, °API	38.2	39.8	35.6	0.0	0.0	0.0
SULFUR (H2S FREE), W %	.09	.24	.24	0.00	0.00	0.00
400 °F+						
GRAVITY, °API	19.4	18.2	19.0	0.0	0.0	0.0
SULFUR (H2S FREE), W %	.27	.32	.13	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	11.1	9.8	10.9	0.0	0.0	0.0
IBP, °F (ASTM D-86)	401.	409.	442.	0.	0.	0.
10 V %	454.	469.	508.	0.	0.	0.
30 V %	499.	509.	553.	0.	0.	0.
50 V %	541.	552.	595.	0.	0.	0.
70 V %	587.	600.	645.	0.	0.	0.
90 V %	680.	693.	774.	0.	0.	0.
FBP	850.	870.	928.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	87.00	83.00	71.00	0.00	0.00	0.00
CARBON, W %	89.86	88.41	88.92	0.00	0.00	0.00
HYDROGEN, W %	9.19	8.74	9.21	0.00	0.00	0.00
NITROGEN, W %	.40	.65	.57	0.00	0.00	0.00
SULFUR, W %	<.03	.10	.14	0.00	0.00	0.00
IBP-650 °F						
GRAVITY, °API	11.2	11.3	13.6	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	1.6	2.3	4.7	0.0	0.0	0.0

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	3 AB	11 B	20 AB			
WATER						
CARBON, W %	2.07	1.75	1.95	0.00	0.00	0.00
AMMONIA, W %	4.45	2.99	2.61	0.00	0.00	0.00
SULFUR, W %	3.02	2.19	1.61	0.00	0.00	0.00
CLEAN OIL TANK						
GRAVITY, °API	9.0	7.5	8.4	0.0	0.0	0.0
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	0.0	316.0	0.0	0.0	0.0	0.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	4.2	3.5	6.0	0.0	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	468.	436.	450.	0.	0.	0.
10 V %	512.	519.	5.	0.	0.	0.
30 V %	585.	588.	600.	0.	0.	0.
50 V %	643.	649.	706.	0.	0.	0.
70 V %	705.	737.	768.	0.	0.	0.
90 V %	824.	790.	865.	0.	0.	0.
FBP	915.	930.	1000.	0.	0.	0.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	54.00	51.00	48.00	0.00	0.00	0.00
CARBON, W %	89.65	89.07	89.37	0.00	0.00	0.00
HYDROGEN, W %	8.25	7.96	8.60	0.00	0.00	0.00
NITROGEN, W %	.93	.71	.62	0.00	0.00	0.00
SULFUR, W %	.07	.17	.16	0.00	0.00	0.00
IBP-650 °F						
GRAVITY, °API	8.7	8.4	11.1	0.0	0.0	0.0
650 °F+						
GRAVITY, °API	.1	.5	4.7	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	3 AB	11 B	20 AB			
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	69.85	64.26	59.30	0.00	0.00	0.00
TOLUENE SOLUBLE, W %	55.27	48.40	50.71	0.00	0.00	0.00
NON-ASH TOLUENE INSOLUBLE, W %	24.92	33.14	29.20	0.00	0.00	0.00
ASH, W %	19.81	18.46	20.09	0.00	0.00	0.00
UNREACTED COAL, W % (EST.)	11.13	10.76	8.84	0.00	0.00	0.00
TOLUENE INSOL. RESID. W % (EST.)	13.79	22.38	20.36	0.00	0.00	0.00
CARBON, W %	70.16	70.00	70.42	0.00	0.00	0.00
HYDROGEN, W %	4.73	4.57	4.49	0.00	0.00	0.00
NITROGEN, W %	1.32	1.65	1.50	0.00	0.00	0.00
SULFUR, W %	2.22	2.22	1.99	0.00	0.00	0.00
ASTM ASH, W %	19.34	17.90	20.80	0.00	0.00	0.00
COKE/ASH RATIO (DMF EXTR.)	.68	.84	.86	0.00	0.00	0.00
DMF-SOLUBLE, W %	67.58	67.14	62.50	0.00	0.00	0.00
VISCOSITY, CP @ 500 °F *	0.0	3430.0	0.0	0.0	0.0	0.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	655.	751.	714.	0.	0.	0.
DISTILLATE TO 975 °F, W %	14.12	9.30	11.10	0.00	0.00	0.00
IBP-975 °F						
GRAVITY, °API	-5.7	-8.5	-3.7	0.0	0.0	0.0
HYDROCLONE OVERFLOW						
GRAVITY, °API	-12.8	-16.5	-14.9	0.0	0.0	0.0
IBP, °F (ASTM D-1160 MODIFIED)	464.	451.	462.	0.	0.	0.
10 V %	576.	574.	574.	0.	0.	0.
30 V %	710.	729.	690.	0.	0.	0.
50 V %	872.	0.	878.	0.	0.	0.
70 V %	0.	0.	0.	0.	0.	0.
END POINT	975.00	975.00	975.00	0.00	0.00	0.00
V % @ 650 °F	21.00	21.00	24.00	0.00	0.00	0.00
V % @ END POINT	59.50	49.75	57.75	0.00	0.00	0.00
ASH, W %	5.96	6.49	7.06	0.00	0.00	0.00
RESIDUE AND SOLIDS, W %	48.10	54.57	51.30	0.00	0.00	0.00
HYDROCLONE UNDERFLOW, ASH, W %	11.15	10.93	14.05	0.00	0.00	0.00
HYDROCLONE FEED, ASH W %	10.23	9.74	11.54	0.00	0.00	0.00
FILTER CAKE						
W % OF FEED TO FILTER	27.36	25.52	32.66	0.00	0.00	0.00
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	25.18	28.19	23.70	0.00	0.00	0.00
NON-ASH INSOLUBLE, W %	28.71	30.28	26.74	0.00	0.00	0.00
ASH, W %	46.11	41.53	52.82	0.00	0.00	0.00
INSOLUBLE RESID., W %	2.70	6.06	3.49	0.00	0.00	0.00
UNREACTED COAL, W % (EST.)	26.01	24.22	23.25	0.00	0.00	0.00
DMF - EXTRACTED CAKE						
ASH (OIL FREE), W %	59.65	54.26	53.68	0.00	0.00	0.00
O - 5 LIQUID						
GRAVITY, °API	13.8	11.8	13.4	0.0	0.0	0.0
O - 12 LIQUID						
GRAVITY, °API	14.4	12.0	17.3	0.0	0.0	0.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	3 AB	11 B	20 AB			
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	485.00	445.00	465.00	0.00	0.00	0.00
PRESSURE, TORR	3.00	2.00	3.00	0.00	0.00	0.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	11.37	8.56	7.60	0.00	0.00	0.00
SULFUR, W %	.18	.42	.34	0.00	0.00	0.00
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	20.89	12.75	12.16	0.00	0.00	0.00
BATCH STILL RESID. FROM FILTRATE	79.11	87.25	87.84	0.00	0.00	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	.32	.95	.66	0.00	0.00	0.00
CALCULATED COMPOSITION OF * 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD	24.80	20.00	52.00	0.00	0.00	0.00
ATMOSPHERIC STILL BOTTOMS	17.10	26.10	0.00	0.00	0.00	0.00
NET VACUUM STILL OVERHEAD	8.90	-5.77	0.00	0.00	0.00	0.00
VACUUM STILL BOTTOMS, SOLIDS FREE OIL: IBP-975 °F	11.10	0.00	1.60	0.00	0.00	0.00
975 °F+	38.11	59.67	46.40	0.00	0.00	0.00
CALCULATED COMPOSITION, W %						
SULFUR, W %	.30	.68	.40	0.00	0.00	0.00
SULFUR (ACTUAL), W %	0.00	.63	.36	0.00	0.00	0.00
VISCOSITY (ACTUAL), SSU @ 250 °F	0.00	0.00	0.00	0.00	0.00	0.00

* THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION F ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 W% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-88
COAL ILLINOIS #6 (HRI 4004)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	3 AB	11 B	20 AB
OPERATING CONDITIONS			
HOURS OF RUN - BEGINNING	28.00	190.00	378.00
END	52.00	202.00	402.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	274.2	867.6	1320.2
CATALYST ADDED, CUMULATIVE* LBS/TON DRY COAL	.54	1.00	.63
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	74.69	77.61	49.25
AVERAGE REACTOR TEMPERATURE, °F	846.	849.	850.
UNIT BACKPRESSURE (UNIT BP), PSIG	2688.	2584.	2631.
H2 PARTIAL PRESSURE, PSIG	1750.	1744.	1818.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.92	1.77	1.72
H2 INLET RATE, MSCF/TON DRY COAL	36.56	35.60	50.69
RECYCLE GAS, MSCF/TON DRY COAL	21.60	20.90	33.47
YIELDS, WT% OF DRY COAL			
CO,CO2	.79	.84	.82
C1-C3 HYDROCARBONS IN GASES	6.56	5.37	6.74
C4-C7 HYDROCARBONS IN GASES	2.92	2.40	3.68
IBP-400 °F NAPHTHA	13.69	9.95	12.93
400-650 °F DISTILLATES	11.68	10.24	16.92
650-975 °F DISTILLATES	10.08	7.21	3.99
975 °F+ RESIDUAL OIL			
TOLUENE SOLUBLE	23.98	25.63	21.68
TOLUENE INSOLUBLE	8.09	15.21	11.14
UNCONVERTED COAL	6.58	7.31	4.84
ASH	11.67	12.65	10.99
H2O (NET)	5.96	4.35	7.65
NH3 (FORCED NITROGEN)	.29	.21	.59
H2S (FORCED SULFUR)	2.03	1.89	2.39
TOTAL	104.21	103.16	104.27
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	15.85	11.90	16.10
COMPOSITION OF 400 °F+ FUEL OIL, WT%**			
ATMOSPHERIC STILL OVERHEAD	24.80	20.00	52.00
ATMOSPHERIC STILL BOTTOMS	17.10	26.10	0.00
NET VACUUM STILL OVERHEAD	8.90	-5.77	0.00
VACUUM STILL BOTTOMS, SOLID FREE OIL: IBP-975 °F	11.10	0.00	1.60
975 °F+	38.11	59.67	46.40
SULFUR, WT%	0.00	.63	.36
VISCOSITY, SSU @ 250 °F	0.00	0.00	0.00

* CATALYST ADDITION RATE WAS CHANGED AT THE BEGINNING OF PERIOD 19. THE CUMULATIVE TOTAL WAS SET TO ZERO AT THE BEGINNING OF PERIOD 19.

** THIS COMPOSITION IS BASED ON THE MATERIAL BALANCE FOR THE PERIOD AND AN ASSUMED RATIO OF 1.5 PARTS OIL PER PART SOLID IN VACUUM BOTTOMS, WITH THE OIL CONSISTING OF 4 PARTS RESID AND 1 PART DISTILLATE. SULFUR CONTENT IN 400 °F+ FRACTION OF ATMOSPHERIC STILL BOTTOMS IS ASSUMED TO BE 0.15 WT% FOR CASES WHERE SULFUR ANALYSIS IS NOT AVAILABLE.

PDU RUN 9 - KENTUCKY COAL - SYNCRUDE MODE

PDU 9 was the smoothest, most successful run achieved to this time in the H-Coal laboratory support program. Originally scheduled for fifteen days, the run was extended for an additional fifteen days at the request of the Commonwealth of Kentucky. The run extension provided data at near equilibrium conditions to form the basis for a commercial design using Kentucky coal.

The run satisfactorily proved that Kentucky coal can be used in the Pilot Plant without any modifications to the plant design and only minor adjustments in operating conditions. Operations with on-line catalyst addition and withdrawal were trouble-free, and the entire system was clear of any deposits at the conclusion of the run.

Several improvements had been made to the system before the start of this run, and mechanical performance was markedly more efficient.

A catalyst tracer study was conducted in cooperation with Sandia Laboratories. The experiment was designed to study catalyst mixing and deactivation in the ebullated bed. It showed that approximately six days are required for catalyst to become mixed but that the results after that closely approximate a well-mixed reactor.

Further experiments were completed at high pressure drop in the two-stage letdown system modeled after the Pilot Plant design. This showed no evidence of solids carried over in the vapor stream which provides additional confidence in the pilot plant design.

Overall, this showed that Kentucky No. 11 is similar to Illinois No. 6. A comparison of product yields from operations using these two coals is given below. Coal conversion was slightly higher with Kentucky coal. The yield of distillate liquid was approximately 8% lower and the yield of gas was 30% lower with Kentucky coal while the consumption of hydrogen was reduced by 15% relative to Illinois No. 6. The Kentucky coal appears to be particularly suitable for producing lower cost, heavier fuel oils by the H-Coal Process.

COMPARISON OF RESULTS - PDU RUNS 9 AND 5

Run	PDU 9		PDU 5	
Periods of Run	21-25	27-29	21-25	27-30
Hydrogen Partial Pressure, psig	1760	1770	1820	1890
Residual Oil Concentration, Recycled	25.6	27.6	25.1	26.4
Yields, W % of M.A.F. Coal				
C_4-400°F	19.1	17.5	20.9	21.1
400-650°F	19.7	20.4	24.7	25.6
650-975°F	9.4	11.2	5.3	7.4
C_4-975°F	48.2	49.1	50.9	54.1
Residual Oil	31.7	29.6	23.4	22.3
C_1-C_3 Gases	10.3	10.9	14.0	12.7
Coal Conversion, W % M.A.F. Coal	96.1	96.4	94.9	94.7
Hydrogen Consumption, W % Dry Coal	4.41	4.39	5.18	5.31

ANALYSIS OF KENTUCKY NO. 11 COAL FOR PDU RUN 9

(Run 130-89)

HRI No.	4091	4100	4101	4091	4092	4092	4100	4101
Feed to Period	As-received			1-6	7-14	15-22	22-28	29-30
Hours on Stream				0-143	143-335	335-527	527-671	671-713
Moisture, W %	6.09	5.76	6.47	2.15	2.44	2.28	2.20	3.18
Proximate, Dry Basis, W %								
Ash	8.23	7.42	7.88	8.88	8.42	7.39	7.04	8.81
Volatile Matter	39.10	37.05	39.33	37.86	39.08	41.40	41.13	39.22
Fixed Carbon	52.67	55.53	52.79	53.26	52.50	51.21	51.83	51.97
Ultimate, Dry Basis, W %								
Carbon	74.48	75.75	74.62	73.22	70.48	73.05	73.63	71.35
Hydrogen	5.07	5.09	5.10	.16	4.91	4.96	5.19	4.89
Nitrogen	1.44	1.49	1.45	1.35	1.42	1.27	1.22	1.35
Sulfur (LECO)	3.74	3.70	3.95	3.81	3.62	3.74	3.84	3.61
Ash	8.23	7.42	7.88	8.88	8.42	7.39	7.04	9.44
Chlorine				0.08	0.07	0.08	0.09	0.09
Oxygen (Difference)	7.00	6.55	7.05	7.50	11.08	9.52	8.98	9.27
Sulfur in Ash, W %				0.79	0.97	1.14	0.86	1.30
Sulfur Forms, Dry Basis, W %								
Pyritic				1.62	1.53	1.39	1.41	1.04
Sulfate				0.06	0.09	0.09	0.04	0.30
Organic (Difference)				1.71	1.85	2.02	2.04	1.78
Total (Eschka)				3.39	3.47	3.50	3.49	3.12
Heating Value, Btu/lb				12,899	12,825	13,051	13,218	12,412

HRI No.	4091	4100	4101	4091	4092	4092	4100	4101
Feed to Period	As-received			1-6	7-14	15-22	22-38	29-30
Sieve Analysis, Screen Size (U.S.S.)								
+50				1.01	2.27	0.78	2.69	2.28
50/70				1.19	2.48	1.20	2.53	3.16
70/100				2.63	4.22	2.76	4.56	4.85
100/140				5.10	6.79	5.52	6.86	7.42
140/200				6.84	8.73	8.28	8.42	8.52
200/325				22.27	23.03	23.66	22.32	22.47
-325				60.97	52.48	57.81	52.63	51.31
Mineral Analysis, W % Ignited								
Silica, SiO_2				43.75	41.63	41.58	41.50	52.57
Alumina, Al_2O_3				20.79	21.38	20.21	20.45	17.15
Titania, TiO_2				0.90	0.92	0.96	0.98	0.82
Ferric Oxide, Fe_2O_3				25.48	26.27	27.62	28.04	21.25
Lime, CaO				2.72	2.65	2.92	2.59	7.24
Magnesia, MgO				1.04	0.92	0.90	0.85	1.04
Potassium Oxide, K_2O				2.25	2.27	2.20	2.22	1.77
Sodium Oxide, Na_2O				0.46	0.44	0.50	0.60	0.53
Sulfur Trioxide, So_3				1.62	1.79	1.86	1.30	5.99
Phos. Pent. P_2O_5				0.26	0.28	0.24	0.21	0.12
Strontium Oxide, SrO				0.00	0.00	0.00	0.00	0.00
Barium Oxide, BaO				0.01	0.00	0.00	0.01	0.02
Manganese Oxide, Mn_3O_4				0.04	0.04	0.00	0.05	0.10
Undetermined (Difference)				0.68	1.41	0.94	1.20	1.40
Silica Value				59.94	58.25	56.94	56.86	59.04
T_2So Poises, °F				2320	2300	2280	2280	2290
Base/Acid				0.49	0.51	0.54	0.55	0.53

SUMMARY OF NORMALIZED YIELDS

RUN NUMBER 130-89
COAL KENTUCKY NO. 11 (HRI 4091,4092,4100, AND 4101)
CATALYST AMERICAN CYANAMID HDS 1442A, 1/16" EXTRUDATES (HRI 3830)

PERIOD	6 AB	12 AB	18 AB	23 AB	28 AB
OPERATING CONDITIONS					
HOURS OF RUN - BEGINNING	119.00	263.00	407.00	527.00	647.00
END	143.00	287.00	431.00	551.00	671.00
CATALYST AGE (END AVERAGE), LB DRY COAL/LB	282.0	548.6	769.8	906.0	999.7
CATALYST ADDED, CUMULATIVE LBS/TON DRY COAL	1.20	1.10	1.05	1.07	1.12
COAL FEED (DRY), LB/HR/CU.FT. REACTOR VOLUME	31.84	32.18	31.32	31.51	31.88
AVERAGE REACTOR TEMPERATURE, °F	848.	850.	851.	849.	850.
UNIT BACK PRESSURE (UNIT BP), PSIG	2703.	2696.	2684.	2681.	2701.
H2 PARTIAL PRESSURE, PSIG	1725.	1862.	1751.	1787.	1765.
OIL/SOLID RATIO (SLURRY TANK), LB/LB SOLIDS	1.70	1.71	1.67	1.74	1.66
H2 INLET RATE, MSCF/TON DRY COAL	57.92	56.22	55.00	54.28	55.31
RECYCLE GAS, MSCF/TON DRY COAL	37.70	36.40	37.00	37.41	36.82
YIELDS, W % OF DRY COAL					
CO,CO2	.67	.55	.62	.69	.88
C1-C3 HYDROCARBONS IN GASES	10.22	8.22	8.67	9.81	9.80
C4-C7 HYDROCARBONS IN GASES	4.06	2.61	2.67	2.67	3.16
IBP-400 °F NAPHTHA	14.47	15.28	16.02	14.68	11.89
400-650 °F DISTILLATES	21.25	21.13	19.83	17.27	16.10
650-975 °F DISTILLATES	7.86	8.67	9.11	8.67	10.88
975 °F+ RESIDUAL OIL					
TOLUENE SOLUBLE	15.30	19.10	18.18	21.66	20.14
TOLUENE INSOLUBLE	5.11	5.74	8.83	8.74	7.45
UNCONVERTED COAL	3.90	3.94	3.65	3.47	3.64
ASH	10.04	8.49	8.14	7.45	8.27
H2O (NET)	8.27	7.36	5.52	5.95	8.82
NH3 (FORCED NITROGEN)	.89	.88	.55	.43	.46
H2S (FORCED SULFUR)	2.79	2.62	2.64	2.82	2.70
TOTAL	104.84	104.58	104.43	104.30	104.19
CHEMICAL HYDROGEN CONSUMPTION MSCF/TON DRY COAL	18.23	17.26	16.68	16.21	15.79
COMPOSITION OF 400 °F+ FUEL OIL, W %					
ATMOSPHERIC STILL OVERHEAD	23.44	21.16	18.41	16.24	8.31
ATMOSPHERIC STILL BOTTOMS	23.74	24.48	21.87	21.50	25.31
NET VACUUM STILL OVERHEAD	0.00	2.96	4.24	1.38	10.17
VACUUM STILL BOTTOMS, SOLID FREE OIL	52.82	51.40	55.48	60.88	56.13
SULFUR, W %					

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	6 AB	12 AB	18 AB	23 AB	28 AB
DATE (END OF PERIOD), 1979	9/ 7	9/13	9/19	9/24	9/29
HOURS OF RUN - BEGINNING	119.00	263.00	407.00	527.00	647.00
END	143.00	287.00	431.00	551.00	671.00
CATALYST INVENTORY, END, LBS	102.40	103.47	106.61	108.93	110.50
CATALYST ADDED, LBS	7.15	3.57	4.50	2.10	3.90
CATLYST WITHDRAWN, LBS *	5.16	3.43	3.48	1.98	3.14
CATALYST AGE (END), LB DRY COAL/LB					
AVERAGE (BASIS)	282.0	548.6	769.8	906.0	999.7
ORIGINAL CHARGE (BASIS)	315.3	653.2	974.1	1236.1	1493.3
CATALYST ADDED, CUMULATIVE					
LBS/TON DRY COAL	1.20	1.10	1.05	1.07	1.12
CATALYST WITHDRAWALS					
WITHDRAWAL, OIL LADEN, LBS	10.90	7.29	7.37	4.22	7.65
OIL, W %	30.39	32.86	26.55	24.49	34.40
MOLYDENUM (OIL FREE), W % *	7.01	7.22	6.63	6.40	6.53
COAL FEED (DRY)					
LBS/HR/CU FT REACTOR VOLUME	31.84	32.18	31.32	31.51	31.88
MOISTURE W % (COAL SAMPLE)	1.69	1.44	1.64	1.71	1.57
ASH,W% (DRY COAL)	9.42	8.28	8.65	6.88	7.40
RECYCLE FLOWS, LBS/LB SOLIDS					
ATMOSPHERIC STILL BOTTOMS	.24	.29	.39	.26	.33
VACUUM STILL OVERHEAD	.23	.25	.22	.27	.12
INVENTORY CHANGE	-.01	-.02	.05	-.12	-.02
HYDROCLONE OVERFLOW (OIL)	1.22	1.19	1.11	1.21	1.19
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00
TOTAL	1.70	1.71	1.67	1.74	1.66
TEMPERATURE, °F					
COAL PREHEATER OUTLET	708.	719.	741.	75_.	773.
REACTOR LIQUID PHASE, AVG.	848.	850.	851.	849.	850.
MAX.	853.	854.	854.	854.	856.
SEPARATOR-2" (@ 12" SKIN)	804.	805.	783.	767.	770.
HYDROCLONE OVERFLOW	502.	502.	500.	496.	489.
VACUUM STILL FLASH ZONE	531.	543.	541.	543.	544.
PRESSURE					
UNIT BACK PRESSURE, PSIG	2703.	2696.	2684.	2681.	2701.
HYDROGEN MAKE-UP, PSIG	2882.	2901.	2888.	2933.	2939.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1725.	1862.	1761.	1787.	1765.
VACUUM FLASH, TORR	4.	2.	2.	1.	1.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	6 AB	12 AB	18 AB	23 AB	28 AB
RECYCLE GAS, MSCF/TON DRY COAL	37.70	36.40	37.00	37.41	36.82
VENT GAS, MSCF/TON DRY COAL	5.94	6.09	6.33	6.53	6.73
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	84.65	85.05	83.11	84.01	83.30
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	38.89	38.57	37.95	38.64	38.00
HYDROGEN, MAKE-UP + RECYCLE					
MSCF/TON DRY COAL	57.92	56.22	55.00	54.28	55.31
PARTIAL PRESSURE, PSIG(INLET)	2635.	2659.	2607.	2655.	2658.
HYDROGEN CONSUMPTION (1)					
MSCF/TON DRY COAL	19.03	17.66	17.05	16.64	17.30
W % DRY COAL	5.05	4.69	4.53	4.15	4.59
CHEMICAL HYDROGEN CONSUMPTION					
MSCF/TON DRY COAL	18.23	17.26	16.68	16.21	15.79
OIL ADDITIONS					
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.003	003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL					
ATMOSPHERIC STILL OVERHEAD	26.98	26.10	27.89	23.26	15.74
ATMOSPHERIC STILL BOTTOMS (2)	10.43	12.91	12.78	11.50	12.97
VACUUM STILL OVERHEAD (2)	.07	1.58	2.48	.72	5.20
VACUUM STILL BOTTOMS	37.30	40.22	46.78	45.85	42.80
H2O	10.57	9.57	8.54	8.23	11.02
C1-C3	9.76	8.05	9.26	9.10	9.54
C4-C7	3.89	2.57	2.85	2.65	3.08
H2S IN GASES	3.80	2.69	3.08	3.15	3.24
CO2 & CO	.65	.54	.66	.68	.85
INPUT QUANTITIES, W % DRY COAL					
DRY COAL	100.03	100.00	106.00	100.00	100.00
MOISTURE IN FEED COAL	1.72	1.46	1.67	1.74	1.60
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.33	.31	.34	.33	.32
HYDROGEN REACTED (1)	5.05	4.69	4.53	4.15	4.59
TOTAL	107.10	106.46	106.51	106.22	106.51
COAL CONVERSION, W % M.A.F. COAL					
TOLUENE CONVERSION (3)	95.96	95.81	95.75	96.55	96.47
DMF CONVERSION (4)	95.69	94.90	93.32	94.45	94.74

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	6 AB	12 AB	18 AB	23 AB	28 AB
NORMALIZED NET PRODUCT DISTRIBUTION*!#					
W % OF DRY COAL					
CO, CO2	.67	.55	.62	.69	.88
C1-C3 HYDROCARBONS IN GASES	10.22	8.22	8.67	9.81	9.80
C4-C7 HYDROCARBONS IN GASES	4.06	2.61	2.67	2.67	3.16
IBP-400 °F NAPHTHA	14.47	16.28	16.02	14.68	11.89
400-650 °F DISTILLATES	21.25	21.13	19.83	17.27	16.10
650-975 °F DISTILLATES	7.86	8.67	9.11	8.67	10.88
975 °F+ RESIDUAL OIL					
TOLUENE SOLUBLE	15.30	19.10	18.18	21.66	20.14
TOLUENE INSOLUBLE	5.11	5.74	8.83	8.74	7.45
UNCONVERTED COAL	3.90	3.94	3.65	3.47	3.64
ASH	10.04	8.49	8.14	7.45	8.27
H2O (NET)	8.27	7.36	5.52	5.95	8.82
NH3 (FORCED NITROGEN)	.69	.88	.65	.43	.46
H2S (FORCED SULFUR)	2.79	2.62	2.64	2.82	2.70
TOTAL (100 + HYDROGEN REACTED)	104.84	104.58	104.43	104.30	104.19
FILTERED LIQUID**					
GRAVITY, °API	-4.8	-9.1	-7.5	-7.2	-3.6
IBP, °F (ASTM D-1160 MODIFIED)	492.	543.	504.	540.	436.
10 V %	588.	640.	588.	628.	525.
30 V %	720.	745.	718.	746.	615.
50 V %	800.	860.	833.	873.	700.
70 V %	963.				898.
90 V %					
FBP	975.	975.	975.	975.	975.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	25.00	11.00	23.00	16.00	38.00
V % AT 975 °F	71.00	64.00	66.00	61.00	76.00
SULFUR, W %	.12	.21	.31	.38	.48
W % 975 °F+	31.69	36.85	37.34	40.25	44.90
W % SULFUR IN 975 °F+	.46	.54	.62	.72	.62
W % NITROGEN IN 975 °F+	1.47	1.87	1.59	1.76	1.79
W % OXYGEN IN 975 °F+	2.68	2.78	3.05	3.23	2.98

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 27 TO 29 FILTRATION OF HYDROCLONE UNDERFLOW (HUF) WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS (ASB) FROM THE SAME PERIOD AS PUSHER (TWO WEIGHTS OF HUF PER WEIGHT OF ASB). GRAVITY AND DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. SULFUR AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HUF.

! PERIODS 6AB,12AB,18AB,23AB,AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	6 AB	12 AB	18 AB	23 AB	28 AB
ATMOSPHERIC STILL OVERHEAD*					
GRAVITY, °API	32.5	33.2	32.9	31.9	36.3
IBP, °F (ASTM D-86)	144.	148.	141.	144.	136.
10 V %	239.	231.	227.	200.	214.
30 V %	317.	310.	307.	304.	270.
50 V %	390.	374.	363.	368.	322.
70 V %	436.	417.	410.	414.	378.
90 V %	502.	480.	465.	465.	475.
FBP	594.	536.	541.	565.	592.
V % @ 400 °F	54.00	60.00	64.00	65.00	75.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00
CARBON, W %	85.35	84.05	85.60	87.33	86.92
HYDROGEN, W %	11.64	11.76	11.57	12.06	12.25
NITROGEN, W %	.31	.36	.33	.42	.28
SULFUR (H2S FREE), W %	<.03	.12	.18	.17	.16
IBP-400 °F					
GRAVITY, °API	40.8	40.5	39.5	38.2	42.1
SULFUR (H2S FREE), W %	<.03	.13	.07	.20	.13
400 °F+					
GRAVITY, °API	22.8	22.0	21.6	20.1	20.3
SULFUR (H2S FREE), W %	<.03	<.03	.08	.11	.11
ATMOSPHERIC STILL BOTTOMS					
GRAVITY, °API	10.4	10.3	10.1	9.4	10.9
IBP, °F (ASTM D-86)	470.	467.	459.	469.	388.
10 V %	521.	521.	508.	511.	452.
30 V %	551.	650.	551.	547.	510.
50 V %	600.	600.	584.	593.	566.
70 V %	647.	649.	633.	646.	629.
90 V %	741.	750.	724.	770.	772.
FBP	845.	842.	789.	890.	910.
V % @ 400 °F	0.00	0.00	0.00	0.00	2.00
V % @ 650 °F	71.90	71.00	76.00	72.00	75.00
CARBON, W %	88.73	88.51	88.74	88.71	88.16
HYDROGEN, W %	9.27	8.99	9.62	8.84	9.21
NITROGEN, W %	.53	.47	.48	.69	.71
SULFUR, W %	<.03	<.03	.04	.11	.08
IBP-650 °F					
GRAVITY, °API	13.9	13.4	13.5	12.6	14.4
650 °F+					
GRAVITY, °API	3.6	1.8	3.1	2.3	1.8

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	6 AB	12 AB	18 AB	23 AB	28 AB
WATER					
CARBON, W %	2.02	3.08	2.27	2.00	1.99
AMMONIA, W %	5.03	5.57	5.08	4.78	4.22
SULFUR, W %	3.67	3.22	3.74	1.94	2.88
CLEAN OIL TANK					
GRAVITY, °API	8.0	6.4	8.3	5.1	8.4
SLURRY MIXING TANK					
VISCOSITY, CP @ 150 °F *	1040.0	1535.0	2430.0	5830.0	5730.0
VACUUM STILL OVERHEAD					
GRAVITY, °API	4.6	2.8	4.1	2.5	2.8
IBP, °F (ASTM D-1160 MODIFIED)	451.	467.	432.	457.	412.
10 V %	549.	557.	537.	553.	521.
30 V %	626.	631.	606.	635.	618.
50 V %	705.	705.	660.	750.	671.
70 V %	765.	755.	730.	794.	752.
90 V %	877.	865.	836.	859.	860.
FBP	975.	940.	920.	992.	1010.
V % @ 400 °F	0.00	0.00	0.00	0.00	0.00
V % @ 650 °F	37.00	38.00	47.00	36.00	39.00
CARBON, W %	88.51	89.26	89.21	89.33	88.38
HYDROGEN, W %	8.36	8.22	8.08	8.13	8.06
NITROGEN, W %	.68	.75	.69	.75	.96
SULFUR, W %	<.03	.05	.11	.17	.13
IBP-650 °F					
GRAVITY, °API	12.3	11.0	10.6	7.9	11.0
650 °F+					
GRAVITY, °API	.1	-.8	-1.2	-.9	-.1

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	6 AB	12 AB	18 AB	23 AB	28 AB
VACUUM STILL BOTTOMS					
W % OF VACUUM STILL FEED	46.99	47.69	53.21	49.93	54.85
TOLUENE SOLUBLE, W %	51.19	55.83	52.86	57.60	54.66
NON-ASH TOLUENE INSOLUBLE, W %	23.10	23.53	28.54	26.33	25.24
ASH, W %	25.71	20.64	18.60	16.07	20.10
UNREACTED COAL, W % (EST.)	13.10	9.58	8.35	7.49	8.88
TOLUENE INSOL. RESID. W % (EST.)	10.00	13.95	20.19	18.84	16.36
CARBON, W %	64.30	68.03	71.54	73.32	70.80
HYDROGEN, W %	4.32	4.35	4.58	4.78	4.48
NITROGEN, W %	1.21	1.28	1.51	1.47	1.48
SULFUR, W %	3.10	2.73	2.75	2.44	2.86
ASTM ASH, W %	26.55	21.55	18.57	17.08	20.27
COKE/ASH RATIO (DMF EXTR.)	.41	.57	.71	.75	.66
DMF-SOLUBLE, W %	62.60	67.37	69.31	71.47	67.04
VISCOSITY, CP @ 500 °F *	710.0	480.0	450.0	690.0	500.0
VACUUM DISTILLATION					
IBP, °F (ASTM D-1160 MODIFIED)	890.	903.	881.	872.	908.
DISTILLATE TO 975 °F, W %	11.40	8.10	10.50	8.50	8.60
IBP-975 °F					
GRAVITY, °API	-6.5	-9.6		-9.8	-10.2
HYDROCLONE OVERFLOW					
GRAVITY, °API	-11.6	-11.2	-12.0	-12.5	-14.7
IBP, °F (ASTM D-1160 MODIFIED)	480.	488.	468.	494.	436.
10 V %	579.	586.	571.	598.	582.
30 V %	677.	700.	698.	708.	715.
50 V %	780.	818.	820.	840.	825.
70 V %					
END POINT	975.00	975.00	975.00	975.00	975.00
V % @ 650 °F	24.00	20.00	24.50	19.00	18.50
V % @ END POINT	71.50	66.00	65.50	63.00	61.00
ASH, W %	6.32	5.64	5.21	4.90	6.56
RESIDUE AND SOLIDS, W %	37.29	41.58	42.02	43.94	46.43
HYDROCLONE UNDERFLOW, ASH, W %	12.53	10.82	13.06	11.95	11.65
HYDROCLONE FEED, ASH W %	10.16	9.71	9.51	6.77	7.86
FILTER CAKE					
W % OF FEED TO FILTER	24.75	24.53	21.54	20.00	21.45
TOLUENE EXTRACTION OF CAKE					
SOLUBLE, W %	31.80	36.86	27.40	30.03	29.64
NON-ASH INSOLUBLE, W %	20.87	22.15	25.41	24.70	24.02
ASH, W %	47.33	40.99	47.19	45.27	46.34
INSOLUBLE RESID., W %	2.46	3.12	4.23	3.59	3.54
UNREACTED COAL, W % (EST.)	18.41	19.03	21.18	21.71	20.48
0 - 5 LIQUID					
GRAVITY, °API	14.9	13.3	13.5	13.0	13.5
0 - 12 LIQUID					
GRAVITY, °API	19.4	18.2	17.5	16.4	15.9

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	6 AB	12 AB	18 AB	23 AB	28 AB
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT					
VACUUM DISTILLATION					
FINAL VAPOR TEMP. °F	520.00	508.00	503.00	501.00	508.00
PRESSURE, TORR	.35	.25	.21	.20	.25
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	12.00	9.40	11.30	10.90	10.10
SULFUR, W %	.06	.15	.26	.36	.26
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %					
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	19.17	13.95	16.30	15.25	15.07
BATCH STILL RESID. FROM FILTRATE	80.83	86.05	83.70	84.75	84.93
CALCULATED COMPOSITION, W %					
SULFUR, W %	.36	.49	.56	.67	.57
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %					
ATMOSPHERIC STILL OVERHEAD	23.44	21.16	18.41	16.24	8.31
ATMOSPHERIC STILL BOTTOMS	23.74	24.48	21.87	21.50	25.31
NET VACUUM STILL OVERHEAD	0.00	2.96	4.24	1.38	10.17
VACUUM STILL BOTTOMS, SOLIDS FREE OIL	52.82	51.40	55.48	60.88	56.13
CALCULATED COMPOSITION, W %					
SULFUR, W %	.20	.27	.34	.44	.36
SULFUR (ACTUAL), W %					

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	1 A	1 B	2 A	2 B	3 A	3 B
DATE (END OF PERIOD), 1979	9/ 1	9/ 2	9/ 2	9/ 3	9/ 3	9/ 4
HOURS OF RUN - BEGINNING	0.00	11.00	23.00	35.00	47.00	59.00
END	11.00	23.00	35.00	47.00	59.00	71.00
CATALYST INVENTORY, END, LBS	102.98	102.98	103.76	102.76	102.47	102.47
CATALYST ADDED, LBS	0.00	0.00	2.86	0.00	3.09	0.00
CATLYST WITHDRAWN, LBS *	0.00	0.00	3.07	0.00	3.37	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	17.8	41.1	62.4	90.9	115.0	142.9
ORIGINAL CHARGE (BASIS)	17.8	41.1	64.1	92.6	119.7	147.6
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	0.00	0.00	.87	.60	.97	.79
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	0.00	5.96	0.00	6.48	0.00
OIL, W %			32.78		30.60	
MOLYDENUM (OIL FREE), W % *			7.88		7.71	
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	22.20	26.74	26.30	32.55	30.90	31.78
MOISTURE W % (COAL SAMPLE)	1.26	1.26	1.10	.96	1.20	1.45
ASH,W% (DRY COAL)		8.30		8.96		8.65
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	1.27	.80	.74	.61	.58	.52
VACUUM STILL OVERHEAD	0.00	.06	.25	.25	.21	.26
INVENTORY CHANGE	.11	-.32	.06	.14	.15	.09
HYDROCLONE OVERFLOW (OIL)	1.61	1.16	1.19	1.04	1.22	1.14
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	2.77	2.34	2.12	1.75	1.86	1.84
TEMPERATURE, °F						
COAL PREHEATER OUTLET	687.	714.	720.	686.	690.	692.
REACTOR LIQUID PHASE, AVG.	804.	837.	849.	851.	849.	849.
MAX.	909.	841.	853.	855.	853.	853.
SEPARATOR-2" (@ 12" SKIN)	761.	795.	778.	805.	801.	806.
HYDROCLONE OVERFLOW	478.	494.	497.	500.	639.	636.
VACUUM STILL FLASH ZONE	406.	406.	524.	518.	527.	532.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2700.	2700.	2700.	2700.	2702.	2701.
HYDROGEN MAKE-UP, PSIG	2754.	2750.	2763.	2840.	2819.	2827.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	2063.	1690.	1683.	1484.	1671.	1651.
VACUUM FLASH, TORR	187.	14.	22.	5.	3.	4.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	1 A	1 B	2 A	2 B	3 A	3 B
RECYCLE GAS, MSCF/TON DRY COAL	50.38	41.23	42.40	38.35	39.72	38.95
VENT GAS, MSCF/TON DRY COAL	4.40	4.37	5.07	3.69	4.77	4.18
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	91.82	87.32	85.19	81.90	81.81	82.34
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	55.66	42.32	42.26	36.04	37.84	37.24
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	78.42	62.60	64.21	56.01	57.88	56.83
PARTIAL PRESSURE, PSIG(INLET)	2630.	2552.	2530.	2540.	2519.	2535.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	22.76	20.28	21.95	19.97	20.04	19.59
W % DRY COAL	6.04	5.38	5.83	5.30	5.32	5.20
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL				21.35		18.80
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.005	.004	.004	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	.07	49.10	48.32	24.05	28.00	23.08
ATMOSPHERIC STILL BOTTOMS (2)	12.19	-31.96	5.87	12.01	12.57	13.51
VACUUM STILL OVERHEAD (2)	0.00	-2.48	2.17	5.24	4.93	4.75
VACUUM STILL BOTTOMS	38.53	54.52	26.56	28.95	31.89	35.71
H2O	-1.24	13.54	5.19	8.96	8.74	11.72
C1-C3	6.72	8.67	11.06	9.57	9.99	9.98
C4-C7	3.97	4.16	4.91	4.10	4.15	4.01
H2S IN GASES	3.62	3.70	4.94	4.48	3.37	3.50
CO2 & CO	.62	.57	.64	.63	.60	.55
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.28	1.28	1.11	.97	1.21	1.47
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.46	.38	.39	.32	.33	.32
HYDROGEN REACTED (1)	6.04	5.38	5.83	5.30	5.32	5.20
TOTAL	107.78	107.04	107.33	106.59	106.86	106.99
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)		95.83		95.78		95.87
DMF CONVERSION (4)		95.88		95.73		95.90

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	1 A	1 B	2 A	2 B	3 A	3 B
NORMALIZED NET PRODUCT DISTRIBUTION*‡						
W % OF DRY COAL						
CO, CO2				.67		.59
C1-C3 HYDROCARBONS IN GASES				10.82		10.14
C4-C7 HYDROCARBONS IN GASES				4.70		4.15
IBP-400 °F NAPHTHA				20.39		15.42
400-650 °F DISTILLATES				26.27		22.18
650-975 °F DISTILLATES				7.63		10.35
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE				12.95		13.66
TOLUENE INSOLUBLE				.67		3.02
UNCONVERTED COAL				3.85		4.18
ASH				8.98		9.45
H2O (NET)				5.62		8.05
NH3 (FORCED NITROGEN)				.98		.91
H2S (FORCED SULFUR)				3.00		2.94
TOTAL (100 + HYDROGEN REACTED)				105.67		104.99
FILTERED LIQUID						
GRAVITY, °API		2.7		-2.5		-2.8
IBP, °F (ASTM D-1160 MODIFIED)		453.		462.		467.
10 V %		518.		547.		553.
30 V %		590.		643.		656.
50 V %		704.		856.		776.
70 V %						938.
90 V %						
FBP		975.		975.		975.
V % @ 400 °F		0.00		0.00		0.00
V % @ 650 °F		44.00		31.00		29.00
V % AT 975 °F		66.00		62.00		74.00
SULFUR, W %		.07		.07		.09
W % 975 °F+		36.05		50.68		29.54
W % SULFUR IN 975 °F+		.22		21		.52
W % NITROGEN IN 975 °F+						
W % OXYGEN IN 975 °F+						

* ASTM DISTILLATION CUT POINT

‡ PERIODS 6AB, 12AB, 18AB, 23AB, AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

‡ FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	1 A	1 B	2 A	2 B	3 A	3 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	48.2	30.8	30.5	32.4	33.4	33.4
IBP, °F (ASTM D-86)	150.	174.	184.	186.	174.	174.
10 V %	186.	250.	254.	248.	242.	242.
30 V %	192.	331.	345.	315.	316.	316.
50 V %	200.	384.	398.	382.	375.	375.
70 V %	214.	423.	430.	421.	420.	420.
90 V %	270.	468.	470.	480.	484.	484.
FBP	437.	578.	554.	586.	579.	579.
V % @ 400 °F	97.00	60.00	51.00	62.00	62.00	62.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	100.00
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR (H2S FREE), W %					.03	.03
IBP-400 °F						
GRAVITY, °API		38.1	39.7	39.3	40.0	40.0
SULFUR (H2S FREE), W %		<.03	<.03	<.03	<.03	<.03
400 °F+						
GRAVITY, °API		20.9	21.9	21.5	21.1	21.1
SULFUR (H2S FREE), W %					<.03	<.03
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	12.5	12.1	12.5	12.3	12.4	12.4
IBP, °F (ASTM D-86)		462.		476.		469.
10 V %		492.		506.		494.
30 V %		515.		532.		535.
50 V %		545.		564.		570.
70 V %		588.		612.		621.
90 V %						
FBP		650.		650.		650.
V % @ 400 °F		0.00		0.00		0.00
V % @ 650 °F		85.00		80.00		76.00
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		<.03		<.03		<.03
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	1 A	1 B	2 A	2 B	3 A	3 B
WATER						
CARBON, W %						
AMMONIA, W %						
SULFUR, W %						
CLEAN OIL TANK						
GRAVITY, °API		12.7		10.8		10.6
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *		25.0		190.0		240.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	2.5	9.3	8.4	7.8	6.6	6.2
IBP, °F (ASTM D-1160 MODIFIED)						
10 V %						
30 V %						
50 V %						
70 V %						
90 V %						
FBP						
V % @ 400 °F						
V % @ 650 °F						
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		<.03		<.03		<.03
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	1 A	1 B	2 A	2 B	3 A	3 B
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	100.00	88.40	47.11	50.21	50.21	44.09
TOLUENE SOLUBLE, W %		57.87		53.53		51.73
NON-ASH TOLUENE INSOLUBLE, W %		14.50		15.57		20.77
ASH, W %		27.63		30.90		27.50
UNREACTED COAL, W % (EST.)		12.72		13.25		11.99
TOLUENE INSOL. RESID. W % (EST.)		1.78		2.32		8.78
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		2.73		3.34		3.00
ASTM ASH, W %		28.06		31.43		28.01
COKE/ASH RATIO (DMF EXTR.)		.45		.43		.43
DMF-SOLUBLE, W %		59.56		55.68		60.37
VISCOSITY, CP @ 500 °F *		110.0		1065.0		495.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)						
DISTILLATE TO 975 °F, W %						
IBP-975 °F						
GRAVITY, °API						
HYDROCLONE OVERFLOW						
GRAVITY, °API		-1.7		-8.7		-7.6
IBP, °F (ASTM D-1160 MODIFIED)		424.		448.		468.
10 V %		508.		540.		534.
30 V %		567.		640.		646.
50 V %		633.		762.		761.
70 V %		776.		0.		953.
END POINT		975.00		975.00		975.00
V % @ 650 °F		53.00		33.50		31.50
V % @ END POINT		83.00		71.50		72.50
ASH, W %		4.51		7.62		5.84
RESIDUE AND SOLIDS, W %		23.85		36.96		34.46
HYDROCLONE UNDERFLOW, ASH, W %		14.77		15.73		12.23
HYDROCLONE FEED, ASH W %		11.83		10.00		8.60
FILTER CAKE						
W % OF FEED TO FILTER		36.02		30.41		34.88
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %		30.65		33.83		36.47
NON-ASH INSOLUBLE, W %		22.39		20.22		20.54
ASH, W %		46.96		45.95		42.99
INSOLUBLE RESID., W %		.77		.51		1.79
UNREACTED COAL, W % (EST.)		21.62		19.71		18.75
O - 5 LIQUID						
GRAVITY, °API	14.1	16.6	16.0	15.7	16.5	16.0
O - 12 LIQUID						
GRAVITY, °API		21.9		20.6		20.8

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	1 A	1 B	2 A	2 B	3 A	3 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F		365.00		479.00		601.00
PRESSURE, TORR		1.20		1.60		2.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY		20.23		3.58		6.70
SULFUR, W %				<.03		<.03
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS				6.43		11.11
BATCH STILL RESID. FROM FILTRATE				93.57		88.90
CALCULATED COMPOSITION, W %						
SULFUR, W %				.20		.46
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD						
ATMOSPHERIC STILL BOTTOMS						
NET VACUUM STILL OVERHEAD						
VACUUM STILL BOTTOMS, SOLIDS FREE OIL						
CALCULATED COMPOSITION, W %						
SULFUR, W %						.46
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	4 A	4 B	5 A	5 B	6 A	6 B
DATE (END OF PERIOD), 1979	9/ 4	9/ 5	9/ 5	9/ 6	9/ 6	9/ 7
HOURS OF RUN - BEGINNING	71.00	83.00	95.00	107.00	119.00	131.00
END	83.00	95.00	107.00	119.00	131.00	143.00
CATALYST INVENTORY, END, LBS	102.61	102.61	100.37	100.37	102.36	102.36
CATALYST ADDED, LBS	3.26	0.00	2.86	0.00	7.15	0.00
CATLYST WITHDRAWN, LBS *	3.22	0.00	5.00	0.00	5.16	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	165.6	193.3	215.7	243.6	254.1	282.0
ORIGINAL CHARGE (BASIS)	175.2	202.9	231.1	259.0	287.4	315.3
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.03	.89	1.02	.91	1.31	1.20
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	6.82	0.00	9.84	0.00	10.90	0.00
OIL, W %	29.63		28.16		30.39	
MOLYDENUM (OIL FREE), W % *	6.91		7.28		7.01	
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	31.40	31.62	31.66	31.13	31.91	31.77
MOISTURE W % (COAL SAMPLE)	.99	.52	1.15	1.78	1.72	1.66
ASH,W% (DRY COAL)		9.33		8.81		9.42
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.26	.23	.21	.30	.27	.21
VACUUM STILL OVERHEAD	.25	.22	.20	.29	.23	.23
INVENTORY CHANGE	-.03	-.05	-.01	.04	-.03	.01
HYDROCLONE OVERFLOW (OIL)	1.13	1.22	1.18	1.25	1.20	1.24
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.66	1.72	1.60	1.69	1.74	1.66
TEMPERATURE, °F						
COAL PREHEATER OUTLET	692.	677.	712.	698.	700.	716.
REACTOR LIQUID PHASE, AVG.	851.	850.	850.	849.	849.	847.
MAX.	855.	855.	854.	854.	853.	853.
SEPARATOR-2" (@ 12" SKIN)	807.	807.	806.	803.	805.	802.
HYDROCLONE OVERFLOW	536.	538.	501.	501.	502.	501.
VACUUM STILL FLASH ZONE	537.	528.	532.	531.	532.	529.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2702.	2700.	2700.	2700.	2704.	2703.
HYDROGEN MAKE-UP, PSIG	2809.	2858.	2864.	2896.	2902.	2863.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1501.	1636.	1631.	1852.	1777.	1672.
VACUUM FLASH, TORR	4.	3.	3.	4.	4.	4.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	4 A	4 B	5 A	5 B	6 A	6 B
RECYCLE GAS, MSCF/TON DRY COAL	38.21	39.04	38.20	41.39	38.35	37.06
VENT GAS, MSCF/TON DRY COAL	3.96	5.04	5.38	6.70	5.60	6.29
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	80.61	82.80	84.67	36.44	87.57	81.73
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	35.86	38.70	38.97	43.49	40.44	37.33
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	55.97	58.35	58.37	62.79	59.37	56.47
PARTIAL PRESSURE, PSIG(INLET)	2494.	2576.	2616.	2672.	2700.	2570.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	20.11	19.64	19.40	19.30	18.93	19.13
W % DRY COAL	5.34	5.21	5.15	5.12	5.03	5.08
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL		20.04		19.34		
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.003	.003	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	27.25	32.42	31.31	29.76	25.47	28.49
ATMOSPHERIC STILL BOTTOMS (2)	15.93	15.43	12.25	14.53	7.80	13.06
VACUUM STILL OVERHEAD (2)	-1.46	-2.30	-.04	2.52	-1.24	1.38
VACUUM STILL BOTTOMS	34.23	31.94	34.21	32.53	39.00	35.60
H2O	8.17	6.02	7.01	7.28	10.16	10.99
C1-C3	10.58	10.82	11.22	8.74	8.77	10.76
C4-C7	5.06	4.37	5.00	3.36	3.82	3.96
H2S IN GASES	3.40	3.50	4.23	3.13	3.64	3.97
CO2 & CO	.83	.55	.72	.60	.63	.67
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.00	.52	1.16	1.81	1.75	1.69
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.33	.32	.32	.33	.32	.33
HYDROGEN REACTED (1)	5.34	5.21	5.15	5.12	5.03	5.08
TOTAL	106.67	106.05	106.63	107.26	107.10	107.10
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)		95.34		95.84		95.96
DMF CONVERSION (4)		94.95		95.38		95.69

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	4 A	4 B	5 A	5 B	6 A	6 B
NORMALIZED NET PRODUCT DISTRIBUTION*!#						
W % OF DRY COAL						
CO, CO2		.72		.70		
C1-C3 HYDROCARBONS IN GASES		11.07		10.33		
C4-C7 HYDROCARBONS IN GASES		4.87		4.43		
IBP-400 °F NAPHTHA		18.13		16.80		
400-650 °F DISTILLATES		23.61		24.48		
650-975 °F DISTILLATES		7.19		9.15		
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE		14.62		14.08		
TOLUENE INSOLUBLE		1.88		3.14		
UNCONVERTED COAL		4.24		3.95		
ASH		9.37		9.16		
H2O (NET)		5.83		5.14		
NH3 (FORCED NITROGEN)		.93		.92		
H2S (FORCED SULFUR)		2.93		2.86		
TOTAL (100 + HYDROGEN REACTED)		105.32		105.14		
FILTERED LIQUID						
GRAVITY, °API		-2.7		-3.7		-4.8
IBP, °F (ASTM D-1160 MODIFIED)		468.		487.		492.
10 V %		567.		585.		588.
30 V %		715.		728.		720.
50 V %		800.		848.		800.
70 V %		968.		917.		963.
90 V %						
FBP		975.		975.		975.
V % @ 400 °F		0.00		0.00		0.00
V % @ 650 °F		27.00		24.00		25.00
V % AT 975 °F		72.00		71.00		71.00
SULFUR, W %		.12		.11		.12
W % 975 °F+		30.48		32.07		31.69
W % SULFUR IN 975 °F+		.44		.46		.46
W % NITROGEN IN 975 °F+						
W % OXYGEN IN 975 °F+						

* ASTM DISTILLATION CUT POINT

! PERIODS 6AB, 12AB, 18AB, 23AB, AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	4 A	4 B	5 A	5 B	6 A	6 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	33.6	31.9	30.8	32.3	32.5	32.4
IBP, °F (ASTM D-86)	184.	176.	155.	162.		
10 V %	233.	247.	242.	237.		
30 V %	301.	322.	322.	313.		
50 V %	360.	395.	388.	382.		
70 V %	414.	430.	442.	427.		
90 V %	476.	496.	502.	484.		
FBP	614.	600.	615.	692.		
V % @ 400 °F	66.00	57.00	55.00	58.00		
V % @ 650 °F	100.00	100.00	100.00	100.00		
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR (H2S FREE), W %						
IBP-400 °F						
GRAVITY, °API	40.0	40.7	39.3	40.4		
SULFUR (H2S FREE), W %						
400 °F+						
GRAVITY, °API	21.6	21.8	21.2	20.9		
SULFUR (H2S FREE), W %	<.03	<.03	<.03	<.03		
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	11.8	10.8	10.6	10.6	10.6	10.2
IBP, °F (ASTM D-86)		475.		497.		608.
10 V %		508.		525.		538.
30 V %		554.		556.		573.
50 V %		588.		596.		612.
70 V %		638.				
90 V %						
FBP		650.		650.		650.
V % @ 400 °F		0.00		0.00		0.00
V % @ 650 °F		73.00		69.00		70.00
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		<.03		<.03		<.03
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	4 A	4 B	5 A	5 B	6 A	6 B
WATER						
CARBON, W %						
AMMONIA, W %						
SULFUR, W %						
CLEAN OIL TANK						
GRAVITY, °API		9.4		8.9		8.0
SLURRY MIXING TANK						
VISCOSITY, CP @ 160 °F *		355.0		1240.0	1110.0	970.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	6.0	5.1	4.5	4.9	4.5	4.7
IBP, °F (ASTM D-1160 MODIFIED)						
10 V %						
30 V %						
50 V %						
70 V %						
90 V %						
FBP						
V % @ 400 °F						
V % @ 650 °F						
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		<.03		<.03		<.03
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	4 A	4 B	5 A	5 B	6 A	6 B
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	43.89	43.53	47.21	46.03	48.10	45.88
TOLUENE SOLUBLE, W %		54.73		52.83		51.19
NON-ASH TOLUENE INSOLUBLE, W %		17.90		20.58		23.10
ASH, W %		27.37		26.59		25.71
UNREACTED COAL, W % (EST.)		12.39		11.46		10.00
TOLUENE INSOL. RESID. W % (EST.)		5.51		9.12		13.10
CARBON, W %						64.30
HYDROGEN, W %						4.32
NITROGEN, W %						1.21
SULFUR, W %		3.32		3.22		3.10
ASTM ASH, W %		27.75		27.35		26.55
COKE/ASH RATIO (DMF EXTR.)		.49		.48		.41
DMF-SOLUBLE, W %		60.29		60.29		62.60
VISCOSITY, CP @ 500 °F *		540.0		825.0		710.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)						
DISTILLATE TO 975 °F, W %						
IBP-975 °F						
GRAVITY, °API						
HYDROCLONE OVERFLOW						
GRAVITY, °API		-8.9		-10.6		-11.6
IBP, °F (ASTM D-1160 MODIFIED)		466.		482.		480.
10 V %		560.		579.		579.
30 V %		660.		683.		677.
50 V %		780.		797.		780.
70 V %		958.				
END POINT		975.00		975.00		975.00
V % @ 650 °F		27.50		23.50		24.00
V % @ END POINT		7.50		68.50		71.50
ASH, W %		6.15		6.70		0.00
RESIDUE AND SOLIDS, W %		36.01		38.70		37.29
HYDROCLONE UNDERFLOW, ASH, W %		12.74		13.05		12.53
HYDROCLONE FEED, ASH W %		9.11		11.03		10.16
FILTER CAKE						
W % OF FEED TO FILTER		24.13		27.82		24.75
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %		29.71		30.33		31.80
NON-ASH INSOLUBLE, W %		22.51		22.12		20.87
ASH, W %		47.78		47.55		47.33
INSOLUBLE RESID., W %		.89		1.63		2.46
UNREACTED COAL, W % (EST.)		21.62		20.49		18.41
0 - 5 LIQUID						
GRAVITY, °API	15.2	15.2	14.7	15.1	14.5	15.3
0 - 12 LIQUID						
GRAVITY, °API		20.0		20.0		19.4

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	4 A	4 B	5 A	5 B	6 A	6 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F		485.00		450.00		479.00
PRESSURE, TORR		1.60		1.60		2.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY		4.85		3.15		5.61
SULFUR, W %		<.03		<.03		.06
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS		8.21		6.22		
BATCH STILL RESID. FROM FILTRATE		91.79		94.78		
CALCULATED COMPOSITION, W %						
SULFUR, W %		.41		.44		
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD						
ATMOSPHERIC STILL BOTTOMS						
NET VACUUM STILL OVERHEAD						
VACUUM STILL BOTTOMS, SOLIDS FREE OIL						
CALCULATED COMPOSITION, W %						
SULFUR, W %						
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	6 AB	7 A	7 B	8 A	8 B	9 A
DATE (END OF PERIOD), 1979	9/ 7	9/ 7	9/ 8	9/ 8	9/ 9	9/ 9
HOURS OF RUN - BEGINNING	119.00	143.00	155.00	167.00	179.00	191.00
END	143.00	155.00	167.00	179.00	191.00	203.00
CATALYST INVENTORY, END, LBS	102.40	102.58	102.58	102.58	102.58	103.01
CATALYST ADDED, LBS	7.15	4.72	0 00	0.00	0.00	2.04
CATLYST WITHDRAWN, LBS *	5.16	4.50	0.00	0.00	0.00	1.61
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	282.0	297.2	325.2	353.1	381.1	402.6
ORIGINAL CHARGE (BASIS)	315.3	344.1	372.1	400.0	428.0	457.3
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.20	1.36	1.26	1.17	1.10	1.11
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	10.90	9.90	0.00	0.00	0.00	4.02
OIL, W %	30.39	34.78				40.65
MOLYDENUM (OIL FREE), W % *	7.01	7.18				6.96
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	31.84	32.66	31.92	31.86	31.98	33.51
MOISTURE W % (COAL SAMPLE)	1.69	1.59	1.53	1.40	1.27	1.48
ASH,W% (DRY COAL)	9.42		9.31		8.87	
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.24	.29	.25	.36	.26	.27
VACUUM STILL OVERHEAD	.23	.23	.26	.12	.23	.23
INVENTORY CHANGE	-.01	.02	0.00	-.02	.03	-.00
HYDROCLONE OVERFLOW (OIL)	1.22	1.17	1.19	1.17	1.17	1.11
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.70	1.67	1.70	1.67	1.63	1.62
TEMPERATURE, °F						
COAL PREHEATER OUTLET	708.	709.	713.	710.	717.	717.
REACTOR LIQUID PHASE, AVG.	848.	849.	847.	849.	847.	851.
MAX.	853.	852.	852.	852.	851.	853.
SEPARATOR-2" (@ 12" SKIN)	804.	804.	802.	804.	803.	806.
HYDROCLONE OVERFLOW	502.	503.	503.	503.	501.	505.
VACUUM STILL FLASH ZONE	531.	531.	541.	470.	542.	546.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2703.	2700.	2710.	2707.	2686.	2703.
HYDROGEN MAKE-UP, PSIG	2882.	2887.	2896.	2904.	2880.	2905.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1725.	1740.	1877.	1933.	1888.	1846.
VACUUM FLASH, TORR	4.	4.	4.	51.	5.	4.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	6 AB	7 A	7 B	8 A	8 B	9 A
RECYCLE GAS, MSCF/TON DRY COAL	37.70	35.42	36.66	36.46	36.96	34.33
VENT GAS, MSCF/TON DRY COAL	5.94	5.73	6.90	6.79	7.04	6.01
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	84.65	81.33	85.12	86.69	85.06	83.44
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	38.89	35.36	39.17	39.54	39.34	35.55
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	57.92	54.46	57.78	58.17	57.13	53.50
PARTIAL PRESSURE, PSIG(INLET)	2635.	2588.	2660.	2694.	2640.	2639.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	19.03	19.10	18.61	18.62	17.79	17.95
W % DRY COAL	5.05	5.07	4.94	4.94	4.72	4.76
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL	18.23		17.95		16.81	
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.02	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.003	.003	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	26.98	26.47	16.97	28.74	26.16	25.05
ATMOSPHERIC STILL BOTTOMS (2)	10.43	11.17	12.85	1.63	14.29	12.41
VACUUM STILL OVERHEAD (2)	.07	1.64	.56	-.61	2.10	.40
VACUUM STILL BOTTOMS	37.30	36.60	38.57	46.50	38.09	32.74
H2O	10.57	5.47	12.15	6.34	10.72	9.12
C1-C3	9.76	8.88	8.59	7.70	7.71	8.35
C4-C7	3.89	3.54	3.08	2.91	2.55	2.39
H2S IN GASES	3.80	2.57	2.32	2.59	2.60	2.43
CO2 & CO	.65	.78	.62	.57	.60	.72
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.72	1.62	1.55	1.42	1.29	1.50
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.33	.26	.33	.26	.31	.27
HYDROGEN REACTED (1)	5.05	5.07	4.94	4.94	4.72	4.76
TOTAL	107.10	106.95	106.82	106.62	106.32	106.53
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	95.96		95.58		95.74	
DMF CONVERSION (4)	95.69		95.10		95.40	

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	6 AB	7 A	7 B	8 A	8 B	9 A
NORMALIZED NET PRODUCT DISTRIBUTION*!#						
W % OF DRY COAL						
CO, CO2	.67		.78		.61	
C1-C3 HYDROCARBONS IN GASES	10.22		9.68		8.16	
C4-C7 HYDROCARBONS IN GASES	4.06		3.76		2.89	
IBP-400 °F NAPHTHA	14.47		13.79		16.35	
400-650 °F DISTILLATES	21.25		19.85		18.94	
650-975 °F DISTILLATES	7.86		9.70		7.51	
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	15.30		17.24		18.67	
TOLUENE INSOLUBLE	5.11		4.65		4.82	
UNCONVERTED COAL	3.90		4.46		5.03	
ASH	10.04		10.35		11.50	
H2O (NET)	8.27		7.22		6.78	
NH3 (FORCED NITROGEN)	.89		.93		.87	
H2S (FORCED SULFUR)	2.79		2.36		2.32	
TOTAL (100 + HYDROGEN REACTED)	104.84		104.76		104.46	
FILTERED LIQUID						
GRAVITY, °API	-4.8				-5.6	
IBP, °F (ASTM D-1160 MODIFIED)	492.				491.	
10 V %	588.				585.	
30 V %	720.				711.	
50 V %	800.				855.	
70 V %	963.					
90 V %						
FBP	975.				975.	
V % @ 400 °F	0.00				0.00	
V % @ 650 °F	25.00				26.00	
V % AT 975 °F	71.00				68.00	
SULFUR, W %	.12				.13	
W % 975 °F+	31.69				34.70	
W % SULFUR IN 975 °F+	.46				.46	
W % NITROGEN IN 975 °F+	1.47					
W % OXYGEN IN 975 °F+	2.68					

* ASTM DISTILLATION CUT POINT

! PERIODS 6AB,12AB,18AB,23AB,AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	6 AB	7 A	7 B	8 A	8 B	9 A
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	32.5	32.5	32.5	33.6	33.6	33.5
IBP, °F (ASTM D-86)	144.	136.	136.	153.	153.	140.
10 V %	239.	224.	224.	225.	225.	237.
30 V %	317.	308.	308.	316.	316.	314.
50 V %	390.	374.	374.	374.	374.	376.
70 V %	436.	426.	426.	421.	421.	420.
90 V %	502.	488.	488.	483.	483.	487.
FBP	594.	560.	560.	551.	551.	546.
V % @ 400 °F	54.00	60.00	60.00	59.00	59.00	59.00
V % @ 650 °F	100.00	100.00	160.00	100.00	100.00	100.00
CARBON, W %	85.35					
HYDROGEN, W %	11.64					
NITROGEN, W %	.31					
SULFUR (H2S FREE), W %	<.03					
IBP-400 °F						
GRAVITY, °API	40.8	41.1	41.1	41.4	41.4	41.8
SULFUR (H2S FREE), W %	<.03					
400 °F+						
GRAVITY, °API	22.8	22.5	22.5	22.9	22.9	22.7
SULFUR (H2S FREE), W %	<.03	.03	.03	.03	.03	.03
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.4	11.0	10.4	10.5	11.6	10.2
IBP, °F (ASTM D-86)	470.		500.		476.	
10 V %	521.		536.		518.	
30 V %	551.		568.		554.	
50 V %	600.		600.		590.	
70 V %	647.		650.		644.	
90 V %	741.					
FBP	845.		650.		650.	
V % @ 400 °F	0.00		0.00		0.00	
V % @ 650 °F	71.90		70.00		72.00	
CARBON, W %	88.73					
HYDROGEN, W %	9.27					
NITROGEN, W %	.53					
SULFUR, W %	<.03		<.03		<.03	
IBP-650 °F						
GRAVITY, °API	13.9					
650 °F+						
GRAVITY, °API	3.6					

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	6 AB	7 A	7 B	8 A	8 B	9 A
WATER						
CARBON, W %	2.02					
AMMONIA, W %	5.03					
SULFUR, W %	3.67					
CLEAN OIL TANK						
GRAVITY, °API	8.0		7.6		7.1	
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	1040.0		650.0		1075.0	
VACUUM STILL OVERHEAD						
GRAVITY, °API	4.6	4.9	4.5	3.1	3.6	3.4
IBP, °F (ASTM D-1160 MODIFIED)	451.					
10 V %	549.					
30 V %	626.					
50 V %	705.					
70 V %	765.					
90 V %	877.					
FBP	975.					
V % @ 400 °F	0.00					
V % @ 650 °F	37.00					
CARBON, W %	88.51					
HYDROGEN, W %	8.36					
NITROGEN, W %	.68					
SULFUR, W %	<.03		<.03		<.03	
IBP-650 °F						
GRAVITY, °API	12.3					
650 °F+						
GRAVITY, °API	.1					

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	6 AB	7 A	7 B	8 A	8 B	9 A
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	46.99	46.98	46.02	70.30	47.44	44.58
TOLUENE SOLUBLE, W %	51.19		53.33		52.35	
NON-ASH TOLUENE INSOLUBLE, W %	23.10		21.84		21.98	
ASH, W %	25.71		24.83		25.67	
UNREACTED COAL, W % (EST.)	13.10		10.70		11.23	
TOLUENE INSOL. RESID. W % (EST.)	10.00		11.14		10.75	
CARBON, W %	64.30					
HYDROGEN, W %	4.32					
NITROGEN, W %	1.21					
SULFUR, W %	3.10		3.34		3.19	
ASTM ASH, W %	26.55		25.01		26.17	
COKE/ASH RATIO (DMF EXTR.)	.41		.48		.47	
DMF-SOLUBLE, W %	62.60		62.65		61.94	
VISCOSITY, CP @ 500 °F *	710.0		480.0		851.0	
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)	890.					
DISTILLATE TO 975 °F, W %	11.40					
IBP-975 °F						
GRAVITY, °API	-6.5					
HYDROCLONE OVERFLOW						
GRAVITY, °API	-11.6		-10.5		-11.6	
IBP, °F (ASTM D-1160 MODIFIED)	480.		498.		488.	
10 V %	579.		595.		684.	
30 V %	677.		680.		682.	
50 V %	780.		798.		818.	
70 V %						
END POINT	975.00		975.00		975.00	
V % @ 650 °F	24.00		22.50		23.50	
V % @ END POINT	71.50		68.50		65.50	
ASH, W %	6.32		6.15		6.98	
RESIDUE AND SOLIDS, W %	37.29		38.48		41.99	
HYDROCLONE UNDERFLOW, ASH, W %	12.53		12.55		12.48	
HYDROCLONE FEED, ASH W %	10.16		11.09		11.20	
FILTER CAKE						
W % OF FEED TO FILTER	24.75		24.85		25.25	
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	31.80		31.18		28.85	
NON-ASH INSOLUBLE, W %	20.87		22.15		22.98	
ASH, W %	47.33		46.67		48.17	
INSOLUBLE RESID., W %	2.46		2.04		1.90	
UNREACTED COAL, W % (EST.)	18.41		20.11		21.08	
O - 5 LIQUID						
GRAVITY, °API	14.9	14.5	15.1	14.8	15.6	13.8
O - 12 LIQUID						
GRAVITY, °API	19.4		18.4		19.5	

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	6 AB	7 A	7 B	3 A	8 B	9 A
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	520.00				470.00	400.00
PRESSURE, TORR	.35				1.20	2.00
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	12.00				4.47	2.30
SULFUR, W %	.06				.04	
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	19.17				7.27	
BATCH STILL RESID. FROM FILTRATE	80.83				92.73	
CALCULATED COMPOSITION, W %						
SULFUR, W %	.36				.43	
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD	23.44					
ATMOSPHERIC STILL BOTTOMS	23.74					
NET VACUUM STILL OVERHEAD						
VACUUM STILL BOTTOMS, SOLIDS FREE OIL	52.82					
CALCULATED COMPOSITION, W %						
SULFUR, W %	.20					
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	9 B	10 A	10 B	11 A	11 B	12 A
DATE (END OF PERIOD), 1979	9/10	9/10	9/11	9/11	9/12	9/12
HOURS OF RUN - BEGINNING	203.00	215.00	227.00	239.00	251.00	263.00
END	215.00	227.00	239.00	251.00	263.00	275.00
CATALYST INVENTORY, END, LBS	103.01	103.41	103.41	103.34	103.34	103.47
CATALYST ADDED, LBS	0.00	3.61	0.00	3.65	0.00	3.67
CATLYST WITHDRAWN, LBS *	0.00	3.21	0.00	3.62	0.00	3.43
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	430.5	444.0	471.8	482.6	510.5	520.4
ORIGINAL CHARGE (BASIS)	485.2	514.1	541.9	569.3	597.2	625.0
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.05	1.13	1.07	1.14	1.08	1.15
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	7.42	0.00	7.45	0.00	7.29
OIL, W %		27.92		29.22		32.86
MOLYDENUM (OIL FREE), W % *		6.18		7.07		7.22
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	31.98	33.12	31.97	31.40	32.12	31.88
MOISTURE W % (COAL SAMPLE)	1.69	1.95	2.20	2.00	1.69	1.59
ASH,W% (DRY COAL)	8.88		8.60		8.63	
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.21	.23	.20	.31	.27	.31
VACUUM STILL OVERHEAD	.24	.26	.23	.26	.25	.26
INVENTORY CHANGE	.01	-.02	-.03	.05	-.01	.05
HYDROCLONE OVERFLOW (OIL)	1.19	1.13	1.20	1.21	1.18	1.21
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.64	1.65	1.66	1.72	1.71	1.72
TEMPERATURE, °F						
COAL PREHEATER OUTLET	718.	723.	720.	723.	727.	719.
REACTOR LIQUID PHASE, AVG.	850.	847.	850.	849.	849.	849.
MAX.	853.	851.	856.	855.	855.	853.
SEPARATOR-2" (@ 12" SKIN)	803.	803.	805.	808.	805.	805.
HYDROCLONE OVERFLOW	501.	501.	501.	502.	500.	502.
VACUUM STILL FLASH ZONE	547.	541.	545.	541.	544.	543.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2700.	2763.	2735.	2683.	2695.	2698.
HYDROGEN MAKE-UP, PSIG	2907.	2915.	2924.	2884.	2888.	2905.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1936.	1951.	1905.	1818.	1787.	1831.
VACUUM FLASH, TORR	4.	2.	3.	2.	3.	1.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	9 B	10 A	10 B	11 A	11 B	12 A
RECYCLE GAS, MSCF/TON DRY COAL	37.48	36.87	37.28	38.90	36.34	36.95
VENT GAS, MSCF/TON DRY COAL	7.28	6.45	6.72	6.21	6.23	6.06
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	85.64	86.23	84.38	83.93	83.80	85.02
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	40.38	39.29	38.88	40.18	37.87	39.01
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	68.43	67.37	67.39	68.48	65.47	66.98
PARTIAL PRESSURE, PSIG(INLET)	2675.	2692.	2668.	2619.	2624.	2661.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	18.05	18.08	18.62	18.30	17.69	17.98
W % DRY COAL	4.79	4.80	4.92	4.86	4.67	4.77
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL	17.83		17.24		17.62	
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.003	.003	.003	.003	.004
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	24.64	22.67	23.99	27.84	25.46	26.53
ATMOSPHERIC STILL BOTTOMS (2)	14.12	12.54	19.15	9.56	8.63	13.29
VACUUM STILL OVERHEAD (2)	1.05	-1.36	-1.46	3.61	6.30	3.14
VACUUM STILL BOTTOMS	38.68	39.65	37.86	41.65	38.86	40.29
H2O	9.01	11.41	8.94	7.91	8.63	8.89
C1-C3	7.02	7.47	7.86	8.77	9.16	8.62
C4-C7	2.35	2.65	2.49	2.97	2.99	2.80
H2S IN GASES	2.34	2.82	2.50	3.08	3.08	3.01
CO2 & CO	.61	.69	.62	.58	.72	.55
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.72	1.99	2.25	2.04	1.93	1.62
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.34	.31	.34	.28	.34	.36
HYDROGEN REACTED (1)	4.79	4.80	4.92	4.86	4.67	4.77
TOTAL	106.85	107.10	107.51	107.18	106.94	106.75
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	96.18		96.18		95.70	
DMF CONVERSION (4)	95.16		95.32		95.16	

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	9 B	10 A	10 B	11 A	11 B	12 A
NORMALIZED NET PRODUCT DISTRIBUTION*!#						
W % OF DRY COAL						
CO, CO2	.73		.70		.66	
C1-C3 HYDROCARBONS IN GASES	8.49		8.26		9.19	
C4-C7 HYDROCARBONS IN GASES	2.62		2.74		3.06	
IBP-400 °F NAPHTHA	15.41		15.21		15.66	
400-650 °F DISTILLATES	22.49		20.42		19.56	
650-975 °F DISTILLATES	8.90		9.21		10.07	
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	15.17		13.50		18.98	
TOLUENE INSOLUBLE	6.59		9.66		5.18	
UNCONVERTED COAL	3.79		3.95		4.15	
ASH	9.67		9.74		9.12	
H2O (NET)	7.41		7.79		6.65	
NH3 (FORCED NITROGEN)	.92		.91		.86	
H2S (FORCED SULFUR)	2.53		2.47		2.54	
TOTAL (100 + HYDROGEN REACTED)	104.73		104.58		104.68	
FILTERED LIQUID						
GRAVITY, °API					-8.3	
IBP, °F (ASTM D-1160 MODIFIED)					529.	
10 V %					626.	
30 V %					746.	
50 V %					850.	
70 V %						
90 V %						
FBP					975.	
V % @ 400 °F					0.00	
V % @ 650 °F					26.00	
V % AT 975 °F					64.00	
SULFUR, W %					.23	
W % 975 °F+					37.42	
W % SULFUR IN 975 °F+					.60	
W % NITROGEN IN 975 °F+						
W % OXYGEN IN 975 °F+						

* ASTM DISTILLATION CUT POINT

! PERIODS 6AB, 12AB, 18AB, 23AB, AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	9 B	10 A	10 B	11 A	11 B	12 A
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	33.6	34.0	34.0	32.9	32.9	33.7
IBP, °F (ASTM D-86)	140.	148.	148.	147.	147.	
10 V %	237.	237.	237.	234.	234.	
30 V %	314.	314.	314.	322.	322.	
50 V %	376.	369.	369.	377.	377.	
70 V %	420.	415.	415.	421.	421.	
90 V %	497.	471.	471.	477.	477.	
FBP	546.	532.	532.	531.	531.	
V % @ 400 °F	59.00	63.00	63.00	60.00	60.00	
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR (H2S FREE), W %						
IBP-400 °F						
GRAVITY, °API	41.8	41.1	41.1	40.0	40.0	
SULFUR (H2S FREE), W %						
400 °F+						
GRAVITY, °API	22.7	23.4	23.4	21.8	21.8	0.0
SULFUR (H2S FREE), W %	.03	.03	.03	.03	.03	0.00
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.3	10.4	10.7	10.0	9.8	10.0
IBP, °F (ASTM D-86)	502.		500.		514.	
10 V %	532.		528.		538.	
30 V %	564.		566.		570.	
50 V %	606.		606.		608.	
70 V %	649.					
90 V %						
FBP	650.		650.		650.	
V % @ 400 °F	0.00		0.00		0.00	
V % @ 650 °F	71.00		66.00		67.00	
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %	<.03		<.03		.06	
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	9 B	10 A	10 B	11 A	11 B	12 A
WATER						
CARBON, W %						
AMMONIA, W %						
SULFUR, W %						
CLEAN OIL TANK						
GRAVITY, °API	6.9		6.9		6.8	
SLURRY MIXING TANK						
VISCOSITY, CP @ 160 °F *	1300.0		2010.0		1790.0	
VACUUM STILL OVERHEAD						
GRAVITY, °API	3.6	3.6	3.7	2.9	2.8	2.8
IBP, °F (ASTM D-1160 MODIFIED)						
10 V %						
30 V %						
50 V %						
70 V %						
90 V %						
FBP						
V % @ 400 °F						
V % @ 650 °F						
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %	<.03		.07		.11	
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	9 B	10 A	10 B	11 A	11 B	12 A
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	47.23	46.56	47.24	43.09	47.15	47.47
TOLUENE SOLUBLE, W %	49.16		43.41		55.34	
NON-ASH TOLUENE INSOLUBLE, W %	26.32		32.99		22.59	
ASH, W %	24.52		23.60		22.07	
UNREACTED COAL, W % (EST.)	9.61		9.58		10.04	
TOLUENE INSOL. RESID. W % (EST.)	16.71		23.41		12.55	
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %	3.08		3.08		2.87	
ASTM ASH, W %	26.01		24.38		22.27	
COKE/ASH RATIO (DMF EXTR.)	.50		.50		.51	
DMF-SOLUBLE, W %	63.09		64.83		66.76	
VISCOSITY, CP @ 500 °F *	726.0		695.0		760.0	
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)						
DISTILLATE TO 975 °F, W %						
IBP-975 °F						
GRAVITY, °API						
HYDROCLONE OVERFLOW						
GRAVITY, °API	-10.6		-11.0		-11.4	
IBP, °F (ASTM D-1160 MODIFIED)	485.		500.		478.	
10 V %	584.		590.		580.	
30 V %	695.		678.		694.	
50 V %	796.		795.		808.	
70 V %						
END POINT	975.00		975.00		975.00	
V % @ 650 °F	22.50		21.00		21.00	
V % @ END POINT	65.50		67.00		67.00	
ASH, W %	6.25		6.44		5.79	
RESIDUE AND SOLIDS, W %	39.98		39.85		40.37	
HYDROCLONE UNDERFLOW, ASH, W %	14.17		13.60		12.43	
HYDROCLONE FEED, ASH W %	11.64		12.02		11.01	
FILTER CAKE						
W % OF FEED TO FILTER	25.70		24.60		24.38	
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	31.36		28.43		32.77	
NON-ASH INSOLUBLE, W %	21.67		23.71		22.71	
ASH, W %	46.97		47.86		44.52	
INSOLUBLE RESID., W %	3.26		4.29		2.46	
UNREACTED COAL, W % (EST.)	18.41		19.42		20.25	
0 - 5 LIQUID						
GRAVITY, °API	15.8	14.8	16.3	12.5	13.4	12.9
0 - 12 LIQUID						
GRAVITY, °API	18.7		19.7		18.2	

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	9 B	10 A	10 B	11 A	11 B	12 A
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	482.00		485.00		480.00	
PRESSURE, TORR	1.60		1.60		.40	
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	4.60		4.19		5.30	
SULFUR, W %	.13		.12		.10	
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	7.29		6.46		8.18	
BATCH STILL RESID. FROM FILTRATE	92.71		93.54		91.82	
CALCULATED COMPOSITION, W %						
SULFUR, W %					.56	
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD						
ATMOSPHERIC STILL BOTTOMS						
NET VACUUM STILL OVERHEAD						
VACUUM STILL BOTTOMS, SOLIDS FREE OIL						
CALCULATED COMPOSITION, W %						
SULFUR, W %						
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	12 B	12 AB	13 A	13 B	14 A	14 B
DATE (END OF PERIOD), 1979	9/13	9/13	9/13	9/14	9/14	9/15
HOURS OF RUN - BEGINNING	275.00	263.00	287.00	299.00	311.00	323.00
END	287.00	287.00	299.00	311.00	323.00	335.00
CATALYST INVENTORY, END, LBS	103.47	103.47	104.27	104.27	105.16	105.16
CATALYST ADDED, LBS	0.00	3.57	3.82	0.00	4.11	0.00
CATLYST WITHDRAWN, LBS *	0.00	3.43	3.02	0.00	3.22	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	548.6	548.6	555.4	582.9	585.5	612.5
ORIGINAL CHARGE (BASIS)	653.2	653.2	680.4	707.9	733.3	760.7
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.10	1.10	1.16	1.12	1.19	1.14
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	7.29	7.36	0.00	7.41	0.90
OIL, W %		32.86	35.43		32.48	
MOLYDENUM (OIL FREE), W % *		7.22	6.55		6.63	
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	32.47	32.18	31.46	31.95	30.01	31.53
MOISTURE W % (COAL SAMPLE)	1.29	1.44	1.35	1.40	1.21	1.02
ASH,W% (DRY COAL)	8.28	8.28		8.01		6.84
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.27	.29	.31	.29	.41	.30
VACUUM STILL OVERHEAD	.25	.25	.23	.25	.43	.28
INVENTORY CHANGE	-.01	-.02	-.01	.02	-.04	.03
HYDROCLONE OVERFLOW (OIL)	1.18	1.19	1.19	1.14	1.15	1.26
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.71	1.71	1.74	1.66	2.02	1.81
TEMPERATURE, °F						
COAL PREHEATER OUTLET	719.	719.	716.	718.	723.	730.
REACTOR LIQUID PHASE, AVG.	850.	850.	847.	850.	849.	848.
MAX.	854.	854.	853.	853.	851.	850.
SEPARATOR-2" (@ 12" SKIN)	805.	805.	805.	805.	806.	804.
HYDROCLONE OVERFLOW	502.	502.	503.	503.	491.	496.
VACUUM STILL FLASH ZONE	544.	543.	535.	536.	537.	539.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2695.	2696.	2688.	2698.	2694.	2709.
HYDROGEN MAKE-UP, PSIG	2898.	2901.	2907.	2905.	2899.	2921.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1893.	1362.	1874.	1770.	1753.	1818.
VACUUM FLASH, TORR	3.	2.	3.	4.	3.	4.

*10.36 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	12 B	12 AB	13 A	13 B	14 A	14 B
RECYCLE GAS, MSCF/TON DRY COAL	35.85	36.40	37.74	36.65	39.91	37.72
VENT GAS, MSCF/TON DRY COAL	6.11	6.09	5.84	5.69	5.90	6.43
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	85.07	85.05	84.99	83.67	83.26	84.50
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	38.13	38.57	39.24	37.92	41.27	40.04
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	55.46	56.22	57.94	55.00	60.61	57.38
PARTIAL PRESSURE, PSIG(INLET)	2656.	2659.	2661.	2633.	2624.	2664.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	17.34	17.66	18.70	17.08	19.34	17.34
W % DRY COAL	4.60	4.69	4.96	4.53	5.13	4.60
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL		17.26		17.24		17.55
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.002	.003	.003	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	25.67	26.10	27.70	26.50	27.71	25.59
ATMOSPHERIC STILL BOTTOMS (2)	12.52	12.91	12.48	14.82	4.66	13.48
VACUUM STILL OVERHEAD (2)	.01	1.58	.05	1.76	-1.60	2.39
VACUUM STILL BOTTOMS	40.15	40.22	40.89	41.43	48.10	40.36
H2O	10.26	9.57	10.08	10.05	11.37	8.96
C1-C3	7.48	8.05	7.20	8.75	9.49	8.74
C4-C7	2.33	2.57	2.35	2.97	3.24	3.50
H2S IN GASES	2.36	2.69	2.52	3.09	3.49	3.53
CO2 & CO	.53	.54	.52	.59	.65	.62
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.31	1.46	1.37	1.42	1.22	1.03
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.25	.31	.29	.25	.25	.25
HYDROGEN REACTED (1)	4.60	4.69	4.96	4.53	5.13	4.60
TOTAL	106.16	106.46	106.60	106.20	106.60	105.88
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	95.81	95.81		96.55		96.60
DMF CONVERSION (4)	94.90	94.90		94.82		95.68

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	12 B	12 AB	13 A	13 B	14 A	14 B
NORMALIZED NET PRODUCT DISTRIBUTION*‡						
W % OF DRY COAL						
CO, CO2		.55		.55		.64
C1-C3 HYDROCARBONS IN GASES		8.22		7.95		9.11
C4-C7 HYDROCARBONS IN GASES		2.61		2.66		3.40
IBP-400 °F NAPHTHA		15.28		15.66		15.01
400-650 °F DISTILLATES		21.13		20.81		17.91
650-975 °F DISTILLATES		8.67		8.64		7.56
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE		19.10		15.66		18.46
TOLUENE INSOLUBLE		5.74		10.14		8.38
UNCONVERTED COAL		3.94		3.22		4.05
ASH		8.49		8.14		8.74
H2O (NET)		7.36		7.65		8.02
NH3 (FORCED NITROGEN)		.28		.88		.80
H2S (FORCED SULFUR)		2.62		2.62		2.57
TOTAL (100 + HYDROGEN REACTED)		104.58		104.58		104.66
FILTERED LIQUID						
GRAVITY, °API	-9.1	-9.1		-8.4		-7.4
IBP, °F (ASTM D-1160 MODIFIED)	543.	543.		514.		516.
10 V %	640.	640.		620.		595.
30 V %	745.	745.		724.		742.
50 V %	860.	860.		840.		800.
70 V %						
90 V %						
FBP	975.	975.		975.		975.
V % @ 400 °F	0.00	0.00		0.00		0.00
V % @ 650 °F	11.00	11.00		14.00		21.00
V % AT 975 °F	64.00	64.00		66.00		69.00
SULFUR, W %	.21	.21		.36		.23
W % 975 °F+	36.85	36.85		37.48		34.65
W % SULFUR IN 975 °F+	.54	.54		.63		.67
W % NITROGEN IN 975 °F+	1.87	1.87				
W % OXYGEN IN 975 °F+	2.78	2.78				

* ASTM DISTILLATION CUT POINT

‡ PERIODS 6AB, 12AB, 18AB, 23AB, AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

‡ FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	12 B	12 AB	13 A	13 B	14 A	14 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	32.8	33.2	33.1	33.1	32.3	32.3
IBP, °F (ASTM D-86)		148.	140.	140.	134.	134.
10 V %		231.	223.	223.	222.	222.
30 V %		310.	302.	302.	300.	300.
50 V %		374.	368.	368.	376.	376.
70 V %		417.	420.	420.	424.	424.
90 V %		480.	478.	478.	482.	482.
FBP		536.	565.	565.	538.	538.
V % @ 400 °F		60.00	61.00	61.00	59.00	59.00
V % @ 650 °F		100.00	100.00	100.00	100.00	100.00
CARBON, W %		84.05				
HYDROGEN, W %		11.76				
NITROGEN, W %		.36				
SULFUR (H2S FREE), W %		.12				
IBP-400 °F						
GRAVITY, °API		40.5	41.4	41.4	39.8	39.8
SULFUR (H2S FREE), W %		.13				
400 °F+						
GRAVITY, °API		22.0	21.0	21.0	21.9	21.9
SULFUR (H2S FREE), W %		<.03	.05	.05	.05	.05
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.6	10.3	10.0	10.2	10.3	10.2
IBP, °F (ASTM D-86)	510.	467.		498.		504.
10 V %	540.	521.		526.		532.
30 V %	570.	650.		567.		566.
50 V %	610.	600.		600.		602.
70 V %		649.				
90 V %		750.				
FBP	650.	842.		650.		650.
V % @ 400 °F	0.00	0.00		0.00		0.00
V % @ 650 °F	69.00	71.00		69.00		69.00
CARBON, W %		88.51				
HYDROGEN, W %		8.99				
NITROGEN, W %		.47				
SULFUR, W %	<.03	<.03		.04		<.03
IBP-650 °F						
GRAVITY, °API		13.4				
650 °F+						
GRAVITY, °API		1.8				

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	12 B	12 AB	13 A	13 B	14 A	14 B
WATER						
CARBON, W %		3.08				
AMMONIA, W %		5.57				
SULFUR, W %		3.22				
CLEAN OIL TANK						
GRAVITY, °API	6.4	6.4		6.3		6.6
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	1535.0	1535.0		2200.0		960.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	2.7	2.8	2.5	2.8	1.3	3.2
IBP, °F (ASTM D-1160 MODIFIED)		467.				
10 V %		557.				
30 V %		631.				
50 V %		705.				
70 V %		755.				
90 V %		865.				
FBP		940.				
V % @ 400 °F		0.00				
V % @ 650 °F		33.00				
CARBON, W %		89.26				
HYDROGEN, W %		8.22				
NITROGEN, W %		.75				
SULFUR, W %	.09	.05		.10		.12
IBP-650 °F						
GRAVITY, °API		11.0				
650 °F+						
GRAVITY, °API		-.8				

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	12 B	12 AB	13 A	13 B	14 A	14 B
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	47.91	47.69	49.24	48.05	43.01	45.92
TOLUENE SOLUBLE, W %	55.83	55.83		47.57		52.14
NON-ASH TOLUENE INSOLUBLE, W %	23.53	23.53		32.59		28.10
ASH, W %	20.64	20.64		19.84		19.76
UNREACTED COAL, W % (EST.)	9.58	9.58		7.86		9.15
TOLUENE INSOL. RESID. W % (EST.)	13.95	13.95		24.73		18.95
CARBON, W %		68.03				
HYDROGEN, W %		4.35				
NITROGEN, W %		1.28				
SULFUR, W %	2.91	2.73		2.73		2.62
ASTM ASH, W %	21.55	21.55		20.73		20.41
COKE/ASH RATIO (DMF EXTR.)	.57	.57		.60		.59
DMF-SOLUBLE, W %	67.37	67.37		67.81		68.40
VISCOSITY, CP @ 500 °F *	480.0	480.0		630.0		460.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)		903.				
DISTILLATE TO 975 °F, W %		8.10				
IBP-975 °F						
GRAVITY, °API		-9.6				
HYDROCLONE OVERFLOW						
GRAVITY, °API	-11.2	-11.2		-11.4		-10.4
IBP, °F (ASTM D-1160 MODIFIED)	488.	488.		479.		483.
10 V %	586.	586.		598.		588.
30 V %	700.	700.		704.		683.
50 V %	818.	818.		808.		808.
70 V %						
END POINT	975.00	975.00		975.00		975.00
V % @ 650 °F	20.00	20.00		21.00		22.50
V % @ END POINT	66.00	66.00		65.50		68.00
ASH, W %	5.49	5.64		6.22		4.98
RESIDUE AND SOLIDS, W %	41.58	41.58		41.09		39.20
HYDROCLONE UNDERFLOW, ASH, W %	10.95	10.82		14.03		10.19
HYDROCLONE FEED, ASH W %	10.68	9.71		10.10		9.86
FILTER CAKE						
W % OF FEED TO FILTER	24.53	24.53		24.80		17.97
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	36.86	36.86		37.32		27.28
NON-ASH INSOLUBLE, W %	22.15	22.15		22.03		25.10
ASH, W %	40.99	40.99		40.65		9.86
INSOLUBLE RESID., W %	3.12	3.12		5.93		3.04
UNREACTED COAL, W % (EST.)	19.03	19.03		16.10		22.06
0 - 5 LIQUID						
GRAVITY, °API	13.8	13.3	12.2	16.9	12.5	13.6
0 - 12 LIQUID						
GRAVITY, °API	18.2	18.2		17.8		17.6

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	12 B	12 AB	13 A	13 B	14 A	14 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	435.00	508.00		468.00		463.00
PRESSURE, TORR	3.00	.25		1.20		1.60
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	8.23	9.40		8.94		5.12
SULFUR, W %	.16	.16		.13		.13
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS		13.95		13.18		7.49
BATCH STILL RESID. FROM FILTRATE		86.05		86.82		95.21
CALCULATED COMPOSITION, W %						
SULFUR, W %		.49		.56		.63
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD		21.16				
ATMOSPHERIC STILL BOTTOMS		24.48				
NET VACUUM STILL OVERHEAD		2.96				
VACUUM STILL BOTTOMS, SOLIDS FREE OIL		51.40				
CALCULATED COMPOSITION, W %						
SULFUR, W %		.27				
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	15 A	15 B	16 A	16 B	17 A	17 B
DATE (END OF PERIOD), 1979	9/15	9/16	9/16	9/17	9/17	9/18
HOURS OF RUN - BEGINNING	335.00	347.00	359.00	371.00	383.00	395.00
END	347.00	359.00	371.00	383.00	395.00	407.00
CATALYST INVENTORY, END, LBS	105.16	105.16	105.60	105.60	105.60	105.60
CATALYST ADDED, LBS	0.00	0.00	3.74	0.00	0.00	0.00
CATLYST WITHDRAWN, LBS *	0.00	0.00	3.30	0.00	0.00	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	638.9	665.6	669.1	695.6	722.7	749.0
ORIGINAL CHARGE (BASIS)	787.1	813.8	841.2	867.6	894.8	921.1
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.10	1.07	1.12	1.08	1.05	1.02
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	0.00	7.56	0.00	0.00	0.00
OIL, W %			31.10			
MOLYDENUM (OIL FREE), W % *			6.53			
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	30.86	31.23	32.05	31.07	31.92	30.87
MOISTURE W % (COAL SAMPLE)	1.08	1.15	1.36	1.56	1.47	1.39
ASH,W% (DRY COAL)		7.25		7.34		7.63
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.27	.18	.43	.48	.47	.49
VACUUM STILL OVERHEAD	.26	.28	.05	.26	.31	.25
INVENTORY CHANGE	.01	-.05	-.17	-.01	.07	.07
HYDROCLONE OVERFLOW (OIL)	1.24	1.20	1.19	1.18	1.13	1.20
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.77	1.71	1.93	1.93	1.83	1.87
TEMPERATURE, °F						
COAL PREHEATER OUTLET	722.	728.	730.	740.	736.	742.
REACTOR LIQUID PHASE, AVG.	851.	847.	848.	849.	850.	851.
MAX.	853.	849.	852.	852.	856.	855.
SEPARATOR-2" (@ 12" SKIN)	805.	799.	803.	804.	806.	806.
HYDROCLONE OVERFLOW	496.	492.	495.	495.	499.	498.
VACUUM STILL FLASH ZONE	538.	544.	578.	539.	538.	541.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2700.	2678.	2702.	2700.	2688.	2692.
HYDROGEN MAKE-UP, PSIG	2948.	2926.	2909.	2863.	2880.	2855.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1767.	1776.	1791.	1779.	1804.	1829.
VACUUM FLASH, TORR	4.	4.	3.	3.	3.	3.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	15 A	15 B	16 A	16 B	17 A	17 B
RECYCLE GAS, MSCF/TON DRY COAL	37.62	37.58	36.92	38.59	36.49	38.24
VENT GAS, MSCF/TON DRY COAL	6.01	5.94	5.49	6.01	5.69	6.31
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	83.54	84.16	84.79	83.49	84.67	84.23
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	38.81	38.80	38.55	40.30	38.48	40.28
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	56.93	55.19	55.68	57.43	55.74	57.41
PARTIAL PRESSURE, PSIG(INLET)	2672.	2654.	2656.	2590.	2631.	2597.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	18.12	16.39	17.13	17.13	17.26	17.13
W % DRY COAL	4.81	4.35	4.55	4.55	4.58	4.55
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL		17.87				15.99
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.002	.002	.002	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	26.16	26.94	24.00	28.55	18.18	23.30
ATMOSPHERIC STILL BOTTOMS (2)	13.65	11.30	-11.93	.02	4.68	5.50
VACUUM STILL OVERHEAD (2)	.89	-2.76	-2.12	.36	3.50	3.20
VACUUM STILL BOTTOMS	38.03	42.90	70.83	48.32	43.37	44.60
H2O	10.34	7.27	9.43	9.54	9.71	6.78
C1-C3	9.22		8.69	9.35	8.20	8.92
C4-C7	2.87		2.80	2.95	2.62	2.71
H2S IN GASES	3.12		3.09	3.23	2.84	2.86
CO2 & CO	.56		.56	.67	.59	.68
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.09	1.16	1.38	1.58	1.49	1.41
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.24	.20	.23	.26	.26	.31
HYDROGEN REACTED (1)	4.81	4.35	4.55	4.55	4.58	4.55
TOTAL	106.14	105.71	106.16	106.39	106.33	106.27
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)		95.68		96.03		95.82
DMF CONVERSION (4)		95.79		94.87		94.78

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	15 A	15 B	16 A	16 B	17 A	17 B
NORMALIZED NET PRODUCT DISTRIBUTION*1#						
W % OF DRY COAL						
CO, CO2		.57				.70
C1-C3 HYDROCARBONS IN GASES		9.65				9.64
C4-C7 HYDROCARBONS IN GASES		2.97				2.99
IBP-400 °F NAPHTHA		16.28				13.22
400-650 °F DISTILLATES		19.90				15.62
650-975 °F DISTILLATES		7.36				8.46
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE		20.32				17.92
TOLUENE INSOLUBLE		5.18				13.08
UNCONVERTED COAL		4.29				4.33
ASH		7.77				8.54
H2O (NET)		7.07				6.81
NH3 (FORCED NITROGEN)		.65				.49
H2S (FORCED SULFUR)		2.82				2.54
TOTAL (100 + HYDROGEN REACTED)		104.74				104.25
FILTERED LIQUID						
GRAVITY, °API		-6.4		-6.2		-7.5
IBP, °F (ASTM D-1160 MODIFIED)		516.		518.		519.
10 V %		602.		596.		591.
30 V %		769.		748.		761.
50 V %		837.		793.		830.
70 V %						
90 V %						
FBP		975.		975.		975.
V % @ 400 °F		0.00		0.00		0.00
V % @ 650 °F		19.00		24.00		22.00
V % AT 975 °F		66.00		69.00		67.00
SULFUR, W %		.27		.23		.27
W % 975 °F+		37.40		35.34		36.55
W % SULFUR IN 975 °F+		.71		.79		.81
W % NITROGEN IN 975 °F+						
W % OXYGEN IN 975 °F+						

* ASTM DISTILLATION CUT POINT

1 PERIODS 6AB, 12AB, 18AB, 23AB, AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	15 A	15 B	16 A	16 B	17 A	17 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	32.7	32.7	32.9	32.9	32.2	32.2
IBP, °F (ASTM D-86)	140.	140.	142.	142.	138.	138.
10 V %	222.	222.	221.	221.	223.	223.
30 V %	300.	300.	300.	300.	306.	306.
50 V %	362.	362.	367.	367.	376.	376.
70 V %	420.	420.	423.	423.	427.	427.
90 V %	476.	476.	475.	475.	480.	480.
FBP	538.	538.	554.	554.	541.	541.
V % @ 400 °F	62.00	62.00	63.00	63.00	60.00	60.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	100.00
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR (H2S FREE), W %						
IBP-400 °F						
GRAVITY, °API	40.3	40.3	39.6	39.6	39.6	39.6
SULFUR (H2S FREE), W %					.13	.13
400 °F+						
GRAVITY, °API	21.3	21.3	21.0	21.0	21.2	21.2
SULFUR (H2S FREE), W %	.04	.04	.03	.03	.06	.06
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.0	9.8	9.7	10.5	10.0	10.1
IBP, °F (ASTM D-86)		500.		507.		495.
10 V %		528.		532.		531.
30 V %		562.		561.		565.
50 V %		600.		600.		594.
70 V %		644.		650.		650.
90 V %						
FBP		650.		650.		650.
V % @ 400 °F		0.00		0.00		0.00
V % @ 650 °F		72.00		70.00		74.00
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		<.03		.04		.06
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	15 A	15 B	16 A	16 B	17 A	17 B
WATER						
CARBON, W %						
AMMONIA, W %						
SULFUR, W %						
CLEAN OIL TANK						
GRAVITY, °API		6.3		8.6		7.8
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	4390.0	1825.0		425.0		950.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	2.9	2.8	2.9	4.7	4.9	4.9
IBP, °F (ASTM D-1160 MODIFIED)						
10 V %						
30 V %						
50 V %						
70 V %						
90 V %						
FBP						
V % @ 400 °F						
V % @ 650 °F						
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		.14		.07		.09
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	15 A	15 B	16 A	16 B	17 A	17 B
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	45.29	47.34	78.79	51.97	46.74	50.21
TOLUENE SOLUBLE, W %		58.88		57.59		55.83
NON-ASH TOLUENE INSOLUBLE, W %		22.59		25.69		26.72
ASH, W %		18.53		16.72		17.45
UNREACTED COAL, W % (EST.)		10.23		8.37		8.84
TOLUENE INSOL. RESID. W % (EST.)		12.36		17.32		17.88
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		2.49		2.35		2.70
ASTM ASH, W %		19.26		17.48		17.66
COKE/ASH RATIO (DMF EXTR.)		.54		.65		.63
DMF-SOLUBLE, W %		71.05		72.51		71.20
VISCOSITY, CP @ 500 °F *		470.0		270.0		350.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)						
DISTILLATE TO 975 °F, W %						
IBP-975 °F						
GRAVITY, °API						
HYDROCLONE OVERFLOW						
GRAVITY, °API		-11.0		-10.1		-10.3
IBP, °F (ASTM D-1160 MODIFIED)		474.		491.		487.
10 V %		585.		580.		574.
30 V %		725.		681.		667.
50 V %		821.		806.		768.
70 V %						
END POINT		975.00		975.00		975.00
V % @ 650 °F		21.50		23.00		27.00
V % @ END POINT		65.50		67.00		66.50
ASH, W %		6.59		4.29		4.46
RESIDUE AND SOLIDS, W %		41.25		40.11		39.27
HYDROCLONE UNDERFLOW, ASH, W %		9.41		8.84		9.16
HYDROCLONE FEED, ASH W %		9.07		8.39		8.81
FILTER CAKE						
W % OF FEED TO FILTER		19.46		18.93		20.74
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %		27.92		28.81		28.54
NON-ASH INSOLUBLE, W %		26.95		25.97		26.21
ASH, W %		45.13		45.22		45.25
INSOLUBLE RESID., W %		2.03		3.33		3.29
UNREACTED COAL, W % (EST.)		24.92		22.64		22.92
0 - 5 LIQUID						
GRAVITY, °API	13.1	12.8	12.6	12.5	13.4	13.4
0 - 12 LIQUID						
GRAVITY, °API		17.2		18.0		18.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	15 A	15 B	16 A	16 B	17 A	17 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F		437.00		488.00		488.00
PRESSURE, TORR		1.40		1.20		1.20
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY		3.00		12.42		7.67
SULFUR, W %		.20		.24		.28
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS		4.28		16.51		10.77
BATCH STILL RESID. FROM FILTRATE		95.72		83.49		89.23
CALCULATED COMPOSITION, W %						
SULFUR, W %		.69		.70		.75
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD						
ATMOSPHERIC STILL BOTTOMS						
NET VACUUM STILL OVERHEAD						
VACUUM STILL BOTTOMS, SOLIDS FREE OIL						
CALCULATED COMPOSITION, W %						
SULFUR, W %						
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	18 A	18 B	18 AB	19 A	19 B	20 A
DATE (END OF PERIOD), 1979	9/18	9/19	9/19	9/19	9/20	9/20
HOURS OF RUN - BEGINNING	407.00	419.00	407.00	431.00	443.00	455.00
END	419.00	431.00	431.00	443.00	455.00	467.00
CATALYST INVENTORY, END, LBS	106.61	106.61	106.61	107.69	107.69	108.03
CATALYST ADDED, LBS	4.50	0.00	4.50	4.66	0.00	2.22
CATLYST WITHDRAWN, LBS *	3.48	0.00	3.48	3.58	0.00	1.89
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	743.4	769.8	769.8	762.8	788.7	798.5
ORIGINAL CHARGE (BASIS)	947.7	974.1	974.1	1000.9	1026.8	1053.2
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.08	1.05	1.05	1.11	1.08	1.09
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	7.37	0.00	7.37	7.37	0.00	4.37
OIL, W %	26.55		26.55	23.89		29.45
MOLYDENUM (OIL FREE), W %-*	6.63		6.63	6.57		6.30
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	31.35	31.29	31.32	31.89	31.00	31.57
MOISTURE W % (COAL SAMPLE)	1.56	1.72	1.64	1.53	1.35	1.65
ASH,W% (DRY COAL)		8.65	8.65		7.76	
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.47	.31	.39	.31	.29	.26
VACUUM STILL OVERHEAD	.24	.20	.22	.23	.24	.23
INVENTORY CHANGE	.10	.01	.05	.01	-.02	.00
HYDROCLONE OVERFLOW (OIL)	1.08	1.15	1.11	1.18	1.28	1.26
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.69	1.65	1.67	1.71	1.84	1.75
TEMPERATURE, °F						
COAL PREHEATER OUTLET	740.	741.	741.	739.	758.	740.
REACTOR LIQUID PHASE, AVG.	850.	851.	851.	849.	849.	851.
MAX.	854.	854.	854.	855.	855.	857.
SEPARATOR-2" (@ 12" SKIN)	792.	774.	783.	722.	778.	772.
HYDROCLONE OVERFLOW	501.	499.	500.	492.	490.	485.
VACUUM STILL FLASH ZONE	540.	542.	541.	533.	544.	543.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2682.	2686.	2684.	2688.	2680.	2695.
HYDROGEN MAKE-UP, PSIG	2880.	2897.	2888.	2910.	2902.	2950.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1763.	1739.	1751.	1747.	1814.	1780.
VACUUM FLASH, TORR	2.	2.	2.	2.	2.	2.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	18 A	18 B	18 AB	19 A	19 B	20 A
RECYCLE GAS, MSCF/TON DRY COAL	37.08	36.93	37.00	36.89	39.E9	37.31
VENT GAS, MSCF/TON DRY COAL	6.38	6.27	6.33	6.08	6.60	6.24
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	83.47	82.74	83.11	82.70	84.92	82.65
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	38.48	37.41	37.95	37.10	40.96	37.44
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	55.70	54.30	55.00	53.89	57.36	54.39
PARTIAL PRESSURE, PSIG(INLET)	2608.	2606.	2607.	2615.	2642.	2649.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	17.22	16.89	17.05	16.79	16.41	16.95
W % DRY COAL	4.57	4.48	4.53	4.46	4.36	4.50
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL			16.68		17.46	
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.004	.003	.003	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	28.82	26.95	27.89	21.40	26.19	24.97
ATMOSPHERIC STILL BOTTOMS (2)	10.06	15.51	12.78	12.38	13.32	11.45
VACUUM STILL OVERHEAD (2)	4.15	.81	2.48	2.53	-.52	.49
VACUUM STILL BOTTOMS	43.86	49.71	46.78	37.03	43.52	41.72
H2O	9.18	7.91	8.54	7.11	11.17	6.72
C1-C3	8.99	9.53	9.26	8.94	8.86	8.95
C4-C7	2.76	2.94	2.85	2.83	2.62	2.68
H2S IN GASES	3.01	3.15	3.08	3.35	2.97	2.95
CO2 & CO	.70	.63	.66	.64	.53	.59
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.58	1.75	1.67	1.55	1.37	1.68
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.38	.31	.34	.33	.29	.31
HYDROGEN REACTED (1)	4.67	4.48	4.53	4.46	4.36	4.50
TOTAL	106.53	106.54	106.51	106.34	106.02	106.49
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)		95.75	95.75		95.92	
DMF CONVERSION (4)		93.32	93.32		94.89	

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	18 A	18 B	18 AB	19 A	19 B	20 A
NORMALIZED NET PRODUCT DISTRIBUTION*1*						
W % OF DRY COAL						
CO, CO2			.62		.62	
C1-C3 HYDROCARBONS IN GASES			8.67		9.34	
C4-C7 HYDROCARBONS IN GASES			2.67		2.87	
IBP-400 °F NAPHTHA			16.02		16.33	
400-650 °F DISTILLATES			19.83		18.55	
650-975 °F DISTILLATES			9.11		9.03	
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE			18.18		15.75	
TOLUENE INSOLUBLE			8.83		9.11	
UNCONVERTED COAL			3.65		4.11	
ASH			8.14		8.48	
H2O (NET)			5.52		7.16	
NH3 (FORCED NITROGEN)			.55		.58	
H2S (FORCED SULFUR)			2.64		2.70	
TOTAL (100 + HYDROGEN REACTED)			104.43		104.63	
FILTERED LIQUID						
GRAVITY, °API		-7.5	-7.5		-8.5	
IBP, °F (ASTM D-1160 MODIFIED)		504.	504.		523.	
10 V %		588.	588.		611.	
30 V %		718.	718.		710.	
50 V %		833.	833.		802.	
70 V %						
90 V %						
FBP		975.	975.		975.	
V % @ 400 °F		0.00	0.00		0.00	
V % @ 650 °F		23.00	23.00		19.00	
V % AT 975 °F		66.00	66.00		68.00	
SULFUR, W %		.31	.31		.42	
W % 975 °F+		37.34	37.34		36.70	
W % SULFUR IN 975 °F+		.62	.62		.63	
W % NITROGEN IN 975 °F+		1.59	1.59		0.00	
W % OXYGEN IN 975 °F+		3.05	3.05		0.00	

* ASTM DISTILLATION CUT POINT

1 PERIODS 6AB,12AB,18AB,23AB,AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

* FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	18 A	18 B	18 AB	19 A	19 B	20 A
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	33.0	32.8	32.9	33.3	33.3	32.9
IBP, °F (ASTM D-86)			141.	135.	135.	140.
10 V %			227.	215.	215.	222.
30 V %			307.	296.	296.	302.
50 V %			368.	360.	360.	368.
70 V %			410.	407.	407.	414.
90 V %			465.	455.	455.	465.
FBP			541.	535.	535.	566.
V % @ 400 °F			64.00	68.00	68.00	65.00
V % @ 650 °F			100.00	100.00	100.00	100.00
CARBON, W %			85.60			
HYDROGEN, W %			11.57			
NITROGEN, W %			.33			
SULFUR (H2S FREE), W %			.18			
IBP-400 °F						
GRAVITY, °API			39.5	39.1	39.1	38.8
SULFUR (H2S FREE), W %			.07	.14	.14	.13
400 °F+						
GRAVITY, °API			21.6	20.9	20.9	20.6
SULFUR (H2S FREE), W %			.08	.07	.07	.10
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.4	10.4	10.1	10.2	10.1	9.7
IBP, °F (ASTM D-86)		495.	459.		497.	
10 V %		521.	508.		525.	
30 V %		552.	551.		556.	
50 V %		585.	584.		593.	
70 V %		629.	633.		644.	
90 V %		0.	724.			
FBP		650.	789.		650.	
V % @ 400 °F		0.00	0.00		0.00	
V % @ 650 °F		72.00	76.00		72.00	
CARBON, W %			83.74		0.00	
HYDROGEN, W %			9.02		0.00	
NITROGEN, W %			.48		0.00	
SULFUR, W %		.05	.04		.03	
IBP-650 °F						
GRAVITY, °API			13.5		0.0	
650 °F+						
GRAVITY, °API			3.1		0.0	

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	18 A	18 B	18 AB	19 A	19 B	20 A
WATER						
CARBON, W %			2.27			
AMMONIA, W %			5.08			
SULFUR, W %			3.74			
CLEAN OIL TANK						
GRAVITY, °API		8.3	8.3		7.6	
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *		2430.0	2430.0	1910.0	2630.0	4320.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	4.5	3.8	4.1	3.5	3.6	3.7
IBP, °F (ASTM D-1160 MODIFIED)			432.			
10 V %			537.			
30 V %			606.			
50 V %			660.			
70 V %			730.			
90 V %			836.			
FBP			920.			
V % @ 400 °F			0.00			
V % @ 650 °F			47.00			
CARBON, W %			89.21			
HYDROGEN, W %			8.08			
NITROGEN, W %			.69			
SULFUR, W %		.10	.11		.08	
IBP-650 °F						
GRAVITY, °API			10.6			
650 °F+						
GRAVITY, °API			-1.2			

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	18 A	18 B	18 AB	19 A	19 B	20 A
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	50.24	56.18	53.21	46.01	50.09	50.12
TOLUENE SOLUBLE, W %		52.86	52.86		48.60	
NON-ASH TOLUENE INSOLUBLE, W %		28.54	28.54		31.31	
ASH, W %		18.60	18.60		20.09	
UNREACTED COAL, W % (EST.)		8.35	8.35		9.73	
TOLUENE INSOL. RESID. W % (EST.)		20.19	20.19		21.58	
CARBON, W %			71.54			
HYDROGEN, W %			4.50			
NITROGEN, W %			1.51			
SULFUR, W %		2.76	2.75		2.76	
ASTM ASH, W %		18.57	18.57		20.55	
COKE/ASH RATIO (DMF EXTR.)		.71	.71		.61	
DMF-SOLUBLE, W %		69.31	69.31		67.49	
VISCOSITY, CP @ 500 °F *		450.0	450.0		595.0	
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)			881.			
DISTILLATE TO 975 °F, W %			10.50			
IBP-975 °F						
GRAVITY, °API						
HYDROCLONE OVERFLOW						
GRAVITY, °API		-12.0	-12.0		-11.5	
IBP, °F (ASTM D-1160 MODIFIED)		468.	468.		464.	
10 V %		571.	571.		576.	
30 V %		698.	698.		692.	
50 V %		820.	820.		817.	
70 V %					0.	
END POINT		975.00	975.00		975.00	
V % @ 650 °F		24.50	24.50		23.50	
V % @ END POINT		65.50	65.50		64.50	
ASH, W %		6.25	5.21		5.25	
RESIDUE AND SOLIDS, W %		42.02	42.02		42.37	
HYDROCLONE UNDERFLOW, ASH, W %		13.06	13.06		10.56	
HYDROCLONE FEED, ASH W %		9.51	9.51		9.15	
FILTER CAKE						
W % OF FEED TO FILTER		21.54	21.54		22.00	
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %		27.40	27.40		27.83	
NON-ASH INSOLUBLE, W %		25.41	25.41		26.28	
ASH, W %		47.19	47.19		45.89	
INSOLUBLE RESID., W %		4.23	4.23		4.05	
UNREACTED COAL, W % (EST.)		21.18	21.18		22.23	
O - 5 LIQUID						
GRAVITY, °API	13.6	13.4	13.5	12.5	12.9	13.0
O - 12 LIQUID						
GRAVITY, °API		17.5	17.5		17.7	

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	18 A	18 B	18 AB	19 A	19 B	20 A
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F		397.00	503.00		383.00	
PRESSURE, TORR		1.20	.21		1.20	
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY		12.15	11.30		12.15	
SULFUR, W %		.26	.26		.33	
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS			16.30		7.54	
BATCH STILL RESID. FROM FILTRATE			83.70		92.46	
CALCULATED COMPOSITION, W %						
SULFUR, W %			.66		.61	
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD			18.41			
ATMOSPHERIC STILL BOTTOMS			21.87			
NET VACUUM STILL OVERHEAD			4.24			
VACUUM STILL BOTTOMS, SOLIDS FREE OIL			55.48			
CALCULATED COMPOSITION, W %						
SULFUR, W %			.34			
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	20 B	21 A	21 B	22 A	22 B	23 A
DATE (END OF PERIOD), 1979	9/21	9/21	9/22	9/22	9/23	9/23
HOURS OF RUN - BEGINNING	467.00	479.00	491.00	503.00	515.00	527.00
END	479.00	491.00	503.00	515.00	527.00	539.00
CATALYST INVENTORY, END, LBS	108.03	108.35	108.35	108.81	108.81	108.93
CATALYST ADDED, LBS	0.00	3.77	0.00	3.71	0.00	2.10
CATLYST WITHDRAWN, LBS *	0.00	3.45	0.00	3.25	0.00	1.98
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	824.3	821.7	847.9	845.0	870.9	880.6
ORIGINAL CHARGE (BASIS)	1079.0	1105.5	1131.7	1158.1	1184.0	1210.7
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.07	1.11	1.08	1.12	1.09	1.10
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	7.46	0.00	7.49	0.00	4.22
OIL, W %		28.01		27.16		24.49
MOLYDENUM (OIL FREE), W % *		6.62		6.13		6.40
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	31.04	31.77	31.67	31.81	31.35	32.25
MOISTURE W % (COAL SAMPLE)	1.95	1.80	1.64	1.52	1.40	1.61
ASH,W% (DRY COAL)	7.93		7.69		7.43	
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.33	.35	.21	.25	.28	.22
VACUUM STILL OVERHEAD	.27	.28	.26	.25	.29	.26
INVENTORY CHANGE	-.02	.06	-.03	.01	-.01	-.01
HYDROCLONE OVERFLOW (OIL)	1.24	1.20	1.21	1.21	1.22	1.18
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.86	1.77	1.72	1.69	1.79	1.64
TEMPERATURE, °F						
COAL PREHEATER OUTLET	742.	747.	738.	745.	749.	742.
REACTOR LIQUID PHASE, AVG.	848.	851.	850.	849.	850.	849.
MAX.	853.	856.	855.	854.	854.	854.
SEPARATOR-2" (@ 12" SKIN)	769.	772.	769.	769.	768.	766.
HYDROCLONE OVERFLOW	489.	496.	491.	495.	498.	493.
VACUUM STILL FLASH ZONE	535.	543.	543.	549.	545.	544.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2696.	2686.	2700.	2678.	2680.	2682.
HYDROGEN MAKE-UP, PSIG	2917.	2877.	2950.	2921.	2900.	2940.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1884.	1784.	1703.	1702.	1751.	1748.
VACUUM FLASH, TORR	2.	2.	1.	1.	1.	1.

*10.36 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	20 B	21 A	21 B	22 A	22 B	23 A
RECYCLE GAS, MSCF/TON DRY COAL	38.03	36.34	35.71	36.72	37.26	36.12
VENT GAS, MSCF/TON DRY COAL	6.78	6.12	6.16	6.15	6.41	6.26
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	86.47	83.39	80.96	82.02	83.59	83.29
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	40.57	37.07	35.51	36.83	38.30	36.96
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	56.63	53.24	51.61	53.11	54.07	52.43
PARTIAL PRESSURE, PSIG(INLET)	2687.	2597.	2620.	2611.	2619.	2650.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	16.05	16.17	16.10	16.28	15.76	15.47
W % DRY COAL	4.26	4.29	4.27	4.32	4.19	4.11
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL	16.52		17.41		16.89	
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.003	.003	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	24.01	25.37	23.16	25.73	22.91	21.86
ATMOSPHERIC STILL BOTTOMS (2)	8.20	11.09	14.64	12.63	11.62	14.07
VACUUM STILL OVERHEAD (2)	-.20	3.60	-1.45	1.17	.42	1.37
VACUUM STILL BOTTOMS	50.05	42.10	42.95	42.35	45.49	44.29
H2O	10.21	7.72	8.43	7.12	8.63	9.54
C1-C3	7.93	8.50	9.54	9.88	9.33	9.10
C4-C7	2.64	2.61	3.12	3.11	3.04	2.66
H2S IN GASES	3.07	2.97	3.39	3.33	3.41	3.22
CO2 & CO	.65	.62	.73	.71	.71	.71
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.99	1.83	1.67	1.64	1.42	1.64
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.33	.31	.32	.32	.31	.32
HYDROGEN REACTED (1)	4.26	4.29	4.27	4.32	4.19	4.11
TOTAL	106.58	106.43	106.26	106.18	105.92	106.07
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	96.10		95.99		96.28	
DMF CONVERSION (4)	94.38		94.53		94.20	

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PRODUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	20 B	21 A	21 B	22 A	22 B	23 A
NORMALIZED NET PRODUCT DISTRIBUTION*‡						
W % OF DRY COAL						
CO, CO2	.65		.70		.72	
C1-C3 HYDROCARBONS IN GASES	8.76		9.28		9.71	
C4-C7 HYDROCARBONS IN GASES	2.76		2.95		3.11	
IBP-400 °F NAPHTHA	15.82		15.63		14.28	
400-650 °F DISTILLATES	17.00		19.47		19.46	
650-975 °F DISTILLATES	7.82		8.77		8.40	
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE	22.86		19.86		18.34	
TOLUENE INSOLUBLE	7.41		8.01		9.38	
UNCONVERTED COAL	3.73		3.56		3.43	
ASH	8.24		7.39		7.40	
H2O (NET)	6.16		5.80		5.88	
NH3 (FORCED NITROGEN)	.50		.54		.45	
H2S (FORCED SULFUR)	2.68		2.76		2.91	
TOTAL (100 + HYDROGEN REACTED)	104.39		104.62		104.48	
FILTERED LIQUID						
GRAVITY, °API	-8.6		-6.1		-9.4	
IBP, °F (ASTM D-1160 MODIFIED)	536.		523.		539.	
10 V %	618.		610.		631.	
30 V %	709.		750.		740.	
50 V %	833.		851.		850.	
70 V %						
90 V %						
FBP	975.		975.		975.	
V % @ 400 °F	0.00		0.00		0.00	
V % @ 650 °F	18.00		18.00		15.00	
V % AT 975 °F	63.00		64.00		63.00	
SULFUR, W %	.31		.41		.45	
W % 975 °F+	41.04		37.59		40.98	
W % SULFUR IN 975 °F+	71		.72		.71	
W % NITROGEN IN 975 °F+						
W % OXYGEN IN 975 °F+						

* ASTM DISTILLATION CUT POINT

‡ PERIODS 6AB, 12AB, 18AB, 23AB, AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

‡ FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	20 B	21 A	21 B	22 A	22 B	23 A
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	32.6	31.9	31.9	31.9	31.9	31.8
IBP, °F (ASTM D-86)	143.	140.	140.	140.	140.	
10 V %	221.	222.	222.	218.	218.	
30 V %	305.	302.	302.	306.	306.	
50 V %	368.	368.	368.	372.	372.	
70 V %	412.	414.	414.	416.	416.	
90 V %	465.	465.	465.	482.	482.	
FBP	556.	566.	565.	560.	560.	
V % @ 400 °F	65.00	65.00	65.00	61.00	61.00	
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00	
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR (H2S FREE), W %						
IBP-400 °F						
GRAVITY, °API	38.8	38.1	38.1	39.9	39.9	
SULFUR (H2S FREE), W %	.13	.14	.14	.16	.16	
400 °F+						
GRAVITY, °API	20.5	19.6	19.6	20.5	20.5	
SULFUR (H2S FREE), W %	.10	.08	.08	.09	.09	
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	10.1	9.8	10.2	9.5	9.5	9.3
IBP, °F (ASTM D-86)	500.		485.		484.	
10 V %	522.		518.		520.	
30 V %	554.		546.		552.	
50 V %	591.		585.		590.	
70 V %	638.		640.		642.	
90 V %						
FBP	975.		650.		650.	
V % @ 400 °F	0.00		0.00		0.00	
V % @ 650 °F	74.00		74.00		74.00	
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %	.04		.04		.06	
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	20 B	21 A	21 B	22 A	22 B	23 A
WATER						
CARBON, W %						
AMMONIA, W %						
SULFUR, W %						
CLEAN OIL TANK						
GRAVITY, °API	6.9		6.5		6.0	
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	2025.0		3880.0		3920.0	
VACUUM STILL OVERHEAD						
GRAVITY, °API	3.4	3.6	3.4	2.8	2.6	2.5
IBP, °F (ASTM D-1160 MODIFIED)						
10 V %						
30 V %						
50 V %						
70 V %						
90 V %						
FBP						
V % @ 400 °F						
V % @ 650 °F						
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %	.10		.12		.16	
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	20 B	21 A	21 B	22 A	22 B	23 A
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	51.46	46.60	48.60	49.26	48.37	49.85
TOLUENE SOLUBLE, W %	59.22		56.58		53.33	
NON-ASH TOLUENE INSOLUBLE, W %	23.44		26.50		29.99	
ASH, W %	17.34		16.92		16.68	
UNREACTED COAL, W % (EST.)	7.85		8.15		7.73	
TOLUENE INSOL. RESID. W % (EST.)	15.59		18.35		22.26	
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %	2.49		2.53		2.40	
ASTM ASH, W %	19.19		17.68		17.23	
COKE/ASH RATIO (DMF EXTR.)	.65		.66		.72	
DMF-SOLUBLE, W %	68.96		71.85		71.25	
VISCOSITY, CP @ 500 °F *	440.0		440.0		450.0	
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)						
DISTILLATE TO 975 °F, W %						
IBP-975 °F						
GRAVITY, °API						
HYDROCLONE OVERFLOW						
GRAVITY, °API	-11.4		-11.5		-11.5	
IBP, °F (ASTM D-1160 MODIFIED)	480.		485.		493.	
10 V %	585.		578.		585.	
30 V %	704.		695.		700.	
50 V %	822.		832.		822.	
70 V %						
END POINT	975.00		975.00		975.00	
V % @ 650 °F	23.50		22.50		22.00	
V % @ END POINT	65.00		64.50		64.00	
ASH, W %	5.19		5.02		5.00	
RESIDUE AND SOLIDS, W %	41.94		42.24		42.37	
HYDROCLONE UNDERFLOW, ASH, W %	10.13		8.80		14.92	
HYDROCLONE FEED, ASH W %	8.09		7.08		9.89	
FILTER CAKE						
W % OF FEED TO FILTER	20.50		20.29		20.42	
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	34.05		28.66		29.84	
NON-ASH INSOLUBLE, W %	22.93		25.38		25.05	
ASH, W %	43.02		45.96		45.11	
INSOLUBLE RESID., W %	3.46		3.24		4.15	
UNREACTED COAL, W % (EST.)	19.47		22.14		20.90	
0 - 5 LIQUID						
GRAVITY, °API	12.8	13.4	13.2	13.2	13.6	13.9
0 - 12 LIQUID						
GRAVITY, °API	17.0		17.2		17.0	

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	20 B	21 A	21 B	22 A	22 B	23 A
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	428.00		347.00		429.00	
PRESSURE, TORR	1.20		1.60		1.20	
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	6.10		7.92		5.94	
SULFUR, W %	.24		.33		.33	
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	8.85		11.02		8.34	
BATCH STILL RESID. FROM FILTRATE	91.15		88.98		91.66	
CALCULATED COMPOSITION, W %						
SULFUR, W %	.67		.68		.68	
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD						
ATMOSPHERIC STILL BOTTOMS						
NET VACUUM STILL OVERHEAD						
VACUUM STILL BOTTOMS, SOLIDS FREE OIL						
CALCULATED COMPOSITION, W %						
SULFUR, W %						
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	23 B	23 AB	24 A	24 B	25 A	25 B
DATE (END OF PERIOD), 1979	9/24	9/24	9/24	9/25	9/25	9/26
HOURS OF RUN - BEGINNING	539.00	527.00	551.00	563.00	575.00	587.00
END	551.00	551.00	563.00	575.00	587.00	599.00
CATALYST INVENTORY, END, LBS	108.93	108.93	109.11	109.11	109.63	109.63
CATALYST ADDED, LBS	0.00	2.10	3.74	0.00	3.87	0.00
CATLYST WITHDRAWN, LBS *	0.00	1.98	3.56	0.00	3.35	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	906.0	906.0	900.5	926.0	918.3	944.0
ORIGINAL CHARGE (BASIS)	1236.1	1236.1	1262.1	1287.6	1313.0	1338.7
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.07	1.07	1.11	1.09	1.12	1.10
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	0.00	4.22	7.49	0.00	7.61	0.00
OIL, W %		24.49	27.13		28.49	
MOLYDENUM (OIL FREE), W % *		6.40	6.71		6.34	
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	30.78	31.51	31.37	30.93	30.80	31.35
MOISTURE W % (COAL SAMPLE)	1.81	1.71	1.95	2.08	2.08	2.08
ASH,W% (DRY COAL)	6.88	6.88		7.20		7.63
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.30	.26	.28	.27	.25	.30
VACUUM STILL OVERHEAD	.27	.27	.28	.27	.23	.28
INVENTORY CHANGE	-.01	-.12	.03	-.00	-.03	0.00
HYDROCLONE OVERFLOW (OIL)	1.24	1.21	1.25	1.24	1.26	1.24
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.83	1.74	1.78	1.79	1.83	1.83
TEMPERATURE, °F						
COAL PREHEATER OUTLET	759.	751.	768.	783.	779.	781.
REACTOR LIQUID PHASE, AVG.	849.	849.	849.	850.	850.	850.
MAX.	853.	854.	853.	853.	855.	853.
SEPARATOR-2" (@ 12" SKIN)	767.	767.	768.	766.	766.	769.
HYDROCLONE OVERFLOW	498.	496.	497.	493.	492.	500.
VACUUM STILL FLASH ZONE	542.	543.	545.	544.	546.	543.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2681.	2681.	2675.	2665.	2667.	2685.
HYDROGEN MAKE-UP, PSIG	2927.	2933.	2904.	2900.	2946.	2950.
HYDROGEN PARTIAL PRESSURE, PSIG						
(REACTOR OUTLET - SEPARATOR)	1825.	1787.	1785.	1790.	1795.	1717.
VACUUM FLASH, TORR	1.	1.	1.	1.	1.	1.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	23 B	23 AB	24 A	24 B	25 A	25 B
RECYCLE GAS, MSCF/TON DRY COAL	38.70	37.41	38.08	37.64	37.79	38.11
VENT GAS, MSCF/TON DRY COAL	6.81	6.53	6.48	6.93	6.55	6.92
HYDROGEN PURITY						
OF RECYCLE GAS AND VENT, %	84.72	84.01	83.06	83.06	84.16	82.00
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	40.32	38.64	38.70	38.65	39.09	38.60
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	56.12	54.28	54.64	54.26	55.61	54.87
PARTIAL PRESSURE, PSIG(INLET)	2661.	2655.	2611.	2609.	2673.	2635.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	15.80	15.64	15.94	15.61	16.52	16.27
W % DRY COAL	4.20	4.15	4.23	4.14	4.39	4.32
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL		16.21		16.05		16.57
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.003	.003	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	24.65	23.26	23.78	22.64	24.73	22.75
ATMOSPHERIC STILL BOTTOMS (2)	8.94	11.50	11.30	13.48	9.54	11.27
VACUUM STILL OVERHEAD (2)	.08	.72	2.03	.63	.53	.69
VACUUM STILL BOTTOMS	47.41	45.85	46.25	43.96	43.18	48.83
H2O	6.91	8.23	6.61	9.43	5.98	9.53
C1-C3	9.10	9.10	8.99	8.99	8.76	10.38
C4-C7	2.63	2.65	2.59	2.62	2.55	3.08
H2S IN GASES	3.07	3.15	3.04	3.12	3.39	3.64
CO2 & CO	.65	.68	.70	.62	.72	.81
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.84	1.74	1.99	2.12	2.12	2.12
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.34	.33	.33	.34	.34	.33
HYDROGEN REACTED (1)	4.20	4.15	4.23	4.14	4.39	4.32
TOTAL	106.38	106.22	106.55	106.85	106.85	106.77
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)	96.55	96.55		96.09		95.49
DMF CONVERSION (4)	94.45	94.45		93.82		93.56

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PRODUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	23 B	23 AB	24 A	24 B	25 A	25 B
NORMALIZED NET PRODUCT DISTRIBUTION*!#						
W % OF DRY COAL						
CO, CO2		.69		.68		.79
C1-C3 HYDROCARBONS IN GASES		9.81		9.13		9.81
C4-C7 HYDROCARBONS IN GASES		2.67		2.65		2.90
IBP-400 °F NAPHTHA		14.68		14.66		15.16
400-650 °F DISTILLATES		17.27		18.30		16.91
650-975 °F DISTILLATES		8.67		9.25		8.17
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE		21.66		20.14		22.29
TOLUENE INSOLUBLE		8.74		9.04		8.12
UNCONVERTED COAL		3.47		3.92		4.16
ASH		7.45		7.76		7.63
H2O (NET)		5.95		5.46		5.20
NH3 (FORCED NITROGEN)		.43		.43		.44
H2S (FORCED SULFUR)		2.82		2.85		2.83
TOTAL (100 + HYDROGEN REACTED)		104.30		104.26		104.40
FILTERED LIQUID						
GRAVITY, °API	-7.2	-7.2		-5.9		-9.3
IBP, °F (ASTM D-1160 MODIFIED)	540.	540.		543.		525.
10 V %	628.	628.		624.		634.
30 V %	746.	746.		745.		763.
50 V %	873.	873.		854.		862.
70 V %						
90 V %						
FBP	975.	975.		975.		975.
V % @ 400 °F	0.00	0.00		0.00		0.00
V % @ 650 °F	16.00	16.00		14.00		13.00
V % AT 975 °F	61.00	61.00		61.00		63.00
SULFUR, W %	.38	.38		.33		.38
W % 975 °F+	40.25	40.25		39.84		40.93
W % SULFUR IN 975 °F+	.72	.72		.65		.67
W % NITROGEN IN 975 °F+	1.76	1.76				
W % OXYGEN IN 975 °F+	3.23	3.23				

* ASTM DISTILLATION CUT POINT

! PERIODS 6AB,12AB,18AB,23AB,AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	23 B	23 AB	24 A	24 B	25 A	25 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	32.0	31.9	32.2	32.2	31.7	31.7
IBP, °F (ASTM D-86)		144.	140.	140.	141.	141.
10 V %		200.	215.	215.	220.	220.
30 V %		304.	305.	305.	305.	305.
50 V %		368.	367.	367.	368.	368.
70 V %		414.	413.	413.	414.	414.
90 V %		465.	462.	462.	464.	464.
FBP		665.	568.	568.	570.	570.
V % @ 400 °F		65.00	65.00	65.00	65.00	65.00
V % @ 650 °F		100.00	100.00	100.00	100.00	100.00
CARBON, W %		87.33				
HYDROGEN, W %		12.06				
NITROGEN, W %		.42				
SULFUR (H2S FREE), W %		.17				
IBP-400 °F						
GRAVITY, °API		38.2	39.3	39.3	38.6	38.6
SULFUR (H2S FREE), W %		.20	.13	.13	.12	.12
400 °F+						
GRAVITY, °API		20.1	19.4	19.4	19.7	19.7
SULFUR (H2S FREE), W %		.11	.13	.13	.09	.09
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	9.5	9.4	9.5	9.6	9.0	9.3
IBP, °F (ASTM D-86)	494.	469.		494.		496.
10 V %	625.	611.		628.		623.
30 V %	656.	647.		656.		655.
50 V %	690.	693.		694.		695.
70 V %	648.	646.		648.		648.
90 V %		770.				
FBP	650.	890.		650.		650.
V % @ 400 °F	0.00	0.00		0.00		0.00
V % @ 650 °F	72.00	72.00		72.00		72.00
CARBON, W %		88.71				
HYDROGEN, W %		8.84				
NITROGEN, W %		.69				
SULFUR, W %	.08	.11		.09		.04
IBP-650 °F						
GRAVITY, °API		12.6				
650 °F+						
GRAVITY, °API		2.3				

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	23 B	23 AB	24 A	24 B	25 A	25 B
WATER						
CARBON, W %	2.00	2.00				
AMMONIA, W %	4.78	4.78				
SULFUR, W %	1.94	1.94				
CLEAN OIL TANK						
GRAVITY, °API	5.1	5.1		5.6		5.4
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *	5831.0	5830.0		6500.0		5980.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	2.5	2.5	2.3	2.6	2.2	2.3
IBP, °F (ASTM D-1160 MODIFIED)		457.				
10 V %		553.				
30 V %		635.				
50 V %		750.				
70 V %		794.				
90 V %		859.				
FBP		992.				
V % @ 400 °F		0.00				
V % @ 650 °F		36.00				
CARBON, W %		89.33				
HYDROGEN, W %		8.13				
NITROGEN, W %		.75				
SULFUR, W %	.14	.17		.17		.15
IBP-650 °F						
GRAVITY, °API		7.9				
650 °F+						
GRAVITY, °API		-.9				

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	23 B	23 AB	24 A	24 B	25 A	25 B
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	50.01	49.93	49.60	48.29	49.48	50.56
TOLUENE SOLUBLE, W %	57.60	57.60		54.82		57.77
NON-ASH TOLUENE INSOLUBLE, W %	26.33	26.33		28.25		26.05
ASH, W %	16.07	16.07		16.93		16.18
UNREACTED COAL, W % (EST.)	7.49	7.49		8.54		8.83
TOLUENE INSOL. RESID. W % (EST.)	18.84	18.84		19.71		17.22
CARBON, W %		73.32				
HYDROGEN, W %		4.78				
NITROGEN, W %		1.47				
SULFUR, W %	2.47	2.44		2.43		2.40
ASTM ASH, W %	17.08	17.08		17.42		16.49
COKE/ASH RATIO (DMF EXTR.)	.75	.75		.80		.78
DMF-SOLUBLE, W %	71.47	71.47		70.05		70.87
VISCOSITY, CP @ 500 °F *	690.0	690.0		520.0		550.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)		872.				
DISTILLATE TO 975 °F, W %		8.50				
IBP-975 °F						
GRAVITY, °API		-9.8				
HYDROCLONE OVERFLOW						
GRAVITY, °API	-12.5	-12.5		-11.8		-13.1
IBP, °F (ASTM D-1160 MODIFIED)	494.	494.		478.		473.
10 V %	598.	598.		587.		593.
30 V %	708.	708.		700.		711.
50 V %	840.	840.		820.		830.
70 V %						
END POINT	975.00	975.00		975.00		975.00
V % @ 650 °F	19.00	19.00		23.00		19.00
V % @ END POINT	63.00	63.00		63.50		63.50
ASH, W %	4.90	4.90		4.65		4.71
RESIDUE AND SOLIDS, W %	43.94	43.94		42.98		44.10
HYDROCLONE UNDERFLOW, ASH, W %	11.95	11.95		9.60		9.20
HYDROCLONE FEED, ASH W %	6.77	6.77		6.76		6.17
FILTER CAKE						
W % OF FEED TO FILTER	20.00	20.00		18.40		20.22
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %	30.03	30.03		24.62		29.86
NON-ASH INSOLUBLE, W %	24.70	24.70		27.27		26.90
ASH, W %	45.27	45.27		48.11		43.24
INSOLUBLE RESID., W %	3.59	3.59		3.00		3.31
UNREACTED COAL, W % (EST.)	21.11	21.71		24.27		23.59
0 - 5 LIQUID						
GRAVITY, °API	12.2	13.0	12.7	12.7	13.0	12.7
0 - 12 LIQUID						
GRAVITY, °API	16.4	16.4		16.6		16.0

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	23 B	23 AB	24 A	24 B	25 A	25 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F	441.00	601.00		452.00		456.00
PRESSURE, TORR	1.40	.20		1.20		1.60
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	6.96	10.90		6.61		7.00
SULFUR, W %	.36	.36		.28		.27
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS		15.25		9.29		9.88
BATCH STILL RESID. FROM FILTRATE		84.75		90.71		90.12
CALCULATED COMPOSITION, W %						
SULFUR, W %		.67		.62		.63
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD		16.24				
ATMOSPHERIC STILL BOTTOMS		21.60				
NET VACUUM STILL OVERHEAD		1.38				
VACUUM STILL BOTTOMS, SOLIDS FREE OIL		60.88				
CALCULATED COMPOSITION, W %						
SULFUR, W %		.44				
SULFUR (ACTUAL), W %		0.00				

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES (HRI 3830), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	26 A	26 B	27 A	27 B	28 A	28 B
DATE (END OF PERIOD), 1979	9/26	9/27	9/27	9/28	9/28	9/29
HOURS OF RUN - BEGINNING	599.00	611.00	623.00	635.00	647.00	659.00
END	611.00	623.00	635.00	647.00	659.00	671.00
CATALYST INVENTORY, END, LBS	109.62	109.62	109.74	109.74	110.60	110.60
CATALYST ADDED, LBS	3.64	0.00	3.63	0.00	3.90	0.00
CATLYST WITHDRAWN, LBS *	3.65	0.00	3.51	0.00	3.14	0.00
CATALYST AGE (END), LB DRY COAL/LB						
AVERAGE (BASIS)	937.5	963.3	957.1	982.7	973.7	999.7
ORIGINAL CHARGE (BASIS)	1363.9	1389.7	1415.7	1441.3	1467.3	1493.3
CATALYST ADDED, CUMULATIVE						
LBS/TON DRY COAL	1.13	1.11	1.13	1.11	1.14	1.12
CATALYST WITHDRAWALS						
WITHDRAWAL, OIL LADEN, LBS	7.61	0.00	7.47	0.00	7.55	0.00
OIL, W %	24.13		26.12		34.40	
MOLYDENUM (OIL FREE), W % *	6.52		6.56		6.53	
COAL FEED (DRY)						
LBS/HR/CU FT REACTOR VOLUME	30.64	31.51	31.70	31.27	31.85	31.92
MOISTURE W % (COAL SAMPLE)	2.11	2.13	1.80	1.47	1.54	1.60
ASH,W% (DRY COAL)		7.12		7.51		7.40
RECYCLE FLOWS, LBS/LB SOLIDS						
ATMOSPHERIC STILL BOTTOMS	.09	.48	.38	.28	.35	.30
VACUUM STILL OVERHEAD	.26	.25	.17	.17	.07	.17
INVENTORY CHANGE	-.36	.22	.14	.02	-.03	-.02
HYDROCLONE OVERFLOW (OIL)	1.24	1.17	1.20	1.23	1.18	1.20
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	1.96	1.68	1.61	1.61	1.63	1.69
TEMPERATURE, °F						
COAL PREHEATER OUTLET	789.	788.	784.	778.	772.	774.
REACTOR LIQUID PHASE, AVG.	850.	850.	850.	850.	850.	849.
MAX.	855.	854.	856.	854.	855.	856.
SEPARATOR-2" (@ 12" SKIN)	773.	767.	766.	768.	769.	771.
HYDROCLONE OVERFLOW	498.	481.	481	483.	488.	498.
VACUUM STILL FLASH ZONE	548.	546.	551	547.	546.	541.
PRESSURE						
UNIT BACK PRESSURE, PSIG	2672.	2675.	2679	2698.	2700.	2702.
HYDROGEN MAKE-UP, PSIG	2909.	2900.	2929	2933.	2933.	2945.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1765.	1740.	1685	1754.	1747.	1783.
VACUUM FLASH, TORR	1.	1.	2	2.	2.	1.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	26 A	26 B	27 A	27 B	28 A	28 B
RECYCLE GAS, MSCF/TON DRY COAL	40.60	37.30	36.56	37.49	36.74	36.90
VENT GAS, MSCF/TON DRY COAL	6.90	6.71	6.42	6.97	6.64	6.81
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	84.38	83.76	82.70	84.13	82.84	83.75
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	41.90	38.61	37.19	39.29	37.61	38.40
HYDROGEN, MAKE-UP + RECYCLE						
MSCF/TON DRY COAL	58.40	54.82	53.92	55.94	54.75	55.87
PARTIAL PRESSURE, PSIG(INLET)	2638.	2625.	2635.	2664.	2643.	2673.
HYDROGEN CONSUMPTION (1)						
MSCF/TON DRY COAL	16.50	16.21	16.73	16.65	17.14	17.47
W % DRY COAL	4.38	4.30	4.44	4.42	4.55	4.64
CHEMICAL HYDROGEN CONSUMPTION						
MSCF/TON DRY COAL		15.41		16.63		
OIL ADDITIONS						
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.003	.003	.003	.003	.003
COLLECTED PRODUCT QUANTITY, W % DRY COAL						
ATMOSPHERIC STILL OVERHEAD	20.57	14.85	16.20	18.17	14.92	16.55
ATMOSPHERIC STILL BOTTOMS (2)	12.67	17.11	11.61	20.67	7.57	18.37
VACUUM STILL OVERHEAD (2)	1.78	8.90	5.43	1.66	10.58	-.18
VACUUM STILL BOTTOMS	46.58	44.82	39.41	41.93	42.17	43.44
H2O	9.29	6.85	9.60	7.16	10.33	11.70
C1-C3	9.74	9.62	10.13	10.06	9.69	9.40
C4-C7	3.31	3.22	3.64	3.39	3.06	3.09
H2S IN GASES	3.95	3.83	3.49	3.84	3.35	3.14
CO2 & CO	.82	.73	.87	.84	.84	.87
INPUT QUANTITIES, W % DRY COAL						
DRY COAL	100.00	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	2.16	2.18	1.83	1.49	1.56	1.63
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.35	.33	.32	.33	.32	.32
HYDROGEN REACTED (1)	4.38	4.30	4.44	4.42	4.55	4.64
TOTAL	106.89	106.81	106.59	106.24	106.43	106.59
COAL CONVERSION, W % M.A.F. COAL						
TOLUENE CONVERSION (3)		95.78		96.44		96.47
DMF CONVERSION (4)		93.94		94.35		94.74

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	26 A	26 B	27 A	27 B	28 A	28 B
NORMALIZED NET PRODUCT DISTRIBUTION*I#						
W % OF DRY COAL						
CO, CO2		.76		.88		
C1-C3 HYDROCARBONS IN GASES		9.55		10.46		
C4-C7 HYDROCARBONS IN GASES		3.21		3.55		
IBP-400 °F NAPHTHA		12.82		12.67		
400-650 °F DISTILLATES		17.75		19.01		
650-975 °F DISTILLATES		11.16		10.36		
975 °F+ RESIDUAL OIL						
TOLUENE SOLUBLE		13.64		17.69		
TOLUENE INSOLUBLE		15.32		8.70		
UNCONVERTED COAL		4.04		3.49		
ASH		7.34		7.97		
H2O (NET)		5.17		6.30		
NH3 (FORCED NITROGEN)		.42		.48		
H2S (FORCED SULFUR)		2.91		2.86		
TOTAL (100 + HYDROGEN REACTED)		104.09		104.42		
FILTERED LIQUID**						
GRAVITY, °API		-10.7		1.7		-3.6
IBP, °F (ASTM D-1160 MODIFIED)		519.		420.		436.
10 V %		646.		493.		525.
30 V %		743.		570.		615.
50 V %		837.		648.		700.
70 V %				760.		898.
90 V %						
FBP		975.		975.		975.
V % @ 400 °F		0.00		0.00		0.00
V % @ 650 °F		11.00		51.00		38.00
V % AT 975 °F		62.00		87.00		76.00
SULFUR, W %		.39		.33		.48
W % 975 °F+		43.64		24.86		44.90
W % SULFUR IN 975 °F+		.64		.74		.62
W % NITROGEN IN 975 °F+						1.79
W % OXYGEN IN 975 °F+						2.98

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 27 TO 29 FILTRATION OF HYDROCLONE UNDERFLOW (HUF) WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS (ASB) FROM THE SAME PERIOD AS PUSHER (TWO WEIGHTS OF HUF PER WEIGHT OF ASB). GRAVITY AND DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. SULFUR AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HUF.

I PERIODS 6AB,12AB,18AB,23AB,AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

\# FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	26 A	26 B	27 A	27 B	28 A	28 B
ATMOSPHERIC STILL OVERHEAD*						
GRAVITY, °API	33.6	36.5	36.3	36.3	36.5	36.2
IBP, °F (ASTM D-86)	150.	141.	138.	138.		
10 V %	218.	206.	210.	210.		
30 V %	296.	265.	269.	269.		
50 V %	357.	330.	330.	330.		
70 V %	406.	383.	385.	385.		
90 V %	465.	452.	471.	471.		
FBP	572.	567.	592.	592.		
V % @ 400 °F	67.00	76.00	74.00	74.00		
V % @ 650 °F	100.00	100.00	100.00	100.00		
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR (H2S FREE), W %						
IBP-400 °F						
GRAVITY, °API	40.1	42.1	42.3	42.3		
SULFUR (H2S FREE), W %	.17	.14	.18	.18		
400 °F+						
GRAVITY, °API	20.2	20.1	20.0	20.0		
SULFUR (H2S FREE), W %	.13	.08	.12	.12		
ATMOSPHERIC STILL BOTTOMS						
GRAVITY, °API	9.3	10.7	11.0	11.3	11.0	10.8
IBP, °F (ASTM D-86)		418.		412.		405.
10 V %		469.		458.		458.
30 V %		521.		508.		508.
50 V %		568.		564.		567.
70 V %		626.		631.		625.
90 V %						
FBP		650.		650.		650.
V % @ 400 °F		0.00		0.00		0.00
V % @ 650 °F		78.00		77.00		74.00
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		.06		.11		.07
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	26 A	26 B	27 A	27 B	28 A	28 B
WATER						
CARBON, W %						
AMMONIA, W %						
SULFUR, W %						
CLEAN OIL TANK						
GRAVITY, °API		7.3		7.8		8.4
SLURRY MIXING TANK						
VISCOSITY, CP @ 150 °F *		6450.0	19100.0	8820.0	4125.0	7250.0
VACUUM STILL OVERHEAD						
GRAVITY, °API	2.3	2.3	2.9	2.8	2.9	2.7
IBP, °F (ASTM D-1160 MODIFIED)						
10 V %						
30 V %						
50 V %						
70 V %						
90 V %						
FBP						
V % @ 400 °F						
V % @ 650 °F						
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		.13		.17		.13
IBP-650 °F						
GRAVITY, °API						
650 °F+						
GRAVITY, °API						

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	26 A	26 B	27 A	27 B	28 A	28 B
VACUUM STILL BOTTOMS						
W % OF VACUUM STILL FEED	50.07	50.72	52.56	53.77	54.85	54.86
TOLUENE SOLUBLE, W %		49.71		52.11		54.66
NON-ASH TOLUENE INSOLUBLE, W %		34.00		28.95		25.24
ASH, W %		16.29		18.94		20.10
UNREACTED COAL, W % (EST.)		8.97		8.29		8.88
TOLUENE INSOL. RESID. W % (EST.)		25.03		20.66		16.36
CARBON, W %						
HYDROGEN, W %						
NITROGEN, W %						
SULFUR, W %		2.37		2.61		2.90
ASTM ASH, W %		16.36		19.34		20.27
COKE/ASH RATIO (DMF EXTR.)		.79		.70		.66
DMF-SOLUBLE, W %		70.99		68.02		67.04
VISCOSITY, CP @ 500 °F *		640.0		620.0		500.0
VACUUM DISTILLATION						
IBP, °F (ASTM D-1160 MODIFIED)						
DISTILLATE TO 975 °F, W %						
IBP-975 °F						
GRAVITY, °API						
HYDROCLONE OVERFLOW						
GRAVITY, °API		-13.6		-13.9		-14.7
IBP, °F (ASTM D-1160 MODIFIED)		460.		433.		436.
10 V %		588.		584.		587.
30 V %		720.		726.		715.
50 V %		834.		855.		825.
70 V %						
END POINT		975.00		975.00		975.00
V % @ 650 °F		22.00		20.00		18.50
V % @ END POINT		63.50		61.00		61.00
ASH, W %		5.24		6.16		6.56
RESIDUE AND SOLIDS, W %		0.00		46.49		46.43
HYDROCLONE UNDERFLOW, ASH, W %		13.69		13.18		11.65
HYDROCLONE FEED, ASH W %		6.71		7.53		7.86
FILTER CAKE						
W % OF FEED TO FILTER		20.12		20.12		21.45
TOLUENE EXTRACTION OF CAKE						
SOLUBLE, W %		28.62		25.50		29.64
NON-ASH INSOLUBLE, W %		28.50		25.34		24.02
ASH, W %		42.88		49.16		46.34
INSOLUBLE RESID., W %		4.88		3.81		3.54
UNREACTED COAL, W % (EST.)		23.62		21.53		20.48
0 - 5 LIQUID						
GRAVITY, °API	13.9	13.8	13.1	12.4	11.1	13.5
0 - 12 LIQUID						
GRAVITY, °API		15.8		16.6		15.9

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	26 A	26 B	27 A	27 B	28 A	28 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT						
VACUUM DISTILLATION						
FINAL VAPOR TEMP. °F		490.00		489.00		480.00
PRESSURE, TORR		1.20		1.20		1.80
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY		5.50		5.97		11.17
SULFUR, W %		.26		.23		.26
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %						
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS		7.75		8.78		
BATCH STILL RESID. FROM FILTRATE		92.25		91.22		
CALCULATED COMPOSITION, W %						
SULFUR, W %		.61		.70		
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %						
ATMOSPHERIC STILL OVERHEAD						
ATMOSPHERIC STILL BOTTOMS						
NET VACUUM STILL OVERHEAD						
VACUUM STILL BOTTOMS, SOLIDS FREE OIL						
CALCULATED COMPOSITION, W %						
SULFUR, W %						
SULFUR (ACTUAL), W %						

UNIT 130 - H-COAL OPERATIONS ON KENTUCKY NO. 11 COAL (HRI 4091,4092,4100, AND 4101)
CATALYST: AMERICAN CYANAMID HDS-1442A, 1/16" EXTRUDATES.(HRI 3330), 103 LBS. DRY INITIAL CHARGE
REACTOR VOLUME: 7.49 CUBIC FEET
RUN NUMBER 130- 89

PERIOD	28 AB	29 A	29 B	30 A	30 B
DATE (END OF PERIOD), 1979	9/29	9/29	9/30	9/30	9/30
HOURS OF RUN - BEGINNING	647.00	671.00	683.00	695.00	707.00
END	671.00	683.00	695.00	707.00	713.00
CATALYST INVENTORY, END, LBS	110.50	110.50	110.50	107.20	107.20
CATALYST ADDED, LBS	3.90	0.00	0.00	0.00	0.00
CATLYST WITHDRAWN, LBS *	3.14	0.00	0.00	3.30	0.00
CATALYST AGE (END), LB DRY COAL/LB					
AVERAGE (BASIS)	999.7	1025.5	1051.1	1076.5	1088.8
ORIGINAL CHARGE (BASIS)	1493.3	1519.1	1544.7	1570.1	1582.4
CATALYST ADDED, CUMULATIVE					
LBS/TON DRY COAL	1.12	1.10	1.08	1.06	1.06
CATALYST WITHDRAWALS					
WITHDRAWAL, OIL LADEN, LBS	7.65	0.00	0.00	7.95	0.00
OIL, W %	34.40			35.81	
MOLYDENUM (OIL FREE), W % *	6.53			6.66	
COAL FEED (DRY)					
LBS/HR/CU FT REACTOR VOLUME	31.88	31.73	31.45	30.78	29.29
MOISTURE W % (COAL SAMPLE)	1.57	1.66	1.71		
ASH,W% (DRY COAL)	7.40		7.68		
RECYCLE FLOWS, LBS/LB SOLIDS					
ATMOSPHERIC STILL BOTTOMS	.33	0.00	.24	.16	.02
VACUUM STILL OVERHEAD	.12	.32	.18	.19	.22
INVENTORY CHANGE	-.02	.03	-.02	-.11	-.39
HYDROCLONE OVERFLOW (OIL)	1.19	1.19	1.21	1.24	1.26
MAKE-UP OIL	0.00	0.00	0.00	0.00	0.00
TOTAL	1.66	1.67	1.65	1.70	1.89
TEMPERATURE, °F					
COAL PREHEATER OUTLET	773.	783.	778.	780.	787.
REACTOR LIQUID PHASE, AVG.	850.	848.	848.	849.	849.
MAX.	856.	854.	854.	854.	854.
SEPARATOR-2" (@ 12" SKIN)	770.	766.	766.	765.	769.
HYDROCLONE OVERFLOW	489.	489.	489.	489.	486.
VACUUM STILL FLASH ZONE	544.	545.	544.	547.	543.
PRESSURE					
UNIT BACK PRESSURE, PSIG	2701.	2706.	2692.	2698.	2660.
HYDROGEN MAKE-UP, PSIG	2939.	2910.	2926.	2921.	2870.
HYDROGEN PARTIAL PRESSURE, PSIG (REACTOR OUTLET - SEPARATOR)	1765.	1860.	1746.	1799.	1772.
VACUUM FLASH, TORR	1.	1.	1.	1.	1.

*10.30 W% MOLYBDENUM IN FRESH CATALYST.

PERIOD	28 AB	29 A	29 B	30 A	30 B
RECYCLE GAS, MSCF/TON DRY COAL	36.82	38.02	37.09	38.86	39.52
VENT GAS, MSCF/TON DRY COAL	6.73	7.37	6.80	7.38	6.72
HYDROGEN PURITY OF RECYCLE GAS AND VENT, %	83.30	84.83	82.23	82.69	82.37
TOTAL H2, MSCF/TON DRY COAL (REACTOR OUTLET)	38.00	40.21	37.71	39.90	39.84
HYDROGEN, MAKE-UP + RECYCLE					
MSCF/TON DRY COAL	55.31	56.33	54.58	56.42	57.62
PARTIAL PRESSURE, PSIG(INLET)	2658.	2653.	2624.	2623.	2574.
HYDROGEN CONSUMPTION (1)					
MSCF/TON DRY COAL	17.30	16.12	16.87	16.51	17.77
W % DRY COAL	4.59	4.28	4.48	4.38	4.72
CHEMICAL HYDROGEN CONSUMPTION					
MSCF/TON DRY COAL	15.79		17.22		17.59
OIL ADDITIONS					
MAKE-UP OIL, LBS/LB DRY COAL	0.00	0.00	0.00	0.00	0.00
LBS/HR/CU FT REACTOR	0.00	0.00	0.00	0.00	0.00
FLUSH OIL,LBS/LB DRY COAL	.003	.003	.003	.003	.004
COLLECTED PRODUCT QUANTITY, W % DRY COAL					
ATMOSPHERIC STILL OVERHEAD	15.74	20.52	15.95	16.61	18.67
ATMOSPHERIC STILL BOTTOMS (2)	12.97	19.48	20.43	24.99	38.47
VACUUM STILL OVERHEAD (2)	5.20	1.90	-.67	-6.93	-40.75
VACUUM STILL BOTTOMS	42.80	43.66	41.50	42.58	55.05
H2O	11.02	4.72	8.49	9.02	10.54
C1-C3	9.54	9.02	9.61	9.60	9.53
C4-C7	3.08	2.92	3.07	2.87	2.87
H2S IN GASES	3.24	3.28	3.55	3.27	3.24
CO2 & CO	.85	.79	.79	.73	.74
INPUT QUANTITIES, W % DRY COAL					
DRY COAL	100.00	100.00	100.00	100.00	100.00
MOISTURE IN FEED COAL	1.60	1.69	1.74	1.74	1.74
MAKE-UP OIL ADDITIONS	0.00	0.00	0.00	0.00	0.00
FLUSH OIL	.32	.32	.33	.35	.37
HYDROGEN REACTED (1)	4.59	4.28	4.48	4.38	4.72
TOTAL	106.51	106.29	106.55	106.47	106.83
COAL CONVERSION, W % M.A.F. COAL					
TOLUENE CONVERSION (3)	96.47		96.22		96.34
DMF CONVERSION (4)	94.74		94.42		94.55

(1) BASED ON ORIFICE FLOWS FOR HYDROGEN, METERED FLOWS FOR OTHER GASES AND ANALYSES.
(2) NEGATIVE VALUES INDICATE DECREASES IN INVENTORY OF SLURRY OIL HOLDING TANK.
(3) BASED ON FILTRATION OF PROUCT SLURRY FED TO VACUUM STILL.
(4) BASED ON EXTRACTION OF VACUUM BOTTOMS PRODUCT.

PERIOD	28 AB	29 A	29 B	30 A	30 B
NORMALIZED NET PRODUCT DISTRIBUTION*‡					
W % OF DRY COAL					
CO, CO2	.88		.81		.79
C1-C3 HYDROCARBONS IN GASES	9.80		9.59		10.21
C4-C7 HYDROCARBONS IN GASES	3.16		3.09		3.08
IBP-400 °F NAPHTHA	11.89		13.56		12.78
400-650 °F DISTILLATES	16.10		21.04		22.05
650-975 °F DISTILLATES	10.88		9.37		.48
975 °F+ RESIDUAL OIL					
TOLUENE SOLUBLE	20.14		19.86		17.08
TOLUENE INSOLUBLE	7.45		7.57		13.74
UNCONVERTED COAL	3.64		3.72		4.26
ASH	8.27		8.19		9.67
H2O (NET)	8.82		4.51		7.62
NH3 (FORCED NITROGEN)	.46		.61		.64
H2S (FORCED SULFUR)	2.70		2.66		2.29
TOTAL (100 + HYDROGEN REACTED)	104.19		104.57		104.67
FILTERED LIQUID**					
GRAVITY, °API	-3.6		-2.8		
IBP, °F (ASTM D-1160 MODIFIED)	436.		447.		
10 V %	525.		503.		
30 V %	615.		614.		
50 V %	700.		707.		
70 V %	898.		877.		
90 V %					
FBP	975.		975.		
V % @ 400 °F	0.00		0.00		
V % @ 650 °F	38.00		40.00		
V % AT 975 °F	76.00		78.00		
SULFUR, W %	.48		.40		
W % 975 °F+	44.90		44.19		
W % SULFUR IN 975 °F+	.62		.73		
W % NITROGEN IN 975 °F+	1.79				
W % OXYGEN IN 975 °F+	2.98				

* ASTM DISTILLATION CUT POINT

** FOR PERIODS 27 TO 29 FILTRATION OF HYDROCLONE UNDERFLOW (HUF) WAS CARRIED OUT WITH THE ADDITION OF ATMOSPHERIC STILL BOTTOMS (ASB) FROM THE SAME PERIOD AS PUSHER (TWO WEIGHTS OF HUF PER WEIGHT OF ASB). GRAVITY AND DISTILLATION DATA ARE FOR DILUTED SOLIDS-FREE LIQUID. SULFUR AND 975 °F+ DATA ARE FOR UNDILUTED SOLIDS-FREE LIQUID OF HUF.

‡ PERIODS 6AB, 12AB, 18AB, 23AB, AND 28AB ARE WORKUP PERIODS AND HAVE NORMALIZED YIELDS BASED ON COMPLETE ELEMENTAL AND DISTILLATION ANALYSES. FOR CALCULATION OF NORMALIZED YIELD DISTRIBUTION OF OTHER PERIODS, INTERPOLATED ELEMENTAL AND DISTILLATION VALUES FROM WORKUP PERIODS WERE USED.

‡ FOR PERIODS OTHER THAN THE WORKUP PERIODS, NORMALIZED YIELDS FOR THE COMBINED A/B PERIOD ARE PRESENTED IN B PERIOD.

PERIOD	28 AB	29 A	29 B	30 A	30 B
ATMOSPHERIC STILL OVERHEAD*					
GRAVITY, °API	36.3	35.9	35.9	35.6	35.6
IBP, °F (ASTM D-86)	136.	133.	133.	136.	136.
10 V %	214.	216.	216.	215.	215.
30 V %	270.	273.	273.	275.	275.
50 V %	322.	327.	327.	330.	330.
70 V %	378.	389.	389.	392.	392.
90 V %	475.	460.	460.	478.	478.
FBP	592.	572.	572.	586.	586.
V % @ 400 °F	75.00	75.00	75.00	72.00	72.00
V % @ 650 °F	100.00	100.00	100.00	100.00	100.00
CARBON, W %	86.92				
HYDROGEN, W %	12.25				
NITROGEN, W %	.28				
SULFUR (H2S FREE), W %	.15				
IBP-400 °F					
GRAVITY, °API	42.1	41.9	41.9	42.1	42.1
SULFUR (H2S FREE), W %	.13	.14	.14	.12	.12
400 °F+					
GRAVITY, °API	20.3	20.0	20.0	20.0	20.0
SULFUR (H2S FREE), W %	.11	.10	.10	.15	.15
ATMOSPHERIC STILL BOTTOMS					
GRAVITY, °API	10.9	11.3	10.9	10.6	10.7
IBP, °F (ASTM D-86)	388.		403.		408.
10 V %	452.		452.		458.
30 V %	510.		503.		508.
50 V %	566.		555.		565.
70 V %	629.		617.		634.
90 V %	772.				
FBP	910.		650.		650.
V % @ 400 °F	2.00		0.00		0.00
V % @ 650 °F	75.00		78.00		76.00
CARBON, W %	88.16		0.00		0.00
HYDROGEN, W %	9.21		0.00		0.00
NITROGEN, W %	.71		0.00		0.00
SULFUR, W %	.08		.14		.11
IBP-650 °F					
GRAVITY, °API	14.4				
650 °F+					
GRAVITY, °API	1.8				

* IDENTICAL VALUES FOR A AND B PERIODS INDICATE THAT THE DATA WERE ACTUALLY FOR THE COMBINED A/B PERIOD.

PERIOD	28 AB	29 A	29 B	30 A	30 B
WATER					
CARBON, W %	1.99				
AMMONIA, W %	4.22				
SULFUR, W %	2.88				
CLEAN OIL TANK					
GRAVITY, °API	8.4		8.0		
SLURRY MIXING TANK					
VISCOSITY, CP @ 150 °F *	5730.0		10190.0		
VACUUM STILL OVERHEAD					
GRAVITY, °API	2.8	3.0	3.0	2.9	3.0
IBP, °F (ASTM D-1160 MODIFIED)	412.				
10 V %	521.				
30 V %	618.				
50 V %	671.				
70 V %	752.				
90 V %	860.				
FBP	1010.				
V % @ 400 °F	0.00				
V % @ 650 °F	39.00				
CARBON, W %	88.38				
HYDROGEN, W %	8.06				
NITROGEN, W %	.96				
SULFUR, W %	.13				
IBP-650 °F					
GRAVITY, °API	11.0				
650 °F+					
GRAVITY, °API	-.1				

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	28 AB	29 A	29 B	30 A	30 B
VACUUM STILL BOTTOMS					
W % OF VACUUM STILL FEED	54.85	53.72	53.24	52.33	56.08
TOLUENE SOLUBLE, W %	54.66		55.48		53.03
NON-ASH TOLUENE INSOLUBLE, W %	25.24		25.80		27.59
ASH, W %	20.10		18.72		19.38
UNREACTED COAL, W % (EST.)	8.88		8.50		8.53
TOLUENE INSOL. RESID. W % (EST.)	16.36		17.30		19.06
CARBON, W %	70.80				
HYDROGEN, W %	4.48				
NITROGEN, W %	1.48				
SULFUR, W %	2.86		2.41		2.88
ASTM ASH, W %	20.27		19.16		19.57
COKE/ASH RATIO (DMF EXTR.)	.66		.67		.66
DMF-SOLUBLE, W %	67.04		68.45		67.98
VISCOSITY, CP @ 500 °F *	500.0		490.0		650.0
VACUUM DISTILLATION					
IBP, °F (ASTM D-1160 MODIFIED)	908.				
DISTILLATE TO 975 °F, W %	8.60				
IBP-975 °F					
GRAVITY, °API	-10.2				
HYDROCLONE OVERFLOW					
GRAVITY, °API	-14.7		-14.1		-12.8
IBP, °F (ASTM D-1160 MODIFIED)	436.		438.		447.
10 V %	582.		584.		585.
30 V %	715.		732.		705.
50 V %	825.		862.		855.
70 V %					
END POINT	975.00		975.00		975.00
V % @ 650 °F	18.50		19.50		20.00
V % @ END POINT	61.00		61.00		62.00
ASH, W %	6.56		6.45		6.02
RESIDUE AND SOLIDS, W %	46.43		46.58		45.30
HYDROCLONE UNDERFLOW, ASH, W %	11.65		10.58		
HYDROCLONE FEED, ASH W %	7.86		7.71		
FILTER CAKE					
W % OF FEED TO FILTER	21.45		22.05		
TOLUENE EXTRACTION OF CAKE					
SOLUBLE, W %	29.64		27.37		
NON-ASH INSOLUBLE, W %	24.02		24.95		
ASH, W %	46.34		47.68		
INSOLUBLE RESID., W %	3.54		3.30		
UNREACTED COAL, W % (EST.)	20.48		21.65		
0 - 5 LIQUID					
GRAVITY, °API	13.5	15.4	15.8	15.8	8.4
0 - 12 LIQUID					
GRAVITY, °API	15.9		16.8		

* AVERAGE OF BROOKFIELD VISCOSITY VALUES AT 5-100 RPM. THE SLURRY HAS NON-NEWTONIAN PROPERTIES.

PERIOD	28 AB	29 A	29 B	30 A	30 B
BATCH DISTILLATON OF VACUUM BOTTOMS SLURRY PRODUCT					
VACUUM DISTILLATION					
FINAL VAPOR TEMP. °F	508.00		474.00		
PRESSURE, TORR	.25		1.20		
DISTILLATE, W % OF VACUUM BOTTOMS SLURRY	10.10		6.57		
SULFUR, W %	.26		.24		
CALCULATED COMPOSITION OF SOLIDS-FREE OIL IN VACUUM BOTTOMS SLURRY PRODUCT, W %					
BATCH STILL DISTILLATE FROM SLURRY PRODUCTS	15.07		9.60		
BATCH STILL RESID. FROM FILTRATE	84.93		90.40		
CALCULATED COMPOSITION, W %					
SULFUR, W %	.57		.58		
CALCULATED COMPOSITION OF 400 °F+ LIQUID PRODUCT, W %					
ATMOSPHERIC STILL OVERHEAD	8.31				
ATMOSPHERIC STILL BOTTOMS	25.31				
NET VACUUM STILL OVERHEAD	10.17				
VACUUM STILL BOTTOMS, SOLIDS FREE OIL	56.13				
CALCULATED COMPOSITION, W %					
SULFUR, W %	.36				
SULFUR (ACTUAL), W %					

PILOT PLANT OPERATING PERFORMANCE

The objective of Run 6 was to demonstrate a long, sustained operation with Illinois No. 6 coal in the Syncrude Mode and to obtain performance data. Coal was fed to the reactor system continuously for 45.5 days. The target conditions were as follows:

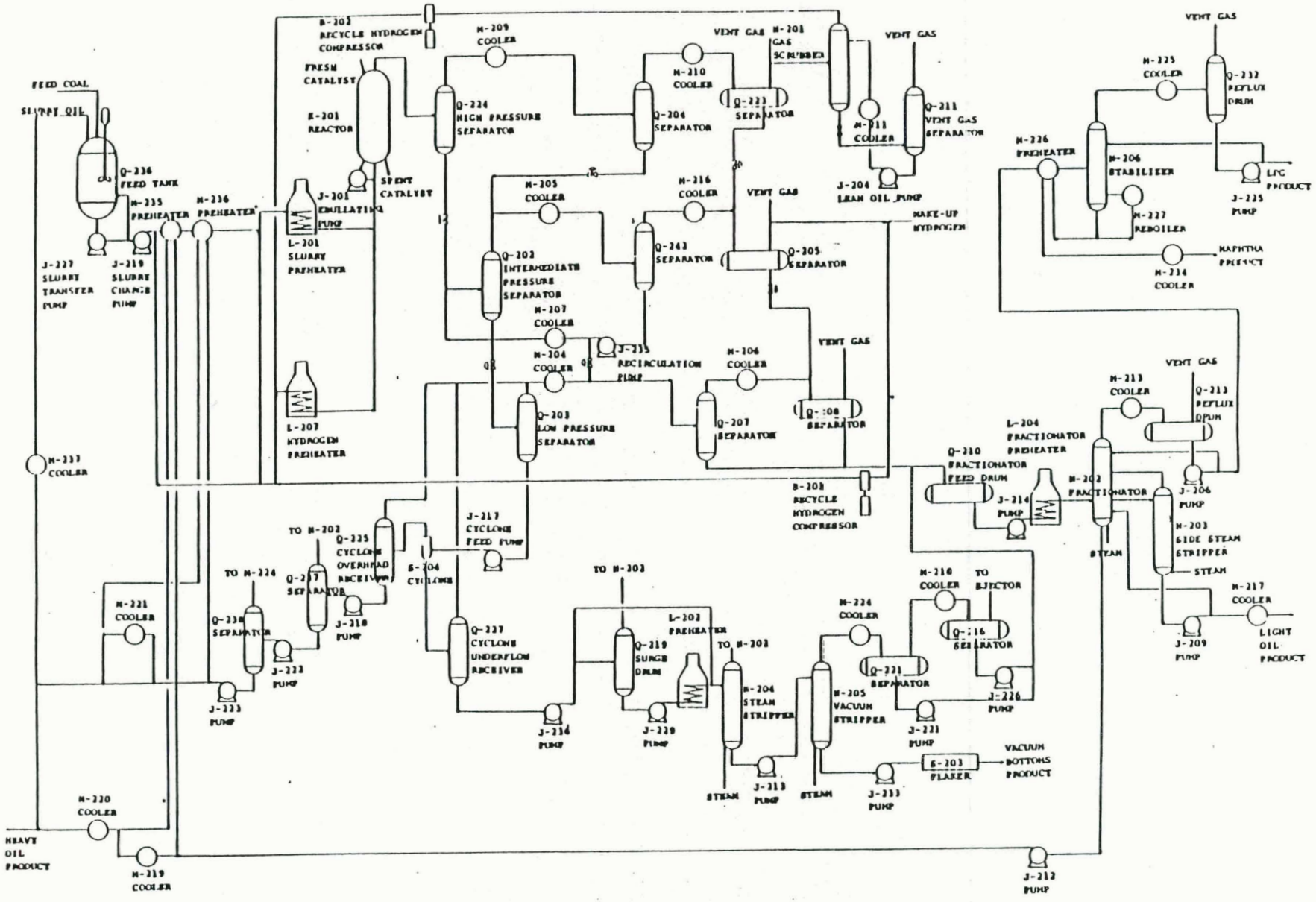
Reactor Temperature	850°F
Reactor Pressure	3000 PSIG
Coal Space Velocity	31.2 Lbs/Hr/Ft^3
Catalyst Replacement Rate	1 Lb/Ton Coal Fed
Oil to Solids Feed Ratio	1.75 Lbs/Lb
% of Slurry Oil as Hydroclone Overflow	67%

The reactor operated up to a temperature of 845°F and at 3000 psig. The average coal space velocity was 26.2; the maximum coal space velocity was 31.6. Catalyst replacement rate was 1.1 lbs/ton. Oil to solids feed ratios as low as 1.6 were demonstrated. The maximum percentage achieved of slurry oil as hydroclone overflow was 50 percent. The following exhibit is a schematic flowsheet of Section 200.

The run was started with dilute solution of feed coal (3.96 pounds oil per pound solids). The solids concentration was then increased to correspond to 1.75 pounds oil per pound of solids and maintained at 1.6 to 1.8 pounds of oil per pound of solids throughout most of the remainder of the run.

Hydroclone recycle to Q-236 was maintained throughout the run. The run was started with approximately 20 percent of the oil used to slurry the coal as hydroclone overflow recycle. As the run progressed, the percent of slurrying oil as hydroclone overflow recycle was increased to approximatley 50 percent. (Note: Approximately 25 lbs/hr of the hydroclone overflow rate shown in Exhibit H-10 was seal oil injected into the hydroclone overflow stream upstream of Q-236 from pumps J-213, J-218, J-222, J-223, and J-233.)

Overall run product yields are presented in the second exhibit.



COAL LIQUEFACTION AND OIL RECOVERY FLOWSHEET

Summary of Operating Data

Run No. 6

Period:	1	2	3	4	5	6	7	8	9	10	11	12
Date:	2/17	2/18	2/19	2/20	2/21	2/22	2/23	2/24	2/25	2/26	2/27	2/28
Hours of Run - Beginning	0800	0	0	0	0	0	0	0	0	0	0	0
End	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
Catalyst inventory, lbs	7,965	7,965	8,469	8,469	8,469	8,469	8,469	8,469	8,469	8,469	8,469	8,469
Catalyst added, lbs	0	0	504	0	0	0	0	0	0	0	0	0
Catalyst withdrawn, lbs	0	0	0	0	0	0	0	0	0	0	0	0
Catalyst age (end), lbs dry coal/lb Catalyst added (cummulative), lb/ton dry coal	17.64	58.48	89.01	124.87	164.58	204.71	244.38	285.1	325.17	367.69	412.82	458.18
Coal feed (~2% H_2O), lb/hr	8,783	13,555	12,020	12,662	14,017	14,168	14,006	14,370	14,153	15,015	15,930	16,015
Space velocity, lb/hr/ft^3	15.04	23.21	20.58	21.68	24.0	24.26	23.99	24.61	24.24	25.72	27.28	27.43
Slurry feed to reactor, lb/hr	43,636	50,119	50,417	51,195	51,765	51,607	50,769	51,566	51,475	51,473	50,977	51,323
Fractionator bottoms	24,165	29,324	25,971	25,535	21,151	23,319	26,247	23,471	24,155	23,294	19,092	22,475
Hydroclone overflow	10,295	6,833	12,046	12,585	16,168	13,715	10,092	13,256	12,717	12,681	15,477	12,429
Seal oil (J-201)	394	407	380	413	429	405	424	468	450	483	478	405
Oil/solids feed ratio, lb/lb	3.96	2.69	2.46	2.34	2.05	2.09	2.18	2.10	2.13	2.04	1.77	1.91
Feed gas to reactor												
MSCFH	527.0	584.8	520.7	498.6	498.7	511.1	497.3	513.1	524.3	552.8	524.9	435.3
% H_2	84.4	80.8	77.3	78.0	76.3	79.6	79.9	85.9	80.9	78.3	82.4	80.7
H_2 inlet partial pressure, psia	2,532	2,428	2,320	2,341	2,292	2,391	2,395	2,577	2,430	2,349	2,472	2,421
Reactor temperature, °F												
22' 2"	806	827	826	821	823	827	824	824	830	832	834	832
1' 4"	763	819	814	811	809	813	811	811	818	817	820	820
Avg.	785	823	820	816	813	820	817	817	824	825	827	826
Reactor pressure, psig	2,985	2,990	2,986	2,987	2,988	2,988	2,983	2,985	2,988	2,985	2,986	2,986
H_2 heater outlet temperature, °F	783	761	745	744	750	751	762	761	762	760	760	763
Slurry heater outlet temperature, °F	715	683	660	659	651	644	632	633	637	625	625	633
Exotherm, °F*	93	144	166	162	173	184	192	191	193	207	209	200

* Temperature at 22' 2" reactor level - temperature of feed gas plus feed slurry to reactor.

Summary of Operating Data

Run No. 6

Period:	13	14	15	16	17	18	19	20	21	22	23	24
Date:	3/1	3/2	3/3	3/4	3/5	3/6	3/7	3/8	3/9	3/10	3/11	3/12
Hours of Run - Beginning	0	0	0	0	0	0	0	0	0	0	0	0
End	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
Catalyst inventory, lbs	8,469	8,469	8,469	8,469	8,469	8,469	8,469	8,469	8,719	8,206	8,495	8,101
Catalyst added, lbs	0	0	0	0	0	0	0	0	250	0	289	260
Catalyst withdrawn, lbs	0	0	0	0	0	0	0	0	0	513	0	654
Catalyst age (end), lbs dry coal/lb	503.5	551.47	601.89	650.22	707.4	757.6	806.4	853.2	866.4	907.4	916.1	933
Catalyst added (cummulative), lb/ton dry coal											0.86	1.05
Coal feed (~2% H_2O), lb/hr	16,015	16,924	17,798	17,065	20,197	17,508	17,267	16,540	13,664	14,033	14,265	15,642
Space velocity, lb/hr/ft^3	27.43	28.98	30.48	29.23	34.59	29.98	29.57	28.33	23.4	24.03	24.43	26.79
Slurry feed to reactor, lb/hr	51,934	51,822	53,078	52,221	55,560	57,378	53,209	51,158	44,313	44,018	44,671	47,854
Fractionator bottoms	22,061	20,299	20,911	19,917	16,803	16,978	15,738	18,292	10,841	10,763	9,067	11,541
Hydroclone overflow	13,393	14,132	13,834	14,704	18,061	22,365	19,620	15,735	19,229	18,692	20,764	20,137
Seal oil (J-201)	466	467	534	534	499	527	584	590	579	531	575	534
Oil/solids feed ratio, lb/lb	1.92	1.71	1.59	1.84	1.50	1.80	1.69	1.72	1.74	1.71	1.67	1.50
Feed gas to reactor												
MSCFH	466.7	466.3	463.7	445.6	423.8	467	488.2	465.8	481.6	484.1	448.6	442
% H_2	79.8	82.5	82.1	81.9	78.6	81.5	82.5	81.5	86.4	84.9	81.8	81.1
H_2 inlet partial pressure, psia	2,393	2,472	2,461	2,455	2,279	2,442	2,475	2,443	2,593	2,547	2,454	2,433
Reactor temperature, °F												
22' 2"	839	837	842	843	845	846	849	849	849	843	845	844
1' 4"	825	824	827	830	831	831	833	833	834	826	829	829
Avg.	832	831	835	837	838	839	841	841	842	835	837	837
Reactor pressure, psig	2,984	2,983	2,983	2,983	2,883	2,983	2,983	2,982	2,986	2,987	2,986	2,983
H_2 heater outlet temperature, °F	760	760	759	759	759	759	757	763	764	767	765	767
Slurry heater outlet temperature, °F	621	626	625	627	621	626	633	626	633	648	635	635
Exotherm, °F*	218	212	218	217	224	221	216	224	217	195	210	209

* Temperature at 22' 2" reactor level - temperature of feed gas plus feed slurry to reactor.

Summary of Operating Data

Run No. 6

Period:	25	26	27	28	29	30	31	32	33	34	35	36
Date:	3/13	3/14	3/15	3/16	3/17	3/18	3/19	3/20	3/21	3/22	3/23	3/24
Hours of Run - Beginning	0	0	0	0	0	0	0	0	0	0	0	0
End	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
Catalyst inventory, lbs	8,350	8,089	8,330	8,330	8,040	8,291	8,469	8,296	7,976	8,227	8,407	8,407
Catalyst added, lbs	249	345	241	0	336	251	178	249	147	251	180	0
Catalyst withdrawn, lbs	0	606	0	0	626	0	0	422	467	0	0	0
Catalyst age (end), lbs dry coal/lb	948.7	954.3	971.5	1,016	1,017	1,032	1,059	1,079	1,109	1,120	1,140	
Catalyst added (cummulative), lb/ton dry coal	1.13	1.28	1.28		1.19	1.20	1.16	1.16	1.13	1.14	1.13	
Coal feed (~2% H_2O), lb/hr	15,116	15,758	16,039	15,437	15,464	15,911	17,083	17,980	16,413	15,474	15,392	16,699
Space velocity, lb/hr/ft^3	25.89	26.99	27.47	26.44	26.48	27.25	29.26	30.79	28.11	26.5	26.36	28.6
Slurry feed to reactor, lb/hr	47,604	47,839	49,887	46,051	50,563	53,455	56,006	52,279	46,192	50,007	45,042	50,609
Fractionator bottoms	10,433	11,590	9,154	12,407	12,972	12,202	17,096	19.805	15,022	14,052	14,773	12,984
Hydroclone overflow	21,564	19,635	23,949	15,746	21,244	24,363	20,971	12,763	14,210	19,889	14,359	20,405
Seal oil (J-201)	492	857	744	2,461	884	979	856	1,731	546	592	518	521
Oil/solids feed ratio, lb/lb	1.70	1.63	1.52	1.54	1.68	1.73	1.78	1.62	1.50	1.76	1.60	1.62
Feed gas to reactor												
MSCFH	454	485.6	463.6	478.7	455.8	497.7	512.3	542.0	501.8	452	475.9	441.7
% H_2	84.9	86.6	85.2	83.9	82.8	85.6	87.3	34.4	87.1	81.8	84.0	86.1
H_2 inlet partial pressure, psia	2,547	2,596	2,555	2,513	2,480	2,566	2,613	2,526	2,609	2,449	2,518	2,580
Reactor temperature, °F												
22' 2"	846	844	848	847	843	838	847	850	855	857	854	850
1' 4"	832	828	832	832	828	819	827	828	835	840	834	831
Avg.	839	836	840	840	836	829	837	839	845	849	844	841
Reactor pressure, psig	2,984	2,982	2,983	2,980	2,982	2,983	2,980	2,977	2,979	2,979	2,982	2,982
H_2 heater outlet temperature, °F	777	763	767	763	764	761	763	786	782	780	781	780
Slurry heater outlet temperature, °F	624	646	639	627	639	644	644	658	628	604	645	639
Exotherm, °F*	222	198	210	220	205	194	204	194	228	254	235	211

* Temperature at 22' 2" reactor level - temperature of feed gas plus feed slurry to reactor.

Summary of Operating Data

Run No. 6

Period:	37	38	39	40	41	42	43	44	45	46	Final
Date:	3/25	3/26	3/27	3/28	3/29	3/30	3/31	4/1	4/2	4/3	
Hours of Run - Beginning	0	0	0	0	0	0	0	0	0	0	
End	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	
Catalyst inventory, lbs	7,870	8,130	8,417	8,417	8,417	8,303	8,408	8,221	8,484	8,484	8,448
Catalyst added, lbs	251	260	287	0	0	250	105	250	263	0	0
catalyst withdrawn, lbs	788	0	0	0	0	364	0	437	0	0	36
Catalyst age (end), lbs dry coal/lb	1,203	1,213	1,223	1,275	1,327	1,336	1,368	1,372	1,370	1,401	
Catalyst added (cummulative), lb/ton dry coal	1.07	1.08	1.1			0.99	0.97	0.98	1.00	0.97	
Coal feed (~2% H_2O), lb/hr	15,940	16,408	17,904	18,353	18,211	16,990	16,879	15,640	14,180	11,223	
Space velocity, lb/hr/ft^3	27.3	28.1	30.66	31.43	31.19	29.1	28.91	26.78	24.28	19.22	
Slurry feed to reactor, lb/hr	51,148	54,076	55,188	55,614	54,770	53,048	54,714	53,656	49,246	46,430	
Fractionator bottoms	13,425	14,871	15,793	15,040	14,890	14,882	13,550	13,675	15,316	29,924	
Hydroclone overflow	21,294	22,296	20,983	21,692	21,230	20,730	23,780	23,771	19,111	4,816	
Seal oil (J-201)	489	501	508	529	439	446	505	570	639	467	
Oil/solids feed ratio, lb/lb	1.77	1.85	1.69	1.60	1.57	1.69	1.73	1.80	1.77	2.81	
Feed gas to reactor											
MSCFH	471.9	471.2	435.4	473.1	515.7	501	455.4	457.0	471.8	336.1	
% H_2	78.7	79.6	79.8	78.1	84.1	83.3	82.6	82.6	85.6	82.0	
H_2 inlet partial pressure, psia	2,358	2,382	2,390	2,338	2,516	2,495	2,475	2,474	2,564	2,456	
Reactor temperature, °F											
22' 2"	855	853	855	856	854	853	854	852	850	849	
1' 4"	835	832	835	833	832	830	831	828	828	830	
Avg.	845	843	845	845	843	842	843	840	839	839	
Reactor pressure, psig	2,980	2,978	2,980	2,979	2,979	2,980	2,981	2,981	2,981	2,980	
H_2 heater outlet temperature, °F	782	782	782	782	782	783	782	782	782	782	
Slurry heater outlet temperature, °F	637	640	633	627	636	639	638	647	665	656	
Exotherm, °F*	218	213	222	229	219	215	217	205	185	193	

* Temperature at 22' 2" reactor level - temperature of feed gas plus feed slurry to reactor.

PROCESS DEVELOPMENT UNIT

SOLIDS SEPARATION SYSTEM

BACKGROUND

WHY SOLIDS SEPARATION IS NECESSARY

The H-Coal PDU can be operated in either the syncrude or the fuel-oil mode. In the syncrude mode, the vacuum bottoms product is utilized in the production of hydrogen. In the fuel-oil mode. it is desirable to recover a fraction of the residual oil in the vacuum bottoms product, (that not needed for hydrogen production), in order to increase the oil yield from the process.

Any liquid fuel must meet certain specifications to be usable. Maximum ash concentrations of 0.4% for boiler fuels and 0.1% for turbine fuels may be considered as workable approximate specifications. In addition, there are certain sulfur and viscosity specifications.

The ash specification cannot be achieved using the same methods for both operating modes: In the syncrude mode the vacuum distillation column can be used effectively to separate the ash and unconverted coal from the liquid product. However in the fuel-oil mode, vacuum distillation is not effective, and HRI undertook an extensive study to determine the best method for removing solids from the liquid product when operating in the fuel oil mode.

INITIAL INVESTIGATION OF SOLIDS SEPARATION TECHNIQUES

Because of the problems associated with liquid-solids separation methods such as magnetic separation, filtration and centrifugation, HRI also investigated solvent precipitation as a separate method. Initial settling data on coal liquids were obtained using batch autoclaves. We then developed a system for continuously handling 30 pounds/hour slurry liquid feed, and several preliminary separation runs were made. Using the latest solvent precipitation equipment for handling hydroclone underflow liquid feed containing about 18% ash (27% solids), overflow liquid product was obtained containing down to about 0.1% ash. Based on the success of these runs, plans were made to construct a 300 pound/hour continuous solvent precipitation settler unit to operate on stream with the Process Development Unit.

As mentioned, four general methods of liquid-solids separation were investigated:

a. Solvent Precipitation

b. Filtration

c. Centrifugation

d. Magnetic Separation

Solvent precipitation, centrifugation and filtration all produced a liquid product containing less than 0.1 weight percent ash.

Though a two-stage centrifugation system was effective in meeting the product ash specification, the flow capacity was very low. Therefore, centrifugation method was not recommended for the Pilot Plant.

Filtration was also effective in meeting the product ash specification. However, it had a number of drawbacks including low filtration rate. In addition, a large number of filters would be required to filter the solid-containing liquid stream. Because of its high cost and complexity, filtration was not recommended for the Pilot Plant.

The magnetic separator was effective in producing a product of reduced sulfur content by removing substantially all the iron sulfide; however, the non-magnetic ash was not removed. Therefore, the product liquid from magnetic separation was not considered acceptable.

The solvent precipitation method used solvent fractions distilled from the product spectrum of the H-Coal Process. It was the most promising of the methods tested and appeared to be the most economic. Therefore, HRI recommended that

1. A solvent precipitation process be included in the Pilot Plant.

2. A larger-scale unit be incorporated in the PDU.

3. The planned Pilot Plant solvents be tested in the PDU.

THE CONCEPT OF SOLVENT PRECIPITATION

In solvent precipitation (also referred to as antisolvent precipitation) an ash-rich liquid stream is treated with a lower boiling liquid which is termed the solvent. The solvent

should adhere to certain specifications as to boiling range, Watson K factor, Kauri-Butanol value, etc. Certain solvents that have either met the specifications or have been found to be effective are H-Coal naphtha, normal Decane and Soltrol 130.

The mechanism by which the solvent "deashes" the slurry is not completely understood. What is known, however, is that the heavy constituents of the product (asphaltenes and pre-asphaltenes) precipitate out of solution. This precipitated material agglomerates about the ash and unconverted coal particles, dragging them down.

SOLVENT PRECIPITATION SYSTEM OPERATION

An important objective of PDU 8 was the investigation of on-line deashing in the H-Coal Process. The solvent precipitation system operated 31 hours before voluntary shutdown. A low ash overflow, .01 W %, was attained with the conditions of .68 solvent to slurry ratio and 49.26 W % overflow.

The solvent precipitation subsystem can operate in any one of three separate modes.

Mode I - Process Derived Solvent Mode

Mode II - External Solvent with Hydroclone Underflow Stripper

Mode III - External Solvent with Hydroclone Underflow Stripper Bypass

MODE I - PROCESS DERIVED SOLVENT MODE

The process derived solvent mode is the basic mode of operation, the other modes are derivatives. The process operates as follows:

Hydroclone underflow is sent by pressure difference from the hydroclone underflow receiver, O-22, to the hydroclone underflow stripper bottoms pump, J-39. (The hydroclone underflow stripper O-24 is bypassed). The hydroclone underflow is pumped to the suction of the slurry charge pump, J-29, the excess material returns to O-22 from J-29. The hydroclone underflow is pumped by J-29 to the inlet of the first stage mixer.

The process derived solvent is produced in the solvent production column, N-5. The N-5 bottoms product is sent to the solvent drum, P-5. From P-5, the solvent is pumped by J-30 up to unit pressure and is sent through the solvent heater, M-23. From M-23 the solvent is injected into the hydroclone underflow stream at a point just upstream of the first stage mixer.

The combined solvent/hydroclone underflow stream passes through the first stage and second stage mixers then enters the settler, O-25. In the settler, the feed stream splits into an ash-rich underflow stream and clean overflow stream.

The underflow stream exits the settler from the bottom. It is picked up by the suction of the settler underflow circulation pump, J-41. The underflow circulation loop precludes the underflow from setting up in the line. A slip stream from the discharge of J-41 is sent to the underflow letdown valve CV-20. The settler underflow is let down in pressure and is sent to the vacuum still, N-3.

The overflow stream exits the settler from the top, passes to the overflow receiver, O-26, is let down in pressure by LCV-21, and is sent to the solvent recovery column, N-4.

The feed to N-4 is comprised of settler overflow and vacuum still overhead product. The solvent is recovered as the overhead product of N-4 and is sent to the solvent drum, P-5. The bottoms product of the solvent recovery column is the fuel-oil product. The fuel-oil product is then sent either to the slurry mix tank for recycle or to storage.

MODE II - EXTERNAL SOLVENT WITH HYDROCLONE UNDERFLOW STRIPPER

This mode of operation is quite similar to Mode I. The primary differences are:

A. Hydroclone underflow from O-22 is stripped by steam in O-24 to remove any material in the boiling range of the external solvent. The stripped underflow is pumped by J-39 to the settler change pump and excess underflow is returned to the plenum chamber in the bottom of O-24. The overhead stream from O-24 passes to a partial condenser, M-20, where hydrocarbon vapors are condensed. The oil from O-27 is taken to O-12. Uncondensed vapors are taken to the O-14 coolers.

B. The solvent is non-process-derived, therefore, the solvent production column is not placed in service and solvent make is from drummed solvent. The remainder of the process description is similar to Mode I.

MODE III - EXTERNAL SOLVENT WITH HYDROCLONE UNDERFLOW STRIPPER BYPASS

This mode of operation is also quite similar to Mode I. The primary difference is that the solvent is non-process derived. Therefore, the solvent production column is not placed in service and solvent make is from drummed solvent. The remainder of the process description is similar to Mode I.

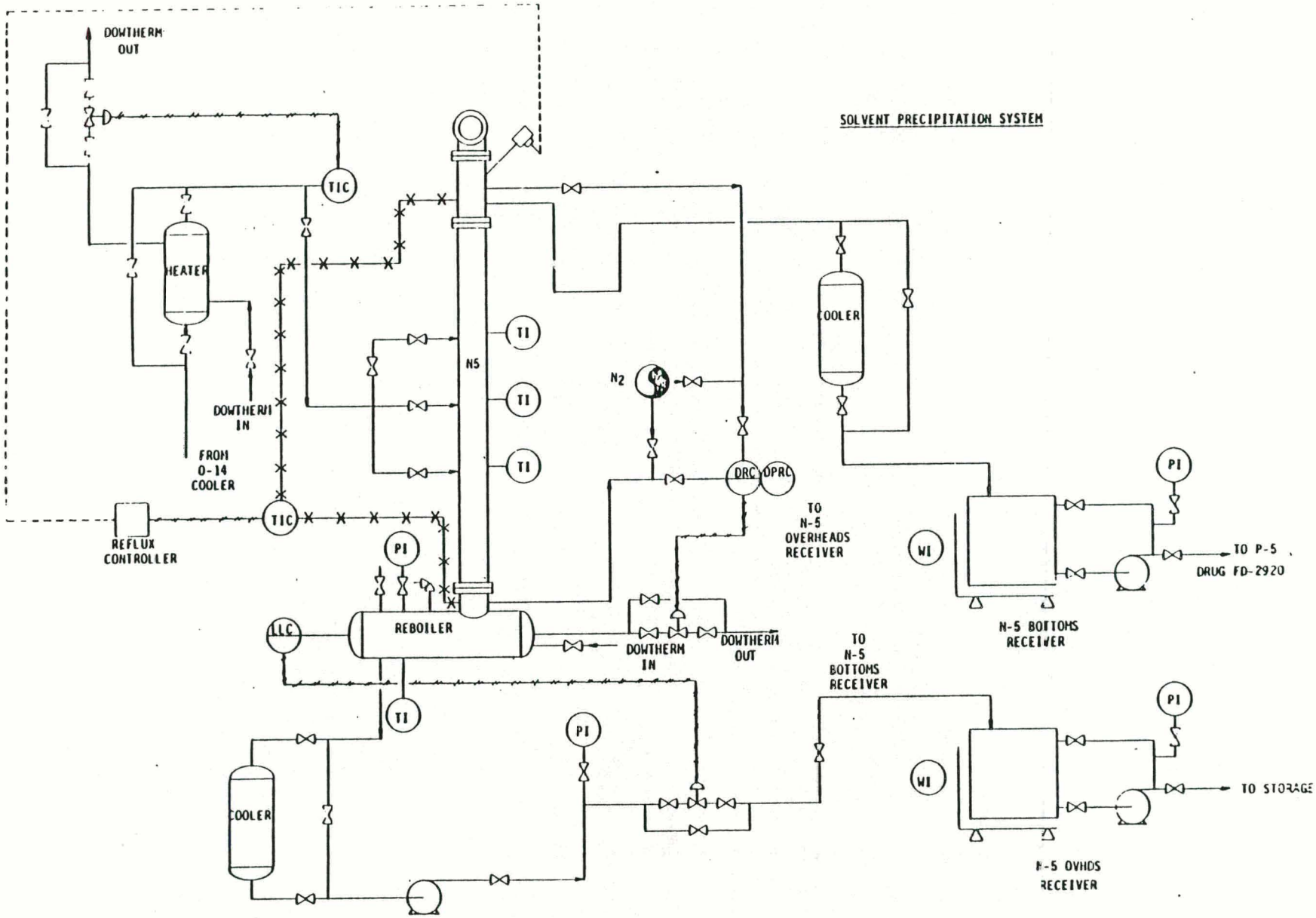

SOLVENT PRECIPITATION SYSTEM
DOWTHERM OUT
TIC
HEATER
DOWTHERM IN
FROM O-14 COOLER
TIC
REFLUX CONTROLLER
N5
TI
TI
TI
N2
DRC
OPRC
TO N-5 OVERHEADS RECEIVER
COOLER
PI
WI
TO P-5 DRUG FD-2920
N-5 BOTTOMS RECEIVER
PI
LLC
REBOILER
DOWTHERM IN
DOWTHERM OUT
TO N-5 BOTTOMS RECEIVER
TI
PI
COOLER
WI
TO STORAGE
N-5 OVHDS RECEIVER

EXHIBIT S-1

PDU SOLVENT PRECIPITATION UNIT PROCESS DESCRIPTION

SYSTEM OVERVIEW

The solvent precipitation system is fully integrated with the PDU. Hydroclone underflow from O-22 will be sent by pressure difference to O-24. The level in O-22 is controlled by LCV-27. Hydroclone underflow from O-24 is pumped by J-39 to the suction of the slurry charge pump, J-29. The balance of the hydroclone underflow not charged to the settler is returned to O-24 through a loop. J-29 pumps the hydroclone underflow to the inline static mixer. J-30 pumps the solvent from the solvent drum, P-5, through a preheater, M-23, to a point just upstream of the inline static mixer. The inline static mixer combines the solvent and hydroclone underflow streams. The mixed stream then passes to the upflow agitated autoclave. The autoclave allows for particle agglomeration and growth. The mixed stream then flows to the settler, O-25. The settler is operated at approximately 200 psig and 550°F. Sufficient residence time is provided for the settling of agglomerated solids and overflow of a clarified oil stream. The settler underflow exits the settler from the bottom. It is sent to the suction of the settler underflow circulation pump, J-42. A slipstream from the discharge of J-42 is sent to the settler control values, CV-20A, B and C. The settler underflow is let down in pressure. It is sent to the vacuum still, N-3, for recovery of solvent and distillate oils. The settler overflow is metered by FIRC-21 and a nuclear density gauge while flowing to the overflow receiver, O-26. Settler pressure is maintained by a nitrogen cap in the overflow receiver. At the overflow receiver, the settler overflow is let down in pressure by LCV-21 and flows to the solvent recovery column, N-4. Vacuum overhead from N-3 is also fed to N-4. The bottoms of this column is the low-solids fuel oil product. The condensed overhead from N-4 is the recovered solvent and is pumped to the solvent drum, P-5.

SAMPLING AND ANALYSES

Sampling and analyses of the solids separation unit streams were performed for online process control purposes and for subsequent workup and process evaluation. Samples and analyses are shown in Exhibit S-2. These were in addition to the other PDU sampling and analytical requirements.

Ash (Total 11)

Hydroclone Underflow
Settler Overflow
Settler Underflow
Fuel-Oil
Vacuum Bottoms
Settler Profile (6)

Vacuum Distillations (Total 4)

Fuel-Oil
Hydroclone Underflow
Settler Overflow
Settler Underflow

Atmospheric Distillations (Total 1)

Solvent

°API (Total 4)

Fuel-Oil
Solvent
Settler Overflow
Hydroclone Underflow

Sulfur (Total 2)

Fuel-Oil
ASB

Heating Value (Total 12)

Fuel-Oil
ASB

SUS (Total 2)

Fuel-Oil
ASB

Extractions, DMF and Toluene (Total 8)

Hydroclone Underflow (975°F+)
Fuel-Oil (975°F+)
Settler Overflow (975°F+)
Settler Underflow (975°F+)

PROCESS CONTROL

Analyses were routinely performed to ensure specification process performance and to indicate any necessary process changes. The type and frequency of sampling and analyses were determined by the needs of the operation.

The ash in the settler overflow and the API gravity of the N-4 column overhead production were determined every shift. The level of ash in the overflow indicates if changes in the solvent to slurry ratio, overflow rate, or settler temperature need to be made. The API gravity of the N-4 column overhead indicates if the N-4 column is operating satisfactory.

EQUIPMENT AND TEST METHODS USED IN SOLIDS SEPARATION EXPERIMENTS

BATCH AUTOCLAVE SEPARATION

Two batch autoclaves were used to obtain settling data prior to using the continuous solvent precipitation separator. The autoclaves had capacities of one-liter and one-gallon, respectively, and were equipped with magnetically-operated stirrers. Both were suitable for operations to 3000 psig and 850°F (or 5000 psig at 650°F).

Operation of both autoclaves consisted of charging a quantity of slurry and anti-solvent, then heating and agitating the mixture until the desired temperature was obtained. The agitation was then stopped and liquid samples withdrawn through an internal tube set at a fixed elevation in the autoclave.

Data from a series of samples were used to calculate the settlin g rate of the solids, and from that data the maximum upflow velocity was calculated that would provide a solids-free overflow. This is the usual procedure for settler or thickener design.

Additional information obtained for thickener design was the compacting time of the solids since most thickener equipment is designed for operation with aqueous liquids. For material of this nature, it is customary to obtain data on compaction rate by observing the lowering of the solids level in a column of slurry. Data of this kind are difficult to obtain from the autoclave with coal-derived heavy oils.

The slurry used was hydroclone underflow from PDU operations - either syncrude mode or fuel oil mode. Antisolvent material in all cases was 350-500°F H-Coal naphtha.

CONTINUOUS 30-POUNDS-PER HOUR SEPARATOR

The continuous 30-pound-per-hour separator was the basis for most of the solids separation work in Phase I. The continuous 30-pounds-per-hour solvent precipitator was operated with feed directly from the PDU to simulate the Pilot Plant as closely as possible. With hydroclone underflow containing about 18 W % of ash (27 W % solids) as feed, the separator produced an overflow product containing less than 0.1 W % ash and an underflow material

containing as much as 30 W % ash (45 W % solids) on a continuous basis. The longest run was 42 hours, and was terminated only because of a lack of feed material.

Run 15 used hydroclone underflow and achieved ash contents from 0.006 W % to 0.093 W %. The anti-solvent was a naphtha produced from the process. The rate of use was approximately ten times the production, based on throughput of the entire hydroclone underflow stream. Therefore, redistillation of the clean product and overflow product would be necessary to recover the solvent.

Run 16 also used hydroclone underflow and naphtha produced by the H-Coal Process. The objective of this run was to start with a solvent ratio lower than needed to achieve the desired ash specification, observe the results and then increase the ratio to see if the product specification could be met. As shown in Table 65 the ash in the clean product was about 6-7 W % with the low ratio and a return to specification level required more than ten hours even with a high ratio. The off-specification results were replicated.

The benzene-insoluble material was preferentially rejected to the underflow. In periods of low ash in the overflow product, more than 80% of the benzene-insoluble material appeared in the bottoms product. Because of the 975°F+ benzene-insoluble material had a sulfur content of 0.97 W % versus a sulfur content of 0.57 W % for the benzene-insoluble material, this preferential rejection of sulfur was important to the sulfur specification of the final product.

The continuous anti-solvent solids separation unit was also operated to produce fuel oil from reconstituted vacuum bottoms and vacuum overhead materials. Prior to the successful operation n PDU hydroclone underflow feed material, runs were made with H-Coal vacuum bottoms diluted with an aromatic plasticizer oil.

Basically, the settler is a 56-inch vertical length of 8" Schedule 40 pipe. During the program a number of modifications were made to the settler vessel, but no changes were made after Run 14.

Slurry entered the settler through a 1/2-inch pipe that extended 30 inches below the top of the settler. Clear liquid overflow was taken through a 1/2-inch pipe nipple six inches below the top of the settler. The concentrated underflow was withdrawn through a 3/4-inch nipple in the center of the bottom flange. For the last three configurations, an internal rake, turning

at about one revolution per minute, was used to keep the lower few inches of the settler contents in constant motion.

Two slurry feed tanks were mounted on platform dial scales and the feed rate was continuously monitored. A third slurry tank was available for interconnection to either of the other two tanks. Hydroclone bottoms were piped directly from the PDU system to any one of the three slurry feed tanks.

Each of the slurry feed tanks had a circulating system and an internal stirrer. Two parallel slurry pumping systems and two locations for anti-solvent liquid injection were provided. Usually solids settling occurred in the lines upstream of the settler when anti-solvent was added upstream of the unit. In most runs the anti-solvent was injected into the slurry just ahead of the settler.

At the start of the program, a mixing vessel was used after the anti-solvent was added to the slurry and before the mixture entered the settler. Earlier work by Consolidation Coal Company indicated that it was essential to the slurry and anti-solvent material. In the HRI experiments, it was observed that solids started settling as soon as the anti-solvent liquid was added to the slurry. When the mixing vessel was employed, some settling occurred in that vessel and in the lines between that vessel and the settler. After Run 15 the mixer vessel was removed from the system.

The procedure for solids separation using solvent precipitation is given below.

1. Slurry was prepared in the slurry tanks (or feed was obtained from the hydrogen underflow from PDU operations) and brought to settler operating temperature.

2. The settler was filled with atmospheric still bottoms or vacuum still overhead material and brought to operating temperature and pressure.

3. Slurry feed to the settler was started at a predetermined flow rate: 15 to 30 pounds per hour.

4. When the slurry feed rate to the settler was established, anti-solvent liquid addition was started and the rate adjusted to a predetermined amount: a ratio of 0.3 to 1.0% based on slurry.

5. Liquid overflow form the settler flowed into a product receiver equipped with a liquid level control. The product receiver was maintained about 50°F lower

temperature than the settler. Liquid product discharged into an atmospheric pressure vessel and anti-solvent portion was flashed. No effort was made to recover the anti-solvent.

6. Pressure was maintained with a cylinder nitrogen bleed rate of about 5-20 SCFH into the overflow product receiver and a back pressure control valve. The nitrogen was vented through a displacement gas meter.

7. Settler underflow was discharged manually on a 15-minute cycle through a 3/4-inch gate valve. The underflow material was discharged into an atmospheric pressure receiver and any anti-solvent in the underflow was allowed to flash.

8. Overflow and underflow products were collected on an hourly basis for analytical inspections.

Slurry composition was made of vacuum and atmospheric still bottoms blended in the slurry feed drums. The total mount of atmospheric still bottoms was added to the slurry drum and brought to about 350°F to 400°F. The vacuum still bottoms, previously ground to -1/8", was added at a rate of about two pounds every five minutes. The slurry was stirred and circulated both while the vacuum still bottoms were being added and for the entire duration of the run. If circulation were to be interrupted, the slurry would settle in the feed drums and, depending on the duration of the interruption, would be difficult to impossible to recover.

The anti-solvent material was an H-Coal fraction in the 300 to 500°F boiling range.

During the runs overflow and underflow were collected hourly. All periods were analyzed for ash and some periods were analyzed for benzene and pyridine insolubles.

At the completion of a run, the settler was flushed with atmospheric still bottoms and cooled to ambient temperature. The total materials shown in the table for slurry, anti-solvent, overflow and underflow do not include the initial start-up oil or the final wash material, so overall material balances are not available.

300 POUNDS/HOUR SOLVENT PRECIPITATION SEPARATOR

A continuous anti-solvent solids separation system to accept the entire hydroclone underflow stream from the PDU was then designed.

The solvent precipitation system (see Exhibits) was operated during PDU Run 8 of the Phase II H-Coal program. The solvent selected was Soltrol 130, a commercial product manufactured by Philips Petroleum Company. Hydroclone underflow did not have to be stripped since the boiling ranges of Soltrol 130 and the hydroclone underflow do not overlap.

When construction of the system was started, HRI decided to provide the capability of using an H-Coal process-derived solvent and an external solvent. To use an H-Coal process-derived solvent, a solvent production column was needed on the PDU to fractionate the atmospheric still overheads to product a 300-500°F solvent for the system.

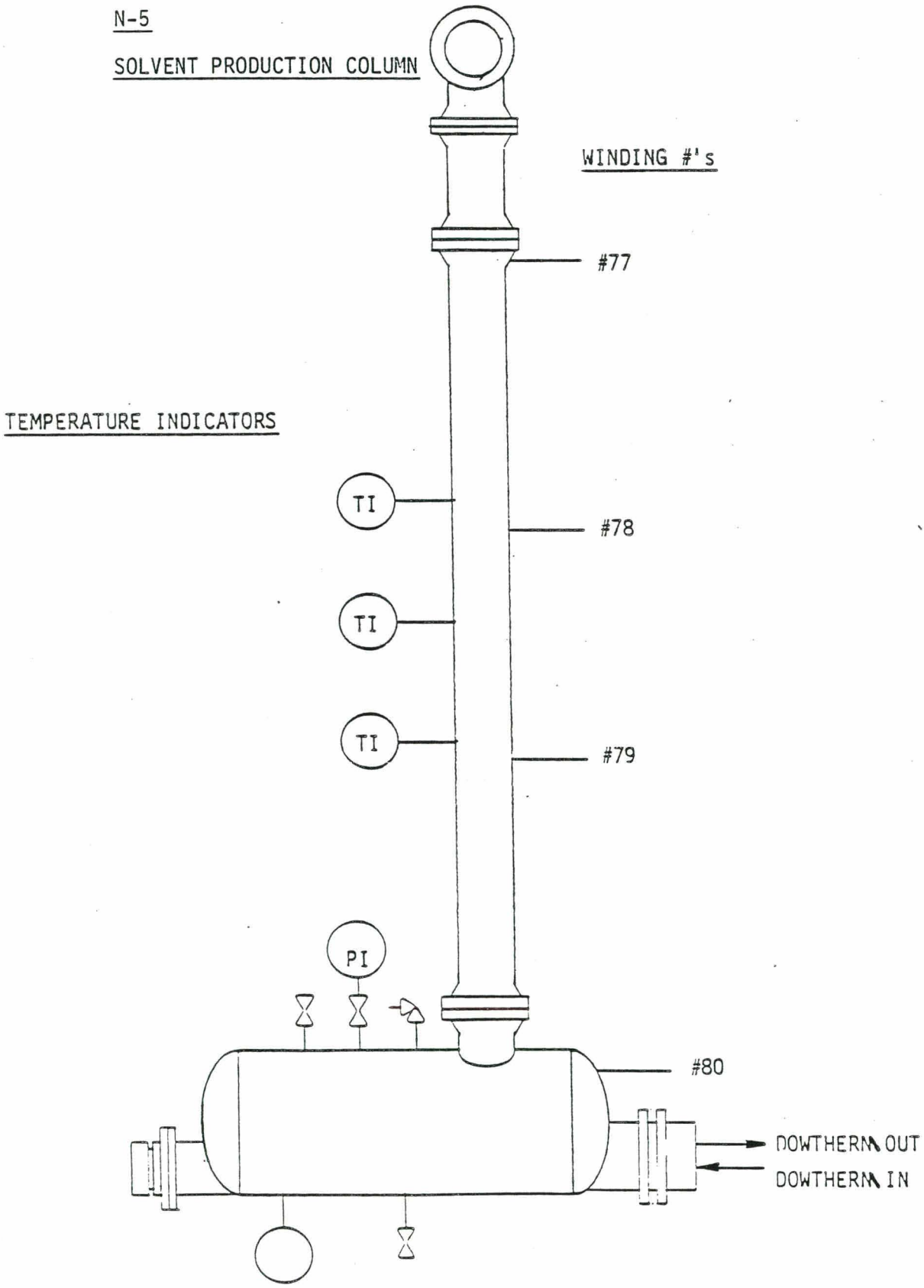
The HRI Process Engineering group designed the solvent production column, and specifications were sent to vendors for price quotations. The column was fabricated by Distillation Engineering Company who also provided the instrumentation and pumps. HRI's Maintenance Staff erected the column and installed the piping and instrumentation.

The column (see Exhibits) is 4-inch schedule 10 with 14 feet of 5/8" ball ring packing capable of 500°F operation from full vacuum to 150 psig. The reboiler is heated with plant Dowtherm G and the reboiler temperature is controlled by the differential pressure across the column. The reflux ratio is automatically controlled by the overhead vapor temperature.

During PDU 8, the solvent production column operation achieved a 300°F cut point on the overhead product.

The IBP-300°F product from the solvent production column must be treated to produce a stable product free of dissolved gases, including hydrogen sulfide and C_1-C_4 hydrocarbons.

A naphtha stabilizer was designed b y the HRI Process Engineering group and fabricated in the HRI maintenance shop. The column consisted of a 20-inch by 10-foot stripping section packed with high efficiency protruded packing. Since the heat duty for the column was only 2500 Btu/hr, electrical tracing on the column was used instead of a reboiler. The naphtha stabilizer operated satisfactorily during PDU 8.


N-5
SOLVENT PRODUCTION COLUMN
WINDING #'s
#77
TEMPERATURE INDICATORS
TI
#78
TI
TI
#79
PI
#80
DOWTHERM OUT
DOWTHERM IN

SOLVENT PRECIPITATION EQUIPMENT LIST

A compilation of equipment in the solvent precipitation system is given below.

D - Storage drum

D-5 - Solvent recovery column bottoms product drum
Description: 55 gallon closed top drum

D-6 - Excess solvent product drum
Description: 55 gallon closed top drum

D-7 - Fuel oil receiver for slurry mix tank
Description: 55 gallon closed top drum

DIR - Density Indicator Recorder

DIR-2 - Settler overflow density indicator recorder
Description: Moore Products Company Model 360A2 Electronic Strip Chart Recorder on a Texas Nuclear Density Gauge 0-40 MA output; W. H. Gregory

DPT - Differential Pressure Transmitter

DPT-11 - Hydroclone underflow stripper differential pressure transmitter (calibrated - 25")

DPT-13 - Hydroclone underflow receiver differential pressure transmitter (calibrated -)

DPT-20 - Settler overflow receiver differential pressure transmitter (calibrated - 40")

DPT-21 - Solvent recovery column differential pressure transmitter (calibrated - 54")

DPT-24 - Solvent recovery column overheads receiver differential pressure transmitter (calibrated - 30")
Description: Above DPT's are Foxboro Pneumatic Differential Pressure Cell Transmitter Model 13A1-MK2, 0-100 mm Hg; The Foxboro Company

DPT-23 - Solvent recovery column bottoms receiver differential pressure transmitter (calibrated - 25")

DPT-25 - Solvent drum differential pressure transmitter (calibrated - 50")

DPT-26 - Preheat/wash oil drum differential pressure transmitter (calibrated - 50")
Description: Above DPT's are Foxboro Pneumatic Differential Pressure Cell Transmitter Model 13FA1-MK-31A-5; Flange mounted; 0-100 mm Hg; The Foxboro Company

DPT-22 - Solvent recovery column reboiler differential pressure transmitter
Description: Moore Products Company Model 25C415 Liquid Level Controller - Float type; Pneumatic

DPRC - Differential Pressure Recorder Controller

DPRC-21 - Solvent recovery column differential pressure recorder controller

CV - Control Valve

CV-21 - Solvent recovery column Dowtherm removal control valve
Description: Research control valve, 1/2" threaded connections; J.R. Simpson & Company, C_V=3

CV-20A - Settler underflow control valve

CV-20B - Settler underflow alternate control valve
Description: Hammel Dahl, 1" Angle body, ID #V811FHC3ELA9, 300 #RF, C_V-0.40; Hammel Dahl

CV-26 - J-42 circulation control valve
Description: Paul Valve, 1/2" size, 1/4" trim, Drwg, D3315, S/N 3807; Flomega Div. of P.J. Hydraulics

FI - Flow Indicator

FI-24 - Settler overflow receiver vent gas flow indicator
Description: Existing gas meter

FI-25 - Settler overflow receiver nitrogen flow indicator
Description: Wallace and Tier on Rotameter 32-D046-5144; Arobone and Cline

FI-26A - Settler overflow receiver differential pressure transmitter low pressure leg nitrogen purge flow indicator
Description: Wallace and Tiernan Rotameter 32-D046-5144; Arobone and Cline

FI-26B - Settler overflow receiver differential pressure transmitter high pressure leg nitrogen purge flow indicator
Description: Wallace and Tiernan Rotameter 32-D046-5144; Arobone and Cline

FIR - Flow Indicator Recorder

FIR-20 - Hydroclone underflow stripper steam flow indicator recorder
Description: Wallace and Tiernan Metal Tube V Area Meter, 80 lbs/hr steam at 350°F and 15 psig, 1/2 to 40 MA output, Arobone and Cline; Moore Model 77-16 Current to Pneumatic Transducer, Input: 4 to 20 MA; Output: 3-15 psig; Moore Products Co.; Moore Products Model 5321SM Two Pen Syncro Recording Control Station with Model 561 Controller, Moore Products Company

FIRC-21- Settler overflow flow indicator recorder controller
Description: Wallace and Tiernan Straight Thru Metal Tube V area meter for Coal Derived Oils, 3-15 psig output, .6 and .1 SGU input; Arobone and Cline. Moore Products Model 5321SM Two Pen Syncro Recording Control Station with Model 561M controller; Moore Products Company

FIR-22 - Vacuum still overhead to solvent recovery column flow indicator recorder
Description: Bearingless Flow Meter Model E-25, output in cps; Bearingless Flow Meter Co. Dynalco Model SS3000 Signal Converter, 4-20 MA output, cps input; Cemtech Control Inc. Moore Products Model 360A2, Electronic Strip Chart Recorder; Moore Products Company

FIR-23 - 0-27 bottoms to 0-12 flow indicator recorder
Description: Bearingless Flow Meter Model E25, output in cps; Bearingless Flow Meter Co. Dynalco Model SS3000 Signal Converter, 4-20 MA DC output; 8.33 -1/3 cps input; Cemtech Control Inc. Moore Products Model 360A2 Electronic Strip Chart Recorder; Moore Products Company

FIR-27 - Solvent recovery column bottoms to fuel oil receiver flow indicator recorder
Description: Electronic Inline Turbine Meter, 4-20 MA output; Valcon Sales. Moore Products Model 360A2 Electronic Strip Chart Recorder; Moore Products Company

J - Pump

J-29A - Slurry charge pump

J-29B - Slurry alternate charge pump

J-30 - Solvent charge pump
Description: The above three pumps as Milton Roy Model MRT51-142T, 3/4 HP, 230/460 V, 3 phase, 1750 RPM, 50 GPH, piston type, positive displacement; Milton Roy Company

J-31 - Solvent drum circulation pump

J-33 - Preheat/wash oil drum circulation pump
Description: Above two pumps are Liquiflo Model 62FS7P, 1 1/2 HP, 3 phase, 230/460 V, 3450 RPM, centrifugal; Liquiflo Equipment Company

J-32 - Solvent drum circulation/storage pump

J-34A - Solvent recovery column bottoms pump

J-34B - Solvent recovery column bottoms alternate pump

J-35 - Solvent recovery column bottoms receiver pump

J-38 - Solvent recovery column overheads receiver product pump
Description: The above five pumps are Worthington 1 GAM gear pump, 1/3 HP, 1 phase, 120/240 V; A-C Supply of Philadelphia

J-36 - Settler underflow control valve stem and alternate control valve stem flushing pump
Description: Milton Roy Model MR-25-49T, 1/4 HP, 230/460 V, 1750 RPM, 10.1 GPH; Milton Roy Company

J-39 - Hydroclone underflow stripper bottoms pump
Description: Tuthill "Bump pump", 1/2 HP, 3 phase,230/460 V, positive displacement; existing

J-40 - Solvent recovery column vacuum pump
Description: Kinney Vacuum pump, 3/4 HP, 120/240 V, 1 phase: Kinney

J-41 - Fuel oil receiver pump to slurry mix tank
Description: Eastern Model 2J-34E, 1 HP. 1 phase, 3450 RPM, 115/230 V; Fluids Controls Division, LFE Corp.

J-42 - Settler underflow circulation pump
Description: Foster RR2, 1/5 Hp, 3 phase 25-250 RPM, 230/460 V, sliding vane; Foster Pump Works

LCV - Level Control Valve

LCV-21A - Settler overflow receiver level control valve

LCV-21B - Settler overflow receiver alternate level control valve
Description: The above two valves are Research Control Valves, equal percentage trim, 1/2" angle body, Trim F; J.R. Simpson & Company

LCV-22A - Solvent recovery column reboiler level control valve

LCV-22B - Solvent recovery column reboiler alternate level control valve

LCV-23 - Solvent recovery column bottoms receiver level control valve

LCV-25 - Solvent drum level control valve
Description: Preceding four valves are Research Control Valves, equal percentage trim, 1/4" globe body, trim F; J.R. Simpson & Company

LCV-24 - Solvent recovery column overheads receiver level control valve
Description: Research Control Valve, "No positioner", 1/4" globe body, trim F; J.R. Simpson & Company

LCV-26 - Hydroclone underflow stripper overheads receiver level control valve
Description: Clark Reliance Float-Trap Assembly

LR - Level Recorder

LR-11 - Hydroclone underflow stripper level recorder

LR-26 - Preheat/wash oil drum level recorder
Description: Moore Products Model 5321SM Two Pen Syncro Recording Control Station; Moore Products Company

LRC - Level Recorder Controller

LRC-13 - Hydroclone underflow receiver level recorder controller

LRC-21 - Settler overflow receiver level recorder controller

LRC-22 - Solvent recovery column reboiler level recorder controller

LRC-23 - Solvent recovery column bottoms receiver level recorder controller

LRC-24 - Solvent recovery column overheads receiver level recorder controller

LRC-25 - Solvent drum level recorder controller
Description: The above six instruments all are Moore Product Model 5321SM Two Pen Syncro Recording Control Station with Model 561M Controller; Moore Products Company

M - Heat Exchangers

M-20 - Hydroclone underflow stripper overheads partial condenser
Description: Griss and Russel

M-21 - Hydroclone underflow stripper steam superheater
Description: Fabricated at HRI

M-22 - Settler underflow lead bath
Description: General Electric MC1502, cut in over the side Calrod Immersion Heaters, 3KW-240 volts; General c/o R. Schadler Company. Fabricated at HRI

M-23 - Solvent heater
Description: Emerson Recirculation Heater 240V, 3P, 20KW, 300 psig; Emerson Electric O., Edwin L. Weigand Division c/o Chromolox

M-24A - Solvent recovery column bottoms primary cooler
Description: Fabricated at HRI

M-24B - Solvent recovery column alternate bottoms primary cooler
Description: Fabricated at HRI

M-25 - Solvent recovery column bottoms secondary cooler
Description: Fabricated at HRI

M-26 - Preheat/wash oil drum vapor condenser
Description: Fabricated at HRI

M-27 - Solvent vapor condenser
Description: Fabricated at HRI

M-28 - Solvent recovery column overheads condenser
Description: Part of N-4 system; Distillation Engineering

M-29 - Settler overflow receiver vent gas condenser
Description: Fabricated at HRI

M-30 - Hydroclone underflow preheater (lead bath)
Description: Existing

N-Column

N-4 - Solvent recovery column
Description: Distillation Engineering

MD-Mixer Drive

MD-1 - Settler mixer drive
Description: Gear case: Input RRM-3450, Output-13 to 0 RPM. Model No. 29MW60, Serial No. 11B8766; Graham Trans., Inc. Motor: Model No. 40190-A AX, 115/230 V, Type KF, 1 phase, 1/4 HP, 60 CVC, 3450 RPM, Doerr Electric Co.

O-Vessel

O-22 - Hydroclone underflow receiver
Description: Existing vessel

O-24 - Hydroclone underflow stripper
Description: Fabricated at HRI

O-25 - Settler vessel
Description: As per drawing DD-2844; Process Engineering and Machine Co., Inc.

O-26 - Settler overflow receiver
Description: As per drawing DD-2845; Process Engineering and Machine Co., Inc.

O-27 - Hydroclone underflow stripper overheads receiver
Description: Fabricated at HRI

O-28 - Solvent recovery column overheads receiver
Description: Fabricated at HRI

P-Drums

P-5 - Solvent drum
Description: As per drawing DD-2846; Process Engineering and Machine Co., Inc.

P-6 - Preheat/wash oil drum
Description: As per drawing DD-2846; Process Engineering and Machine Co., Inc.

P-7 - Solvent recovery column bottoms receiver
Description: Fabricated at HRI

PCV-Pressure Control Valve

PCV-19 - Hydroclone underflow stripper steam pressure control valve

Description: Watts Model 143WI Steam Regulator; Lincoln Supply

PCV-20A- Hydroclone underflow striper overheads receiver pressure control valve
Description: Masonelian Back Pressure Regulator, Model 17-17, 2-12 psig range, C_V=1.8

PCV-20B- Hydroclone underflow stripper overheads receiver alternate pressure control valve
Description: Masonelian Back Pressure Regulator, Model 17-17, 2-12 psig range, C_V=1.8

PCV-22A- Settler overflow receiver back pressure control valve

PDC-22B- Settler overflow receiver back pressure alternate control valve
Description: Above two valves are Tescon Back Pressure Regulators, ID. 26-1727-24-027; Brisco Sales

PCV-23 - Settler overflow receiver nitrogen pressure control valve

PCV-24A- Settler overflow receiver differential pressure transmitter low pressure leg nitrogen purge pressure control valve

PDV-24B- Settler overflow receiver differential pressure transmitter high pressure leg nitrogen purge pressure control valve
Description: The previous three valves are all Tescon Model 26-1622-24-008-024 Hand Louder pressure regulators; 0-250 psig, 600 psig; Brisco Sales

PI-Pressure Indicator

PI-100 - Hydroclone underflow stripper steam pressure indicator
Description: McDaniel Safety Gauge, 0-60 psi; Crown Controls

PI-101 - Hydroclone underflow stripper overheads receiver pressure indicator

Description: McDaniel Safety Gauge, 0-60 psi; Crown Controls

PI-102A- Hydroclone underflow stripper bottoms pump suction pressure indicator
Description: USG Diaphram Gauge, 0-100 psi; Power Associates

PI-102B- Hydroclone underflow stripper bottoms pump discharge pressure indicator
Description: USG Diaphram Gauge, 0-100 psi; Power Associates

PI-103A- Hydroclone underflow to settler charge pump discharge pressure indicator
Description: USG Liquid Filled Gauge, 0-400 psi; Power Associates

PI-103B- Hydroclone underflow to settler charge pump discharge pressure indicator
Description: USG Liquid Filled Gauge, 0-400 psi; Power Associates

PI-103C- Hydroclone underflow to settler alternate charge pump discharge pressure indicator
Description: USG Liquid Filled Gauge, 0-400 psi; Power Associates

PI-103D- Hydroclone underflow to settler alternate charge pump discharge pressure indicator
Description: USG Liquid Filled Gauge, 0-400 psi; Power Associates

PI-103E- Second stage mixer pressure indicator
Description: USG Liquid Filled Gauge, 0-400 psi, Power Associates

PI-104A- Settler overflow receiver level control valve inlet pressure indicator
Description: USG Diaphram Gauge, 0-400 psi; Power Associates

PI-104B- Settler overflow receiver alternate level control valve pressure indicator
Description: USG Diaphram Gauge, 0-400 psi; Power Associates

PI-105 - Nitrogen manifold pressure indicator
Description: McDaniel Safety Gauge, 0-5000 psi; Crown Controls

PI-106A- Settler overflow receiver nitrogen pressure control valve outlet pressure indicator
Description: McDaniel Safety Gauge, 0-400 psi; Crown Controls

PI-106B- Settler overflow receiver differential pressure transmitter low pressure leg nitrogen purge pressure control valve outlet pressure indicator
Description: McDaniel Safety Gauge, 0-400 psi; Crown Controls

PI-106C- Settler overflow receiver differential pressure transmitter high pressure leg nitrogen purge pressure control valve outlet pressure indicator
Description: McDaniel Safety Gauge, 0-400 psi; Crown Controls

PI-107A- Settler overflow receiver back pressure control valve inlet pressure indicator
Description: McDaniel Safety Gauge, 0-400 psi; Crown Controls

PI-107B- Settler overflow receiver alternate back pressure control valve inlet pressure control valve inlet pressure indicator
Description: McDaniel Safety Gauge; 0-400 psi; Crown Controls

PI-108 - Settler underflow line pressure indicator
Description: USG Diaphram, 0-400 psi; Power Associates

PI-109A- Settler underflow control valve inlet pressure indicator
Description: USG Diaphram, 0-400 psi; Power Associates

PI-109B- Settler underflow alternate control valve inlet pressure indicator
Description: USG Diaphram, 0-400 psi; Power Associates

PI-110A- Settler underflow control valve stem flush line pressure indicator
Description: USG Diaphram, 0-400 psi; Power Associates

PI-100B- Settler underflow alternate control valve stem flush line pressure indicator
Description: USG Diaphram, 0-400 psi; Power Associates

PI-112 - Solvent recovery column reboiler bottoms pump and alternate bottoms pump suction line pressure indicator
Description: Weskler Vacuum Gauge, 0-30" Hg; Arobone and Cline

PI-113A- Solvent recovery column bottoms pump discharge pressure indicator
Description: USG 316 SS Bourdon Tube; Power Associates

PI-113B- Solvent recovery column alternate bottoms pump discharge pressure indicator
Description: USG 316 SS Bourdon Tube; Power Associates

PI-114 - Solvent recovery column bottoms receiver pump discharge pressure indicator
Description: USG 316 SS Bourdon Tube; Power Associates

PI-115A- Solvent recovery column pressure indicator
Description: Weskler Vacuum, 0-30" Hg; Arobone and Cline

PI-116 - Solvent recovery column overheads receiver product pump suction line pressure indicator
Description: Weskler Vacuum, 0-30" Hg; Arobone Cline

PI-117 - Solvent recovery column overheads receiver product pump discharge pressure indicator
Description: USG 316 SS Bourdon Tube; Power Associates

PI-118 - Solvent drum circulation pump discharge pressure indicator

Description: USG Diaphram, 0-100 psi; Power Associates

PI-119A- Solvent to settler charge pump discharge pressure indicator
Description: USG Liquid Filled, 0-400 psi; Power Associates

PI-119B- Solvent to settler charge pump discharge pressure indicator
Description: USG Liquid Filled, 0-400 psi; Power Associates

PI-120A- Solvent drum circulation/storage pump discharge pressure indicators
Description: USG Diaphram, 0-100 psi; Power Associates

PI-120B- Solvent drum circulation/storage pump discharge pressure indicators
Description: USG Diaphram, 0-100 psi; Power Associates

PI-121 - Preheat/wash oil drum circulation pump discharge pressure indicator
Description: USG Diaphram, 0-100 psi; Power Associates

PI-122 - Settler overflow line pressure indicator
Description: USG Liquid Filled, 0-400 psi; Power Associates

PI-123 - Fuel oil receiver pump discharge pressure
Description: McDaniel Liquid Filled, 0-200 psi, Crown Controls

PI-124 & 125 - Settler underflow circulation loop
Description: USG Liquid filled, 0-400 psi; Power Associates

PT-Pressure Transmitter

PT-101 - Hydroclone underflow stripper overheads receiver pressure transmitter
transmitter blind, 0-200 psi range, 3-15 psig output; Moore Products Company

PT-104 - Settler overflow receiver pressure transmitter
Description: Moore Products Model 173 S pressure transmitter blind, 0-200 psig range, 3-15 psig output; Moore Products Company

WI-Weight Indicator

WI-5 - Solvent recovery column bottoms storage drum weight indicator

WI-6 - Solvent storage drum weight indicator

WI-7 - Fuel oil receiver weight indicator
Description: Electroscale, Flexure Base Scale Model 2424, Input - 1000 lbs to 1/2 lb, output is digital; Accurate Scale Company

PROCESS DEVELOPMENT UNIT

and

PILOT PLANT

HYDROCLONE SYSTEMS

HYDROCLONE PERFORMANCE IN THE PDU SYSTEM

Previous work demonstrated that improved yield structure and conversion could be attained when the feed coal slurrying oil contained residuum instead of being all distillate. However, it was also known that an excessively high solids content in the reactor was intolerable. HRI, as part of the Phase I H-Coal project, investigated various methods to separate ash and unreacted coal from the non-distillable residual oil before it is recycled.

Filtration had worked successfully in bench unit tests, but economic considerations dictated that another method be found. A logical candidate for this service was the hydroclone because of its ability to function continuously, lack of moving parts and the fact that fabrication for high temperature was possible. Initial tests indicated that hydroclones could, in fact, do the job, but that the commercially-available hydroclones suffered from excessive erosion susceptibility.

A test loop was utilized to study hydroclone operation under controlled conditions and, with the information gained, the hydroclones were placed in continuous service in the PDU system. Based on these tests we concluded that hydroclones are a simple, reliable, cost-effective method of achieving satisfactory residuum recycle.

Hydroclones have achieved excellent efficiencies in all seven PDU operations in which they have seen service. These runs used, variously, Illinois, Kentucky and Wyodak coals. Highlights of several of these runs are presented here to demonstrate the quality of hydroclone service in operations using these several different coal feeds.

ILLINOIS NO. 6 COAL - PDU RUN 4 - SYNCRUDE MODE

A single, ceramic-lined hydroclone was in service for all of PDU Run 4, which was a major improvement over the one-day life initially obtained. In addition, data were obtained on the combination of viscosity and flow rate required to give the optimum performance in terms of capacity and efficiency. The objective of this was to minimize the number of parallel units in the Pilot Plant.

Operation began with full use of hydroclone overhead recycle, at a catalyst age of about 300 pounds coal per pound catalyst and the yield

of total distillates decreased from about 54 W % of dry coal to about 43% of dry coal as a catalyst age of 1500 pounds coal/pound catalyst was approached. The downward trend clearly moderated towards the end of the run and was mostly a reflection of the yield of C_4-400°F naphtha decreasing from about 32 W % of dry coal to 23 W % of dry coal. There was a more moderate decrease in the yield of 400-975°F distillates, from about 22 W % of dry coal to 20 W % of dry coal.

ILLINOIS NO. 6 COAL - PDU RUN 8 - DUAL MODE

PDU 8 successfully operated in two modes with no interruption during transition. The first phase of the run operated in a fuel oil mode to produce hydroclone underflow. Forty drums of this material were manufactured for further tests designed to establish the most favorable Pilot Plant operating conditions for the solvent precipitation system.

KENTUCKY COAL - PDU RUN 9 - SYNCRUDE MODE

In order to investigate the solids separation in the hydroclone, samples of hydroclone underflow and overflow were compared for ash and dimethylformamide (DMF) insolubles. Exhibit H-1 shows the analysis and the ratios for five periods of PDU Run 9. The DMF insolubles to ash ratio is higher by 30% in the overflow than the underflow. This may indicate an advantageous selective separation in the hydroclone with higher carbonaceous insolubles to ash ratio in the overflow recycling back to the slurry mix tank than in the underflow going to the vacuum bottoms product.

WYODAK COAL - PDU RUN 10 - SYNCRUDE MODE

Separation efficiencies were very good, averaging 31.6% for the entire run as illustrated in Exhibit H-2. Flow conditions were such that a pressure drop of 65 to 70 psi was maintained between the feed and overflow and at 50 to 60 psi between the feed and underflow. Feed rate to the hydroclone system was about 0.9 gpm, which resulted in about 15% of the overflow being recycled to the feed for single

hydroclone operation. The feed to the hydroclone system contained about 17% recycled atmospheric still bottoms and 16% recycled vacuum still overhead. These ASB's and VSO's were added to reduce viscosity and solids concentration of the hydroclone feed and bring the hydroclone closer to maximum capacity to attain higher efficiency. The operating temperature was 470 to 490°F.

Hydroclone Particle Analysis

Hydroclone flow samples (feed, overflow, underflow) were analyzed from Periods 7B, 21B, 26B, 30B, and 33B. Each sample, in a suitable solvent such as toluene, was placed in a particle analyzer and kept in suspension by constant stirring. A laser beam shone through the sample and the deflection patterns were correlated with particle size. The analyzer gives the following data:

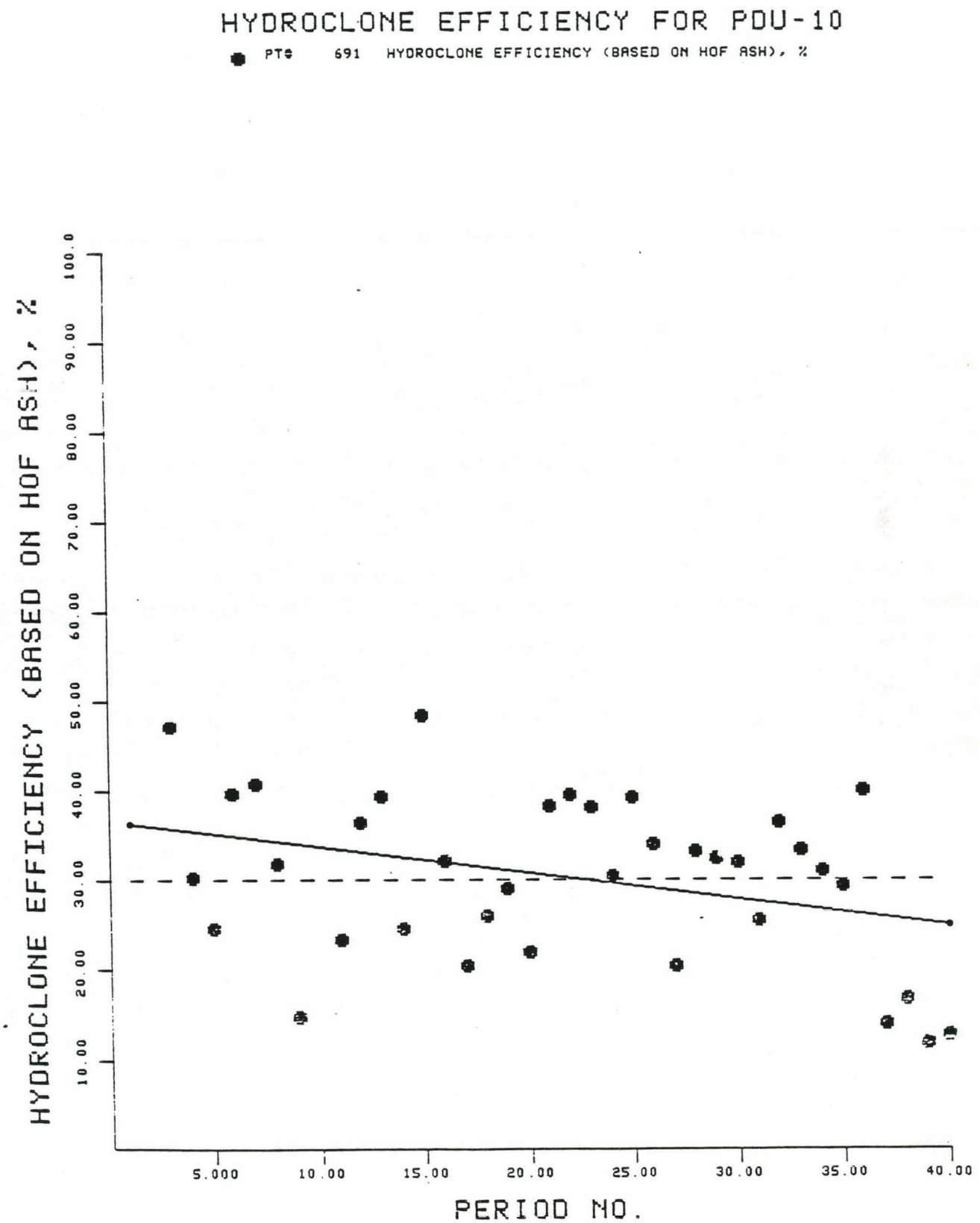
1. Micron size distribution,
2. Surface area (m^2/cm^3),
3. Volume, mean diameter (microns),
4. 90% smaller (microns),
5. 50% smaller (microns), and
6. 10% smaller (microns).

The data clearly showed that the hydroclone splits the larger feed particles to the underflow. For no overflow sample were particles reported greater than 7.8 microns, while in the underflow, particles up to at least 44 microns were reported in each case, save one (-31 microns) in Period 21B.

DMF INSOLUBLES TO ASH RATIOS FOR HYDROCLONE OVERFLOW AND UNDERFLOW ON PDU 9

Sample	Period	DMF Insolubles	Ash	Ratio I/A	Ratio I/A Overflow / I/A Underflow
Overflow	14B	3.24	4.67	.693	1.325
Underflow	14B	4.88	9.33	.523	
Overflow	16B	2.53	3.33	.760	1.343
Underflow	16B	4.57	8.08	.566	
Overflow	20B	3.61	4.86	.744	1.222
Underflow	20B	5.92	9.72	.609	
Overflow	25B	4.70	4.63	1.101	1.736
Underflow	25B	5.36	9.15	.586	
Overflow	29B	5.16	6.18	.835	1.369
Underflow	29B	6.38	10.46	.610	

EXHIBIT H-2


HYDROCLONE EFFICIENCY FOR PDU-10
PT# 691 HYDROCLONE EFFICIENCY (BASED ON HOF ASH), %
HYDROCLONE EFFICIENCY (BASED ON HOF ASH), %
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.0
5.000
10.00
15.00
20.00
25.00
30.00
35.00
40.00
PERIOD NO.

HYDROCLONE TEST LOOP

DESCRIPTION

The hydroclone test loop consisted of a 55-gallon agitated feed drum with a steam heating coil, a variable speed gear type pump, an electrical preheater, and a hydroclone unit. Connections were all 1/2-inch steel pipe (see Exhibit H-3). Sample taps were located at the pump discharge for obtaining feed samples and at the outlets of the hydroclone for obtaining overflow and underflow samples. Pressure gauges were located at the pump discharge and at the hydroclone inlet and outlet. Skin temperature thermocouples were used to measure fluid temperatures. The preheater section consisted of three-and-one-half loops of 1/2-inch Schedule 80 steel pipe having a total length of 27 feed. It was wrapped with about 200 feet of heating wire. All liquid lines were electrically heated to avoid plugs. The pumps used were either a Model 4GA Worthington gear pump with variable speed drive or a Model 4A Bump-Ulrich positive displacement type pump also with variable speed drive.

The hydroclone was a 10-mm internal diameter type A Dorr-Oliver "Doxie" impurity separator with a 0.099-inch diameter overflow orifice and a 0.09375-inch diameter underflow orifice (see Exhibit H-4). The Doxie was designed for about 1.2 gpm liquid feed at 80 psi differential pressure.

OPERATION

Based on previous unsatisfactory wear experience with standard Doxies made of type 316 stainless steel and having an average life of only about one day at rated capacity, the worn units were rebuilt using internal hard surfacing. A layer approximately 0.006-inch thick of chromium was plated on the entrance vortex area and the area was then built up with stellite and machined to the original dimension using the electro-static-discharge machining technique. The hydroclone system is detailed in Figure 58.

The modifications did not adversely affect the separation efficiency of the Doxies; however, a change in the outlet flow split between the overflow and underflow streams was noted on the stellited Doxies since the rebuilt units had enlarged underflow

orifices from previous use. Data from loop tests of new Doxie hydroclones are presented in Exhibit H-5. Data from tests on rebuilt hydroclones are presented in Exhibit H-6.

An all-ceramic hydroclone made by Heyl & Patterson also was tested. It was unsuccessful because of excessive plugging of the orifices (0.060-inch diameter) and because of a 40 psi differential pressure limitation which was insufficient for this application.

Liquid for the loop tests was taken from the PDU during a period when reactor liquid was being taken overhead and the reactor flushed with hydrogenated anthraceme and No. 2 fuel oils. This was done to obtain a sufficiently low viscosity. Solids levels of the test loop feed were adjusted by addition of high solids vacuum bottoms product.

Separation efficiencies, defined as 100 (1 - % Ash in Overflow)/ % Ash in Feed varied from about 78% for diluent feed (1.1% ash) at 424°F to 7.5% for feeds containing 7.58% ash at 398°F. As would be expected, increasing feed temperature (which decreases viscosity) increased separation efficiency. Results showed a rough correlation between viscosity and hydroclone separation efficiency.

Separation efficiency as a function of pressure drop (D/P) across the hydroclone also was determined for a feed containing 2.48 to 3.02 W % ash. Increasing the D/P from.30 to 60 psi increased efficiency from about 36% to about 65%.

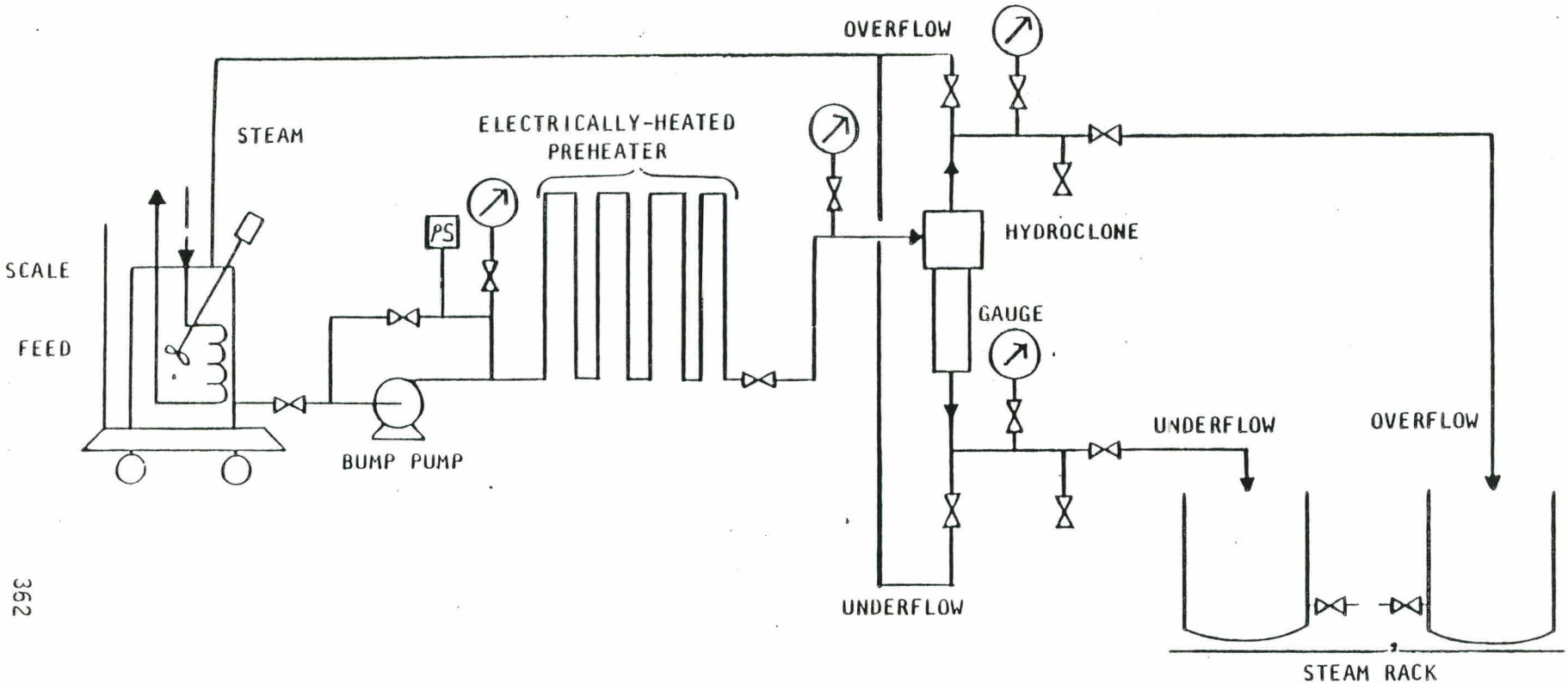
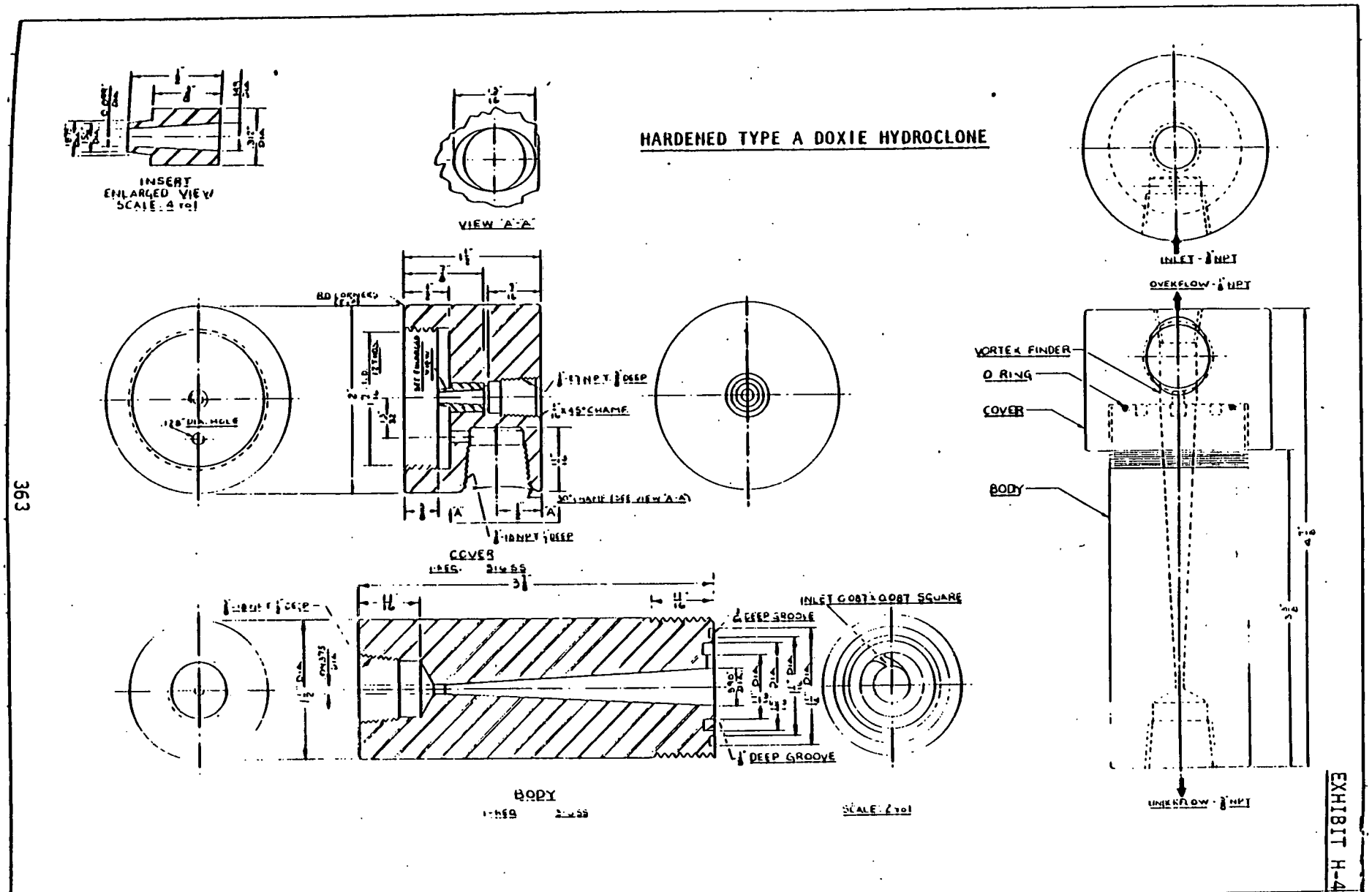


EXHIBIT H-3

HYDROCARBON RESEARCH, INC. a subsidiary of DYNALECTRON CORPORATION	HYDROCLONE BUMP PUMP TEST LOOP	DRAWN: L. C. DATE: 7/29/75 ENGR: DATE: DWG. NO. AF-2638


HARDENED TYPE A DOXIE HYDROCLONE
INSERT
ENLARGED VIEW
SCALE: 4 to 1
VIEW "A-A"
COVER
BODY
SCALE: 2 to 1
INLET - 1/8" NPT
OVERFLOW - 1/8" NPT
VORTEX FINDER
O RING
COVER
BODY
UNDERFLOW - 1/8" NPT
INLET 0.087 x 0.087 SQUARE
DEEP GROOVE
EXHIBIT H-4
HYDROCARBON RESEARCH, INC.
HARDENED TYPE A DOXIE HYDROCLONE
DD-2654

TESTS ON NEW DOXIE HYDROCLONES USING TEST LOOP

Time	Date	Doxie ΔP	Temp.@ Doxie	% Ash in Feed	% Ash in Overflow	% Ash in Underflow	Separation (1-% O% F)100	W % Ash in Underflow/ W % Ash in Feed	Material Balance By Analysis % Overflow	Material Balance By Analysis % Underflow	
1330	5/27	75-80	424	1.10	0.24	1.97	78.2	0.89	50.3	49.7	43.2
1600		75-80	450		0.34	2.37	69.1		47.8	52.2	33.4
1130	5/28	75-80	378	1.14	0.44	1.78	61.4		47.8	52.2	33.4
1600		80	394	3.74	1.65	5.51	55.9	0.768	45.9	54.1	95.8
1055	6/2	80	409	3.60	1.68	5.58	53.3		50.7	49.3	97.6
1535	6/3	80	332	4.44	3.26	6.19	26.6	0.562	59.7	40.3	70.5
1200	6/4	80	398	7.58	7.01	8.74	7.5		67	33	38.3
1315		80	428	7.81	5.92	9.11	24.2		40.8	59.2	77
1400		80	470	7.97	6.00	9.06	24.7		35.6	64.4	70.2
1525		78	446	7.51	4.63	9.74	38.3		43.6	56.4	125.8
2110	6/10	80	480	8.05	5.13	11.01	36.3		50.3	49.7	147.1
1240		80	474	7.92	5.61	10.96	29.2		56.8	43.2	131.3
1340		80	502	8.24	5.34	11.83	35.2		55.3	44.7	134.6
1500	6/16	80	452	6.59	3.63	9.06	44.9	0.749	45.5	54.5	134.6
1600		80	461	7.01	3.46	10.12	50.6	0.769	46.7	53.3	165.8

EXHIBIT H-5

TESTS ON RESURFACED DOXIES USING TEST LOOP

Time	Date 1975	Doxie ΔP	Temp.@ Doxie	% Ash in Feed	% Ash in Overflow	% Ash in Underflow	Separation 100 $(1-A_O/A_F)$	% Overflow Calculated	% Overflow Weight	% Underflow Calculated*	% Underflow Weight	Lbs/ Hour
1800	7/24	60	440	2.88	1.01	5.48	64.9	58.2	49	41.8	51	452
1000	7/25	40	442	3.02	1.53	4.65	49.3	52.2	41.9	47.8	58.1	370
1335	7/25	30	453	2.48	1.58	3.73	36.3	58.1	44.5	41.9	55.5	368
1515	6/18	80	425	5.45	3.09	6.58	43.3	32.4		67.6		
1500	6/29	52	457	3.56	1.52	6.71	57.3	60.7	46	39.3	54	

* By Analysis

EXHIBIT H-6

PDU HYDROCLONE SYSTEM CONFIGURATION

DESCRIPTION

This system, illustrated in Exhibit H-7, consisted of a Durco centrifugal feed pump, a feed preheating lead box, a feed strainer, two Doxie hydroclones connected in parallel, two storage vessels for overflow and underflow liquid streams, and an overflow liquid meter. This equipment was all incorporated into the PDU process system.

Feed material to the Durco pump consisted of flashed reactor liquid from a flash drum, diluted with a metered stream of vacuum still overhead liquid, and a metered stream of atmospheric still bottoms liquid. About 30 gpm of this feed liquid was recycled from the feed pump discharge to the pump suction, and about one gpm was discharged at about 110 psig to the 12 KW lead box preheater through a 40 mesh pipeline strainer and then fed to one of the hydroclones.

Both the overflow and underflow streams were sent to holding tanks to regulate the overflow and underflow pressures. This controlled the split between the streams. Both tanks were equipped with pressure and level recording control instruments. Surface thermocouples were used to measure fluid temperatures. Automatic temperature controllers maintained set temperatures of all electrically-heated pipes and tanks. A 24-point recorder was used to record temperatures. The overflow from the hydroclone ultimately passed through a flow meter and then to the coil-oil slurry mix tank. The underflow was sent to the vacuum still.

DEVELOPMENT

Two hydroclone system runs were made during PDU Run 130-72 (Eighth Shakedown Run) for 86 hours and 121 hours, respectively (Exhibit H-8). From the appearance of the hydroclones and the separation efficiency obtained, the life expectancy was expected to be about 121 hours before replacement was needed.

A Durco centrifugal pump, operating at 3500 rpm, was used as the feed pump, and a steady discharge pressure of about 15 to 20 psig was maintained for the 207 hours of hydroclone operation. Some wear on the pump impellor was observ ed, but it was not enough to

noticeably affect the pump performance. The welded pump parts were Durco 100 metal, a hard, high-chrome stainless steel.

The percent ash in the feed stream varied between about 5.7 and 8.2 (by material balance calculations). Ash separation efficiencies varied from about 29% to about 53%. but averaged about 34%. The efficiency data scatter was probably due to the kinds of samples taken, i.e., spot samples instead of composite samples. The pressure drop across the Doxie hydroclones was steady. The range of the data masked any correlation between pressure drop, temperature, feed viscosity and efficiency. The higher average D/P (7 psi) and the higher average temperature (17°F) may have resulted in a small (3.3%) increase in separation efficiency in Periods 9A to 14A over that for Periods 3B to 6B.

Liquid viscosities for this run were measured with a Brookfield viscosimeter using an LVT No. 18 spindle at 30 rpm. Viscosities were measured for three samples (ash contents of 4.33%, 8.24% and 10.28%) at three temperatures, 350, 400 and 450°F), and extrapolated for other concentrations and temperatures.

The worn parts of the Durco feed pump impellor were resurfaced with tungsten-carbide to reduce erosion. To provide for continuity of operation, an on-line, spare Durco pump was installed.

Composite samples of hydroclone liquid feed, overflow and underflow streams were taken in an attempt to reduce irregularities in the data.

A Dorr-Oliver Model TMC-4 Dorrclone assembly containing one metal-jacketed ceramic hydroclone, designed for use at high temperature and up to 80 psi pressure differential, was tested on the PDU. This type of hydroclone operated for about five days the first time it was used. Subsequently a single, ceramic hydroclone was in operation throughout PDU Run 4. Measured wear was minimal - 0.009" in the underflow orifice, 0.001-inch in the overflow orifice, none in the inlet, and a slight groove on the tangential wall of the hydroclone.

Based on these results we concluded that hydroclones present a simple, reliable, cost-effective way to achieve residuum recycle.

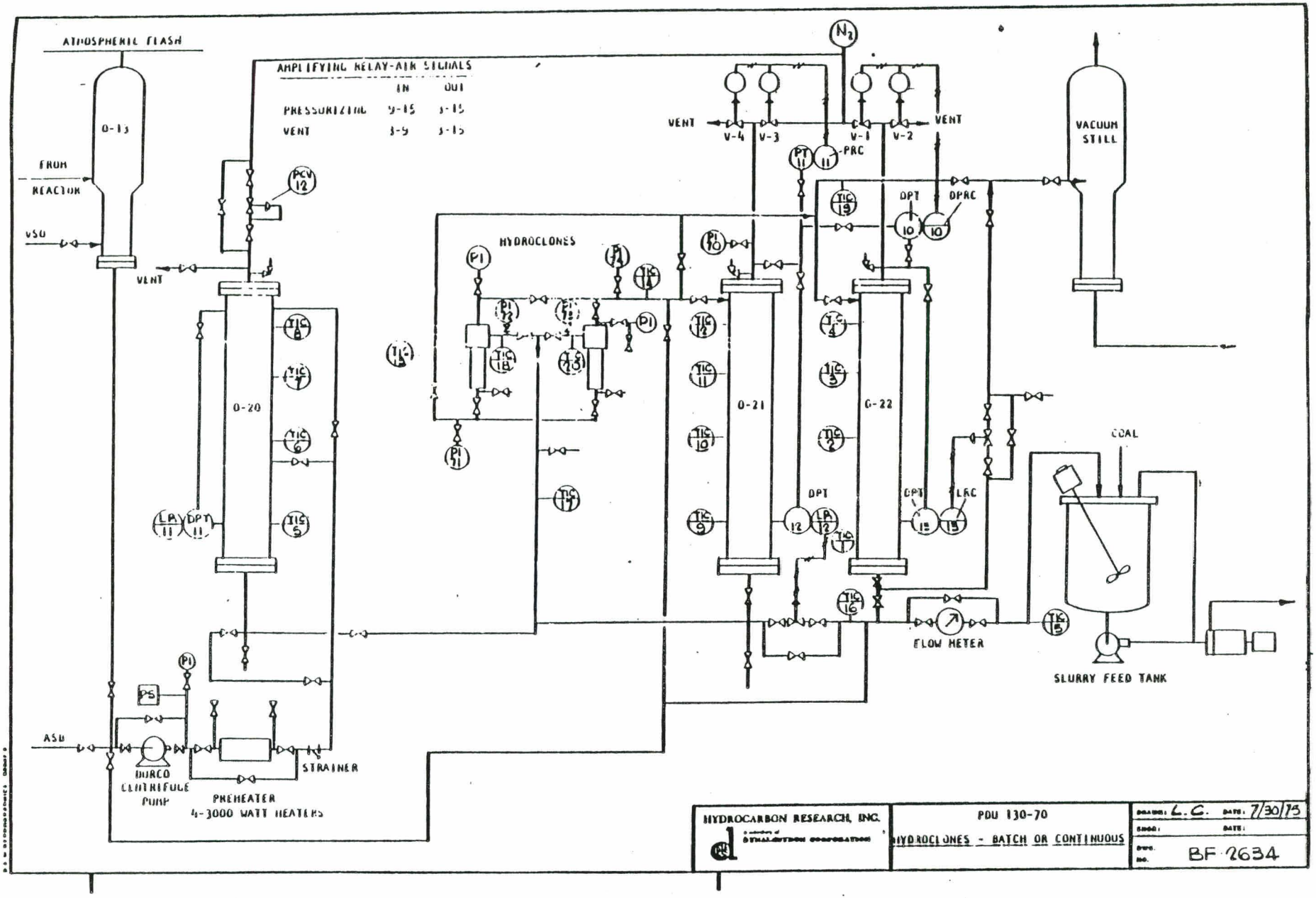

ATMOSPHERIC FLASH
AMPLIFYING RELAY-AIR SIGNALS
IN OUT
PRESSURIZING 9-15 3-15
VENT 3-9 3-15
FROM REACTOR
VSU
VENT
O-13
O-20
HYDROCLONES
O-21
O-22
VENT
V-4
V-3
V-1
V-2
VENT
PRC
DPT
DPRC
VACUUM STILL
COAL
DPT
DPT
LRC
FLOW METER
SLURRY FEED TANK
ASU
DURCO CENTRIFUGE PUMP
PREHEATER
4-3000 WATT HEATERS
STRAINER
HYDROCARBON RESEARCH, INC.
PDU 130-70
HYDROCLONES - BATCH OR CONTINUOUS
DRAWN: L.C. DATE: 7/30/75
BF-2634

EXHIBIT H-7

HDYROCLONES SYSTEM TESTS

Period	ΔP psi	Temp. °F	Brookfield Viscosity Extrapolated	Ash Content Flow, Pounds/Hour: Feed Calculated	By Analysis: Overflow	By Analysis: Underflow	Overflow	Underflow	% Overflow	Separation Efficiency 100 (1-% A_O/% A_F)
3B	74	475	9	6.29	4.36	8.53	355	308	53.6	30.7
4A	69	470	9.8	7.43	5.46	9.19	306	34	47.3	26.5
4B	65	459	11.8	7.01	4.96	8.71	290	352	45.2	29.3
5A	60	460	11.5	6.64	4.36	8.21	218	317	40.8	34.3
5B	60	458	11.8	6.69	4.89	8.65	282	340	45.4	29.6
6A	60	455	10.7	5.69	3.6	7.88	260	337	43.5	42.6
6B	60	460					201	306	39.6	
3B-6B Average	64	462	10.8	6.63	4.60	8.53	203			32.2
9A	78	509	7.8	8.18	5.21	10.28	203	287	41.4	36.3
9B	75	486	8.4	6.8	4.70	8.64	258	294	46.7	30.9
10A	71	475	9.5	7.22	4.13	10.39	296	288	50.7	42.8
10B	68	480	9.2	7.05	4.77	9.11	283	314	47.4	32.4
11A	73	477	10.6	8.07	6.0	9.83	269	315	46	25.7
11B	74	480	9.4	7.4	5.32	9.36	286	305	48.4	28.3
12A	71	475	9.7	7.5	5.35	9.3	274	327	45.6	28.6
12B	70	480	9.4	7.23	4.21	9.97	295	324	47.6	41.8
13A	71	475	9.1	6.43	3.43	9.52	305	299	50.5	47.0
13B	70	470	9.6	6.88	3.24	10.48	310	314	49.7	52.9
14A	60	465	9.4	6.32	4.79	7.75	304	324	48.5	24.2
9A-14A Average	71	479	9.3	7.19	4.65	9.51				35.5

Note: Periods 3B-6B - 86 Hours Running Time on One Stellited Doxie Hydroclone
Periods 9A-14A- 121 Hours Running Time on One Stellited Doxie Hydroclone

EXHIBIT H-8

PILOT PLANT HYDROCLONE PERFORMANCE

RUN 5

A sustained operation with a bank of 30 hydroclones was carried out in late 1980.

Exhibits H-9 and H-10 present a measure of the hydroclone efficiencies achieved. Although there is some scatter in the data, it appears that the targeted hydroclone efficiency of at least 40 percent can be achieved.

RUN 6

A bank of 60 hydroclones was used throughout Run 6. The run began with 'E' bank, and then switched to the 'D' bank. Operations continued for 27 days when a switch was made to the 'C' bank, which was used for the remainder of the run. The data for 'C' bank performance only is given, because during this time a special effort was being made to maintain adequate flow to the hydroclones. A hydroclone efficiency slightly over 30 percent was obtained for the first several days and then gradually dropped.

The gradual drop-off in efficiency may have been caused by oversize particles getting trapped in some of the hydroclones. Since the hydroclone underflow orifice is smaller than the overflow orifice, any oversize particles would tend to plug at the underflow orifice, filling the hydroclone with solids. The feed near the top of the hydroclone would then pass out with the overflow contaminating the rest of overflow from those hydroclones which are working properly.

Filters are installed upstream to prevent oversize material from getting to the hydroclones but these filters are located at about 150 feet from the hydroclones. Since oversize material coating the walls of this line could have been flaking off and entering the hydroclones, installation of additional filters right at the hydroclones or moving the present filters nearer would probably solve the problem.

During inspection after shutdown we found that the metallic shell around a number of ceramic hydroclones in 'D' bank had corroded. This metal shell is made of beryllium and copper, and the corrosion is believed to be sulfur corrosion. We are purchasing Dorr-Oliver hydroclones with nickel coating. We also found that some of the vortex finders in the hydroclones, which are made of tungsten carbide, were eroded in 'D' bank. These will be replace with ceramic vortex finders.

None of these problems were found in 'C' or 'E' banks. However, 'E' bank was only used for about nine days, the 'C' bank for about ten days, and the 'D' bank had been used for about twenty-seven days.

HYDROCLONE PERFORMANCE

Date	Time	Feed % Solids	Feed % Ash	Overflow % Solids	Overflow % Ash	% Efficiency* Solids	% Efficiency* Ash	Pressure Differential psi	Hydroclone Temp, °F
10/25	1000	6.7	4.8	4.3	2.8	37.4	42.9	43.5	565
10/30	0150	9.1	5.8	5.29	3.6	44.2	39.3	57.6	626
	0950	6.55	4.7	2.9	1.8	57.4	62.8	66.5	615
	1945	8.16	7.2	6.54	4.0	21.2	46.3	41.2	542

$$* \text{ Efficiency} = 1 - \frac{(1 - x_f)\, x_0}{(1 - x_0)\, x_f}$$

Where

x_f = weight fraction solids in feed
x_0 = weight fraction solids in overflow

EXHIBIT H-9

HYDROCLONE PERFORMANCE

DATE	HOUR	HOURS ONSTREAM B	C	D	FEED % ASH	FEED % SOLIDS	OVERFLOW % ASH	OVERFLOW % SOLIDS	% EFFICIENCY ASH	% EFFICIENCY SOLIDS	TEMP., °F	SAMPLE POINT
5/9	1015	19	22	--	16.2	27.0	8.3	13.7	53.2	57.1	570	B + C
							8.1	12.8	54.5	60.4		C
								AVG.	53.8	58.7		
5/9	1755	27	30	--	21.9	--	13.5	--	44.4	--	572	B + C
							11.5	--	51.8	--		B
							12.6	--	48.6	--		C
								AVG.	48.3			
5/10	0235	33	38	--	21.0	--	10.2	--	57.3		634	B + C
							10.7	--	54.1			C
								AVG.	55.7			
5/10	1015	41	46	--	17.3	25.3	10.3	16.2	45.1	42.9	598	B + C
5/14	0926	--	--	35	20.3	27.3	10.0	14.25	56.4	55.8	618	Overall
							9.7	13.93	57.8	56.9		D
								AVG.	57.1	56.3		

EXHIBIT H-10

HYDROCLONE PERFORMANCE

DATE	HOUR	HOURS ONSTREAM B	HOURS ONSTREAM C	HOURS ONSTREAM D	FEED % ASH	FEED % SOLIDS	OVERFLOW % ASH	OVERFLOW % SOLIDS	% EFFICIENCY ASH	% EFFICIENCY SOLIDS	TEMP., °F	SAMPLE POINT
5/9	1015	19	22	--	16.2	27.0	8.3	13.7	53.2	57.1	570	B + C
							8.1	12.8	54.5	60.4		C
								AVG.	53.8	58.7		
5/9	1755	27	30	--	21.9	--	13.5	--	44.4	--	572	B + C
							11.5	--	51.8	--		B
							12.6	--	48.6	--		C
								AVG.	48.3			
5/10	0235	33	38	--	21.0	--	10.2	--	57.3		634	B + C
							10.7	--	54.1			C
								AVG.	55.7			
5/10	1015	41	46	--	17.3	25.3	10.3	16.2	45.1	42.9	598	B + C
5/14	0926	--	--	35	20.3	27.3	10.0	14.25	56.4	55.8	618	Overall
							9.7	13.93	57.8	56.9		D
								AVG.	57.1	56.3		

EXHIBIT H-10 (cont'd)

HYDROCLONE PERFORMANCE

DATE	HOUR	HOURS ONSTREAM B	C	D	FEED % ASH	FEED % SOLIDS	OVERFLOW % ASH	OVERFLOW % SOLIDS	% EFFICIENCY ASH	% EFFICIENCY SOLIDS	TEMP., °F	SAMPLE POINT
5/9	1015	19	22	--	16.2	27.0	8.3	13.7	53.2	57.1	570	B + C
							8.1	12.8	54.5	60.4		C
								AVG.	53.8	58.7		
5/9	1755	27	30	--	21.9	--	13.5	--	44.4	--	572	B + C
							11.5	--	51.8	--		B
							12.6	--	48.6	--		C
								AVG.	48.3			
5/10	0235	33	38	--	21.0	--	10.2	--	57.3		634	B + C
							10.7	--	54.1			C
								AVG.	55.7			
5/10	1015	41	46	--	17.3	25.3	10.3	16.2	45.1	42.9	598	B + C
5/14	0926	--	--	35	20.3	27.3	10.0	14.25	56.4	55.8	618	Overall
							9.7	13.93	57.8	56.9		D
								AVG.	57.1	56.3		

EXHIBIT H-10 (cont'd)

HYDROCLONE PERFORMANCE

DATE	HOUR	HOURS ONSTREAM B	C	D	FEED % ASH	FEED % SOLIDS	OVERFLOW % ASH	OVERFLOW % SOLIDS	% EFFICIENCY ASH	% EFFICIENCY SOLIDS	TEMP., °F	SAMPLE POINT
5/9	1015	19	22	--	16.2	27.0	8.3	13.7	53.2	57.1	570	B + C
							8.1	12.8	54.5	60.4		C
								AVG.	53.8	58.7		
5/9	1755	27	30	--	21.9	--	13.5	--	44.4	--	572	B + C
							11.5	--	51.8	--		B
							12.6	--	48.6	--		C
								AVG.	48.3			
5/10	0235	33	38	--	21.0	--	10.2	--	57.3		634	B + C
							10.7	--	54.1			C
								AVG.	55.7			
5/10	1015	41	46	--	17.3	25.3	10.3	16.2	45.1	42.9	598	B + C
5/14	0926	--	--	35	20.3	27.3	10.0	14.25	56.4	55.8	618	Overall
							9.7	13.93	57.8	56.9		D
								AVG.	57.1	56.3		

EXHIBIT H-10 (cont'd)

HYDROCLONE PERFORMANCE

DATE	HOUR	HOURS ONSTREAM B	HOURS ONSTREAM C	HOURS ONSTREAM D	FEED % ASH	FEED % SOLIDS	OVERFLOW % ASH	OVERFLOW % SOLIDS	% EFFICIENCY ASH	% EFFICIENCY SOLIDS	TEMP., °F	SAMPLE POINT
5/9	1015	19	22	--	16.2	27.0	8.3	13.7	53.2	57.1	570	B + C
							8.1	12.8	54.5	60.4		C
								AVG.	53.8	58.7		
5/9	1755	27	30	--	21.9	--	13.5	--	44.4	--	572	B + C
							11.5	--	51.8	--		B
							12.6	--	48.6	--		C
								AVG.	48.3			
5/10	0235	33	38	--	21.0	--	10.2	--	57.3		634	B + C
							10.7	--	54.1			C
								AVG.	55.7			
5/10	1015	41	46	--	17.3	25.3	10.3	16.2	45.1	42.9	598	B + C
5/14	0926	--	--	35	20.3	27.3	10.0	14.25	56.4	55.8	618	Overall
							9.7	13.93	57.8	56.9		D
								AVG.	57.1	56.3		

EXHIBIT H-10 (cont'd)

HYDROCLONE PERFORMANCE

DATE	HOUR	HOURS ONSTREAM B	HOURS ONSTREAM C	HOURS ONSTREAM D	FEED % ASH	FEED % SOLIDS	OVERFLOW % ASH	OVERFLOW % SOLIDS	% EFFICIENCY ASH	% EFFICIENCY SOLIDS	TEMP., °F	SAMPLE POINT
5/9	1015	19	22	--	16.2	27.0	8.3	13.7	53.2	57.1	570	B + C
							8.1	12.8	54.5	60.4		C
								AVG.	53.8	58.7		
5/9	1755	27	30	--	21.9	--	13.5	--	44.4	--	572	B + C
							11.5	--	51.8	--		B
							12.6	--	48.6	--		C
								AVG.	48.3			
5/10	0235	33	38	--	21.0	--	10.2	--	57.3		634	B + C
							10.7	--	54.1			C
								AVG.	55.7			
5/10	1015	41	46	--	17.3	25.3	10.3	16.2	45.1	42.9	598	B + C
5/14	0926	--	--	35	20.3	27.3	10.0	14.25	56.4	55.8	618	Overall
							9.7	13.93	57.8	56.9		D
								AVG.	57.1	56.3		

EXHIBIT H-10 (cont'd)

HYDROCLONE PERFORMANCE

DATE	HOUR	HOURS ONSTREAM B	C	D	FEED % ASH	FEED % SOLIDS	OVERFLOW % ASH	OVERFLOW % SOLIDS	% EFFICIENCY ASH	% EFFICIENCY SOLIDS	TEMP., °F	SAMPLE POINT
5/9	1015	19	22	--	16.2	27.0	8.3	13.7	53.2	57.1	570	B + C
							8.1	12.8	54.5	60.4		C
								AVG.	53.8	58.7		
5/9	1755	27	30	--	21.9	--	13.5	--	44.4	--	572	B + C
							11.5	--	51.8	--		B
							12.6	--	48.6	--		C
								AVG.	48.3			
5/10	0235	33	38	--	21.0	--	10.2	--	57.3		634	B + C
							10.7	--	54.1			C
								AVG.	55.7			
5/10	1015	41	46	--	17.3	25.3	10.3	16.2	45.1	42.9	598	B + C
5/14	0926	--	--	35	20.3	27.3	10.0	14.25	56.4	55.8	618	Overall
							9.7	13.93	57.8	56.9		D
								AVG.	57.1	56.3		

EXHIBIT H-10 (cont'd)

APPENDIX

PDU OPERATIONS
VARIOUS COAL TYPES

Run No.	Dates of Operation	Run Length Hours	Feed Material	Program Sponsorship
130-36	3/4-4/2/66	430	Illinois No. 6 Coal River King Mine Bituminious	Office of Coal Research U.S. Dept. of Interior Contract 14-01-001-477
130-43	6/10-8/11/66	395	"	"
130-52	4/2-4/28/67	473	"	"
130-56	6/16-6/22/67	101	"	"
130-57	6/26-7/14/67	438	"	"
130-60	2/21-3/8/73	347	Illinois No. 6 Coal Monterey Mine Bituminous	Joint Participation Industrial Consortium
130-62	3/16-3/29/73	301	Illinois No. 6 Coal River King Mine Bituminous	"
130-63	4/12-4/19 and 5/11-5/20/73	386	"	"
130-64	6/27-10/23/73	1,046	Wyodak Mine Coal Subbituminous	"
130-65	2/8-2/24/75	121	Illinois No. 6 Coal Burning Star Mine Bituminous	ERDA - Industry Contract EX-76-C-01-1544
130-69	4/16-5/20/75	814	"	"
130-70	7/4-7/20/75	297	"	"
130-71	8/26-9/3/75	137	"	"
130-72	9/9-9/25/75	285	"	"
130-73	10/17-11/8/75	535	"	"
130-74	12/14/75 - 1/16/76	128	"	"

Run No.	Dates of Operation	Run Length Hours	Feed Material	Program Sponsorship
130-76	2/10-3/8-76	475	Illinois No. 6 Coal Burning Star Mine Bituminous	ERDA - Industry Contract EX-76-C-01-1544
130-77	3/28-4/8/76	272	"	"
130-78	4/25-5/6/76	274	"	"
130-79	5/31-7/1/76	603	"	"
130-80	11/22-12/6/76	270	German Coal Bituminous	Ruhrkohle A.G. Essen, West Germany
130-81	7/10-7/20/77	196	Illinois No. 6 Coal Burning Star Mine Bituminous	DOE - Industry Contract: EX-77-C-01-2547
130-82	9/4-10/6/77	891	"	"
130-83	11/13-12/22/77	702	Wyodak Mine Coal Bituminous	"
130-86	9/9-9/19/78	248	Illinois No. 6 Coal Burning Star Mine Bituminous	"
130-88	7/2-7/28/79	462	"	"
130-89	9/1-9/30/79	713	Kentucky No. 11 Coal Bituminous	"
130-91	4/5-5/29/80	270	Southern Hemisphere Coal	Client
130-92	5/3-5/29/80	183	"	"
130-93	9/1-9/24-80	988	Wyodak Mine Coal Subbituminous	DOE - Industry Contract: DE-AC05-77ET-10152
130-94	10/12-11/6/80 and 11/12-12/2/80	525 136	Southern Hemisphere Coal	Client

HYDROGEN PRODUCTION FROM COAL LIQUEFACTION RESIDUES

PREPARED BY:
TEXACO, INC.
ALLEN M. ROBIN

PREPARED FOR:
ELECTRIC POWER RESEARCH INSTITUTE
(EPRI)
AF-233
PROJECT 714-1
DECEMBER 1976

REF. 40

This report is not included due to its size and nature. It may be obtained from the Electric Power Research Institute (EPRI).

AF-233

PROJECT 714-1

TEXACO PROPRIETARY DESIGN DATA PACKAGE

FOR

TEXACO GASIFICATION PROCESS

REF. 41

This design data is incorporated into the Gasification Section Process Design and is included only in the limited access version because it contains proprietary information. See Plant 12, Limited Access Report.

PUBLISHED DATA FOR

HALDOR TOPSOE LOW TEMPERATURE

SHIFT CATALYST

APRIL 1980

REF. 42

TOPSØE CATALYSTS

SULPHUR TOLERANT SHIFT CATALYST

TYPE SSK

TOPSØE sulphur resistant shift catalyst type SSK has a high and stable activity for conversion of carbon monoxide in sulphur containing gases. It can be used in the temperature range from below 200°C to 475°C, which means that SSK is a HTS as well as a LTS catalyst.

In order to maintain its activity, SSK requires a certain minimum of sulphur in the feed gas. This minimum, which depends on the operating conditions, is above the sulphur level in process gas produced by conventional steam reforming.

The SSK catalyst is suitable for plants based on partial oxidation of heavy oil or coal. Due to the high activity and the wide temperature range in which SSK can be used, it offers several advantages for ammonia, hydrogen, and SNG plants:

High conversion per catalyst bed due to the possibility of operating at a low inlet temperature.

Low CO content in exit gas due to high activity at low temperatures. In ammonia and hydrogen plants, it is possible to lower the CO content to a level where purification by methanation becomes economically attractive.
In existing plants operating with conventional HTS catalyst it is possible to lower the CO leakage corresponding to an increase in production rate of 3-5%.

Low steam consumption. Due to the high activity at low temperatures, it is possible to operate at a low steam to dry gas ratio and still obtain a reasonably low CO content in the exit gas.

The optimal process lay-out with SSK catalyst will depend on the individual plant.

PHYSICAL PROPERTIES

SSK catalyst is normally delivered in the form of spheres.

Catalyst size	3-6 mm	5-10 mm
Bulk density	0.9 kg/l	1.0 kg/l

Other sizes and shapes can be supplied upon customer's request.

CATALYST POISONS

No catalyst poisons are known for SSK. Chlorine, which for conventional LTS catalyst is a very serious poison, does not harm SSK catalyst. Industrially, a chlorine content of up to 100 ppm in feed gas to a reactor operating with SSK catalyst has been experienced.

Since SSK catalyst requires sulphur in order to maintain its activity, sulphur is of course no poison. In most cases, the sulphur content in feed gas is in the range from 10 ppm to 3%.

Carbonyl sulphide present in the feed gas will be converted according to the reaction:

$$COS + H_2O \rightleftarrows H_2S + CO_2$$

The COS concentration in exit gas will be close to the chemical equilibrium at the exit temperature.

CATALYST ACTIVATION

SSK catalyst is delivered in the oxidized form. For activation of SSK catalyst, a H_2 and H_2S containing gas is required. During shut-down, the catalyst is kept in the active state. At ambient temperature, the activated SSK is stable in air, which means that no oxidation and re-reduction is required in case the reactor has to be opened during shut-down.

NORMAL OPERATION

SSK can be used in the temperature range from below 200°C up to 475°C. The minimum inlet temperature, however, is often determined by the dew point of the gas in that an inlet temperature of 30°C above the dew point is required to avoid pore condensation.

In order to maintain its high activity, SSK requires a certain minimum content of sulphur in the process gas. This minimum depends mainly on the operating temperature in such a way that at higher temperatures, a higher sulphur content is required.

In plants based on partial oxidation of heavy oil, the CO content in process gas will typically be 47% (dry). In such plants, inlet temperature to SSK catalyst will normally be in the range 230-270°C (dependent on the dew point of the gas) giving a CO conversion across a single bed from 47% (dry) to 3-6% (dry). The CO leakage obtainable exit the last SSK bed is from 0.2% to 1% (dry) depending on the steam/dry gas ratio and on the number of beds.

Topsøe Topics
APRIL 1980
CATALYST RESEARCH AND MANUFACTURING · LICENSING · ENGINEERING · CONSULTING · COMPUTER SYSTEMS

A New TOPSØE Process for Fuel Oil Based Ammonia Plants

Two new process steps representing a marked advance in process schemes for the manufacture of ammonia from fuel oil or coal have recently been introduced by TOPSØE – the SSK sulphur-tolerant high/low temperature shift conversion unit and the Series 200 ammonia synthesis loop.

The introduction of these new process steps, which are now proven in industrial operation has significantly improved the economy and efficiency of the overall ammonia from coal or oil process scheme. With fuel oil as the feedstock, the new process scheme is shown in Figure 1 and is described in the following.

Overall Process Scheme

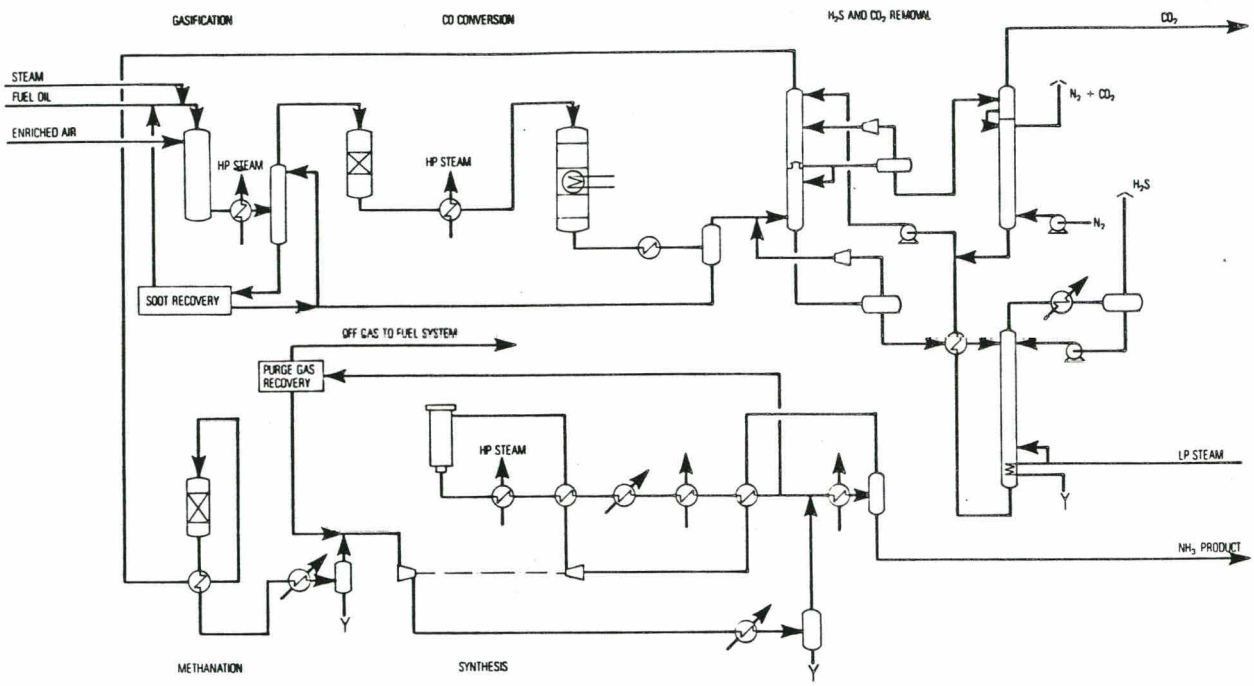
Fuel oil and recycled soot slurry are reacted in a partial oxidation unit (licensed by others) at say 80 kg/cm^{2}g with steam and enriched air containing 43% oxygen. The resulting gas is cooled in a boiler producing high pressure steam at 115 kg/cm^{2}g. The gas passes a water scrubbing unit for removal of soot and then enters the Topsøe sulphur-tolerant shift unit.

In the shift converter the gas is reacted over three catalyst beds containing SSK catalyst and operating at temperatures between 240°C and 440°C, thereby reducing in one step the CO-content from say 45 vol% to less than 0.5 vol% on a dry gas basis. No less than 90% of the heat of the shift reaction is available for HP boiler feed water preheating.

After shift conversion the gas passes a sour gas removal unit, in which CO_2 and H_2S – together with a few ppm of COS – are removed. This process can be one of several conventional processes. In Figure 1 we have used a physical absorption process, which will give the best overall energy efficiency. The gas then goes via an inlet/effluent heat exchanger to a conventional methanation unit and through a water cooler to compression. The compression takes place in a steam turbine driven, single-stage turbo compressor delivering the make-up gas at 160 kg/cm^{2}g.

The synthesis section is the Topsøe loop with the radial flow type Series 200 converter. More than 90% of the heat of the synthesis reaction is converted into high pressure steam. For energy efficiency reasons a purge gas stream may go to a cryogenic recovery unit, from which hydrogen is recycled.

Figure 1: New Topsøe Process Scheme



Flow diagrams and process descriptions are given in Figure 2 for two classical and widely used process schemes. One process scheme includes gasification with subsequent steam production and H_2S removal upstream of the shift unit, and the other scheme includes gasification followed by quench and a combined H_2S/CO_2 removal downstream of the shift unit.

A comparison of the new Topsøe process scheme in Figure 1 with the lay-outs in Figure 2 shows the superiority of the scheme in the following points:

- Uses more economical enriched air instead of pure oxygen
- Provides more efficient recovery of latent heat in the effluent from the gasifier
- Improves the recovery of heat released in the shift section
- Reduces energy requirements for CO_2 and H_2S removal
- Deletes the expensive low temperature nitrogen wash step
- Takes full advantage of the energy-efficient Series 200 system
- Balances energy requirements for compressors and other big machinery with energy recovered from the various process steps, cfr Figure 3.

In the following summary, the individual process steps in the new Topsøe scheme are discussed:

Figure 3: Steam Balance for High Pressure Steam (115 kg/cm^{2}g)

	Production MT/h	Consumption MT/h
- Process boilers	122.3	
- Auxiliary boilers	37.0	
- Steam for process		15.9
- Steam for turbines*)		143.4
Balance	159.3	159.3

*) 3 MT/h is extracted at 40 kg/cm^{2}g for use in the purge gas recovery section. Remaining amount is condensed.

Gasification

The partial oxidation process has been used for many years in the manufacture of ammonia and synthesis gases. The two foremost processes are the Shell process and the Texaco process (Figure 2). Both process licensors have wide experience in the operation of gasifiers at high pressure.

Sulphur Tolerant Shift Conversion

The shift conversion unit uses the highly active sulphur tolerant shift catalyst SSK which was invented by Exxon Research and Engineering Co. and developed for commercial application by Topsøe. The SSK catalyst features the following unique properties:

- High activity in the presence of hydrogen sulphide at temperatures down to 200°C
- Stable activity within a wide range of conditions including temperatures up to 475°C
- Resistance to poisoning. No specific poisons to SSK are known
- High mechanical strength even after many years of use

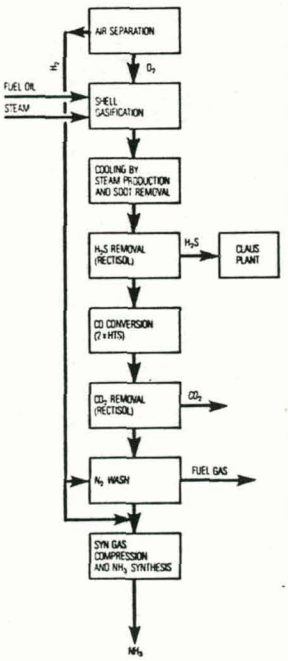
Based on the unique properties of this catalyst and the industrial experience gained, Topsøe will design a shift conversion unit adapted for each specific case and offering the optimum combination of the following options:

- **High conversion of carbon monoxide.** With proper choice of process variables, CO-concentrations low enough to permit final clean up by methanation are easily obtained.
- **Significant reduction in steam consumption.** The highly active catalyst makes it possible to take advantage of equilibrium at lower temperatures. This is favourable for CO conversion, meaning that low concentrations can be achieved with much smaller amounts of steam than required by any competing catalyst.
- **Total security against overheating of reactor at changes in feed rate.** Even for the most demanding cases, the maximum temperature can be kept below 500°C.
- **The process operates directly on the raw gas as obtained from the soot removal system.** It consists of a series of adiabatic catalyst beds with energy-efficient interbed cooling by high pressure steam production or boiler feed water preheating.
- **High conversion of COS.** The catalyst converts COS to the equilibrium concentration, which is lowest at low temperatures.

Figure 2: Conventional Ammonia Plant with Shell Gasification

Process Scheme

Oxygen from the air separation unit is reacted with preheated fuel oil and steam in the Shell gasifier. The gas leaving the gasifier is cooled in a high pressure waste heat boiler and further down to the dewpoint in a soot removal system. The sulphur removal takes place in a Rectisol or Sulfinol unit following the soot removal. After the sulphur removal the gas is sent to the shift section and on to the CO_2-removal unit using the Rectisol process. The remaining impurities are removed from the raw synthesis gas in the nitrogen wash and after adjustment of the hydrogen to nitrogen ratio, the make-up synthesis gas is compressed and sent to the synthesis loop.



Conventional Ammonia Plant with Texaco Gasification

Process Scheme

Oxygen from the air separation unit is reacted with preheated fuel oil and steam in the Texaco gasifier. The gas leaving the gasifier is cooled by direct quench, and after passing a soot removal unit the gas enters the shift section. Downstream of the shift section H_2S and CO_2-removal takes place in a Rectisol unit. The remaining impurities are removed from the raw systhesis gas in the nitrogen wash, and after adjustment of the hydrogen to nitrogen ratio, the make-up gas is compressed and sent to the synthesis loop.

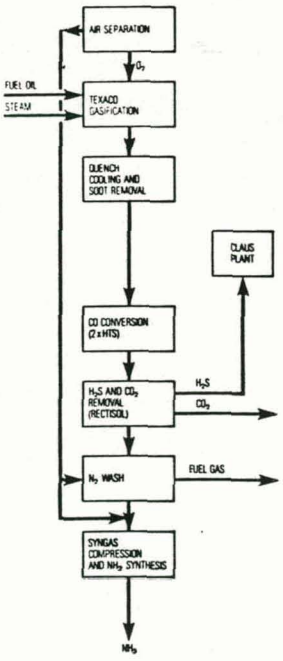


Figure 4. Operating conditions for 3-bed shift unit with SSK, CAT. A ($T_{min.}$ = 360°C) and CAT. B ($T_{min.}$ = 300°C)

FEED:		
	H_2	34.19 vol% DRY
	N_2	24.38
	CO	36.25
	CO_2	3.41
	Ar	0.83
	CH_4	0.24
	$H_2S + COS$	0.70
	H_2O/DRY	0.80

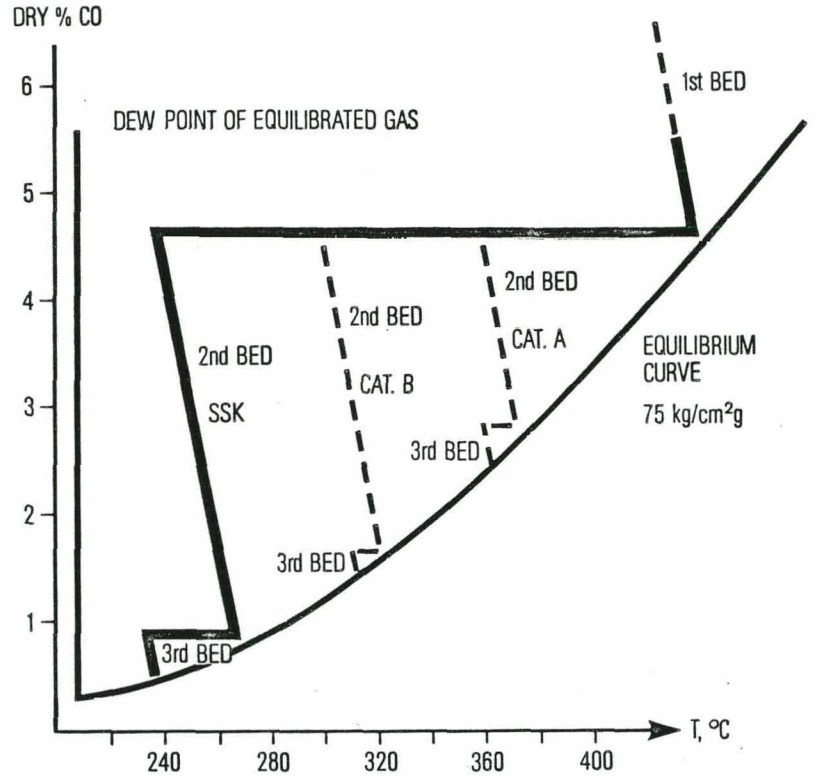


Figure 4 illustrates the operation in the shift section of the new Topsøe process for production of ammonia from fuel oil. The process operates at 75 kg/cm²g and a steam/dry gas ratio of 0.80 at inlet first bed. In a 3-bed system the CO-concentration in the dry gas is reduced from 36.25 to 0.55 vol%. Figure 4 further illustrates operation at the same conditions but with catalysts requiring higher operating temperatures. The possible CO-leakage and the equilibrium COS-concentration are:

Catalyst	T_{min}°C	Min. CO-leakage	COS-concentration Vol. ppm, dry
SSK	235*)	0.55	5
Catalyst A	360	2.50	16
Catalyst B	300	1.30	10

*) imposed by approach to dewpoint

H_2S and CO_2 Removal

The Topsøe fuel oil based ammonia process scheme includes a physical absorption unit for removal of H_2S and CO_2, e.g. the Selexol process licensed by Allied Chemical, which is characterized by low consumption figures.

The gas is sent to the bottom section of the Selexol absorber in which H_2S is selectively removed by washing with CO_2-rich Selexol coming from the upper part of the absorber. In the top section of the absorber CO_2 is removed down to about 0.1%, and the gas leaves the absorber virtually free of H_2S (and COS).

The major part of the CO_2 is removed from the solvent by flash. The amount of high purity CO_2 thus liberated will amply cover the requirements for conversion of the ammonia product into urea if so desired. After flashing the remaining CO_2 is stripped from the solvent by N_2.

H_2S, which is more soluble in Selexol than CO_2, is removed from the solvent by steam stripping. The H_2S-rich vapour stream is normally sent to a Claus kiln in which conversion to elementary sulphur takes place. The sulphur product is exported mainly for use as raw material in sulphuric acid plants.

An interesting alternative to this route is the direct conversion of H_2S into concentrated sulphuric acid by the Wet Sulphuric Acid Process developed by Topsøe. Very lean gases may be treated by the process, and up to 99% conversion is achieved. The first two commercial installations have now been in successful operation for several months in Sweden.*

Methanation

A classical methanation step is foreseen for final clean-up of the synthesis gas.

Synthesis

The synthesis loop incorporates the Topsøe Series 200 radial flow converter.**

The synthesis loop is operating at a pressure of 160 kg/cm^{2}g, and therefore the synthesis gas compressor has only one casing.

Substantially all large ammonia plants based on fuel oil constructed during the past 10 years are based on the Topsøe S-100 radial flow converter, and recently the S-200 converter, which has been developed on the basis of the S-100 converter, was selected for the 900 MTPD fuel oil based ammonia plant to be built by Quimigal, Portugal. The S-200 converter is in operation in Esso's 1500 MTPD natural gas based ammonia plant at Rotterdam and at S.N.A.'s 1000 MTPD naphtha based ammonia plant at Le Havre. The operating records from these plants are excellent.

Purge Gas recovery

The H_2 in the purge gas from the synthesis loop is recovered in a cryogenic unit or in a unit with molecular sieves, after which it is recirculated to the suction side of the synthesis gas compressor.

High Pressure Steam Generation

Sensible heat and heat of reaction are converted into high pressure steam. Steam generation or high pressure boiler feed water preheating takes place at exit of the gasifiers, in the shift units, and in the synthesis. The steam pressure selected for the present case is 115 kg/cm^{2}g.

Energy Consumption

In the development of the new process scheme, emphasis has been placed on achieving the highest possible energy efficiency. At normal conditions the overall energy consumption will be equal to 8.3 MM kcal/MT of ammonia at −33°C. This figure represents a very considerable saving compared to conventional process lay-outs as for instance described in Figures 2 and 3, the saving being in the order of 1–1.5 MM kcal/MT.

Plant Simplicity

A very important aspect when selecting the process lay-out has been plant simplicity. Fuel oil based plants are necessarily more complex than reformer based plants, and the fairly complex classical lay-out has often resulted in a lower onstream efficiency. The new Topsøe process scheme is very simple, deleting a number of process steps and using well proven and rugged processes and catalysts. As a consequence, this scheme results in a high operating efficiency. It should be noted that the new process scheme does not necessitate the use of large auxiliary boilers as required in classical lay-outs.

Investment Cost

The simplicity of the scheme further results in lower investment cost, typically 10–15% lower than for processes otherwise available.

* Reprint of an article in SULPHUR, July/August 1978, entitled "Sulphuric Acid Production from Lean H_2S-containing Gases" is available at request.

** For a detailed description of the S-200 process/converter, please refer to TOPSØE TOPICS of June 1976 and April 1979, and to the separate brochure available on this process.

DENMARK
HALDOR TOPSØE A/S
P.O. Box 213
Nymøllevej 55
DK-2800 Lyngby
DENMARK
Phone: (02) 87 81 00
Cable: HALTOPS
Telex: 37444 htas

FRANCE
HALDOR TOPSØE S.A.
142, Avenue des
Champs-Elysees
75 Paris (8e)
FRANCE
Phone: (256) 2581
Cable: HALTOPS PARIS
Telex: 650064

JAPAN
HALTOPS INTERNATIONAL
ENGINEERING A/S
Tokyo Branch Office
Hazama Building, 14th floor
5-8, Kita Aoyama 2-Chome
Minato-Ku, Tokyo
JAPAN 107
Phone: 478-3759/478-3750
Cable: HALTOPSTOK
Telex: J 24906 TOPSTOK

KUWAIT
P.I.C.O.
P.O. Box 25785
Safat
Kuwait
Phone: 444804
Telex: 2142 marata kwt

TURKEY
Tümas
Ziya Gökalp Cad. 17/2
Kizilay-Ankara
TURKEY
Phone: 181941-181968-181981
Telex: 42265 tümas

USA
HALDOR TOPSØE INC.
Houston Office
10010 Bayport Blvd.
Pasadena
Texas 77507
USA
Phone: 713-474-3261
Telex: 910.880.4358
TOPSOE HOU

Ammonia plants:

- Topsøe has signed a contract with Exxon Chemical Company for the first stage of the implementation of Exxon's new 1500 t/d ammonia plant at Redwater, Canada. The contract covers a study of a number of alternative lay-outs based on the Topsøe S-200 ammonia synthesis converter.
- Topsøe has signed a contract for supply of reforming technology for a 185 t/d naphtha based ammonia plant to be built in Madagascar by Z-Ren.
  The reformer will be fired with heavy fuel oil.
- Fertilizer (Planning & Development) India Ltd. has awarded to Topsøe the contract for supply of technology for the reforming section and the ammonia synthesis loop of the 600 t/d ammonia plant to be built by Hindustan Fertilizer Corporation Ltd. at Namrup, India.
- Topsøe has signed a contract with Petrochemical Industries Company K.S.C. for supply of licenses and complete engineering for the 1000 t/d ammonia plant to be set up in the Shuaiba Industrial Area, Kuwait. The scope of supply is identical to the scope for the existing 2x800 t/d ammonia plants supplied by Topsøe to P.I.C.

In the past few months Topsøe has been awarded a number of orders for S-200 converters for new or existing plants. The reference list for the S-200 converter is now as follows:

In operation:	
- Société Normande de l'Azote, France	1000 t/d
- Esso Chemie N.V., Holland	1500 t/d
Ordered for installation in:	
- Imperial Oil, Canada	750 t/d
- Petrochemical Industries Company, Kuwait	1000 t/d
- Quimigal, Portugal	900 t/d
- D.S.M., Holland	1500 t/d
- Compagnie Néerlandaise de l'Azote, Holland	900 t/d
- Anic, Italy	1200 t/d
Letter of Intent:	
- Borden Chemical, U.S.	1150 t/d
- CNEA/Sulzer, Argentina	2x2035 t/d
- Exxon Chemical Company, Canada	1600 t/d
- Agrico, U.S.	1000 t/d

Hydrogen plants:

- Topsøe will supply technology under a contract with Snamprogetti for a hydrogen plant to be built by Italimpianti. The hydrogen will be used in a steel plant for direct reduction of iron ore.
- Under a contract with Chiyoda Chemical Engineering & Construction Co. Topsøe will supply reforming technology for a hydrogen plant forming part of a lube oil complex to be built by Alexandria Petroleum Company.
- Topsøe will supply technology under a contract with Industria Italiana Petroli SpA for a hydrogen plant to be built at Taranto, Italy. The hydrogen plant will form part of a refinery complex.

HALDOR TOPSØE A/S

NYMOLLEVEJ 55 . P. O. BOX 213 . DK-2800 LYNGBY . COPENHAGEN . DENMARK . CABLE ADDRESS: HALTOPS
TELEX: 37 444 HTAS DK . REG. NO. 52 370 . TELEPHONE: (02) 87 81 00

HALDOR TOPSØE A/S

AN INTRODUCTION

The HALDOR TOPSØE organization was founded in 1941 and engaged in chemical process development, engineering and catalyst manufacture. The company is particularly active in the fields of heterogeneous catalysis, including research and development of catalysts and industrial processes, as outlined in the following:-

- Theoretical research relative to catalytic processes, their kinetics, the physical and chemical properties of catalysts, the mechanism of catalytic processes, catalyst activation procedures, stability of catalysts, effects of poisons, ageing, etc.

- Applied research relative to catalytic processes and new catalysts to develop necessary data for engineering of catalytic units and for application of catalysts in existing industrial units.

- Specialized computer work applicable in the field of research in heterogeneous catalysis, engineering of catalytic process units and analysis of performance of industrial units.

- Process engineering of catalytic industrial units and associated equipment and of complete plants incorporating such units.

- Detailed engineering of such units.

- Supervisory engineering services during construction, start-up and operation of catalytic units or complete plants.

- Manufacture of catalysts in plants located in Denmark and in the United States, and sale of such catalysts worldwide.

- Engineering and management consulting services including feasibility studies for industrial projects, development of tender documents and evaluation of tenders, project management and assistance in training of operating staffs.

A considerable part of the company's engineering work is undertaken in collaboration with other engineering companies, contractors or operating companies within the chemical processing industry, however, the company can if desired undertake all detailed engineering for a project. The company has established a close collaboration with competent and experienced engineering contractors throughout the world.

A recent count of the process units engineered and licensed by HALDOR TOPSØE A/S worldwide during the past twenty years alone reached into several hundred. The leading processes are ammonia synthesis and tubular steam reforming, with more than 100 units each.

HALDOR TOPSØE A/S is licensing worldwide proprietary processes in the fields listed below and described in the following pages.

- Desulphurization of liquid hydrocarbons
- Final desulphurization of hydrocarbons
- Tubular steam reforming of hydrocarbons (hydrogen, town's gas and synthesis gas)
- Secondary reforming and autothermal reforming
- HT and LT shift conversion
- Sulphur resistant LT shift conversion
- CO_2-removal
- Methanation
- Ammonia synthesis
- Methanol synthesis
- Formaldehyde
- Reducing gas
- Ethanol
- Wet sulphuric acid (WSA)

PROCESS DESCRIPTIONS

Desulphurization of liquid hydrocarbons with EBP up to 240°C. This process is based on gas-phase hydrogenation of sulphur compounds and distillation of H_2S from hydrocarbons. The process is a so-called "primary desulphurization process", and sulphur is removed down to a level of 5 ppm. HTAS also supplies the hydrogenation catalyst (NMK-3/CMK-3) for the process.

Secondary desulphurization: This process is used for desulphurization of hydrocarbons down to a level of 0.05 ppm. The process comprises hydrogenation of the sulphur compounds, followed by absorption of the H_2S on zinc oxide. The process is widely used upstream of tubular steam reforming units, where the maximum allowable sulphur level, depending on the type of feedstock, may be as low as 0.1 to 1 ppm. The hydrogenation catalyst (NMK/CMK) used for secondary desulphurization is identical to that used for primary desulphurization. Sulphur absorption catalysts (HTZ-3/HTZ-4) are also supplied by HTAS.

Tubular steam reforming of hydrocarbons: This process is used for production of hydrogen, oxo-gases, methanol, ammonia, town's gas, reducing gases, etc. HTAS has supplied tubular reformers based on its own proprietary processes for plants using these gases and based on feedstocks ranging from refinery off-gas and natural gas all the way up to naphtha with EBP of 240°C. HTAS has its own reformer design and catalysts (R-67, RKG, RKS, RKN), and the company is leading in the field of naphtha reforming.

Secondary reforming and autothermal reforming: These processes are catalytic adiabatic processes, where steam, air and hydrocarbons react to H_2, CO, CO_2, and CH_4. The secondary reforming process is normally used in ammonia plants, and HTAS has designed a large number of units to this process.

One special reforming process is the HTAS/SBA autothermal process which can replace primary and secondary reforming in ammonia plants. In the HTAS/SBA unit, feedstocks can be natural gas, LPG or naphtha which are reacted with steam and air or oxygen to form ammonia synthesis gas, methanol synthesis gas or oxo-gas.

Shift conversion processes: HTAS supplies processes and catalysts for High Temperature and Low Temperature shift conversion units. The HTAS low temperature shift catalysts (LSK) can be regenerated/reactivated after ageing or poisoning, leading to many years' lifetime.

Sulphur-resistant Low Temperature shift conversion: Contrary to all other brands of low temperature shift catalysts, there is no maximum limit on the amount of sulphur permitted in the feed gas to this process (SSK). It is therefore particularly well suited for shift conversion units used in fuel oil and coal based plants. It has proven its reliability in industrial operation for a period of four years.

CO_2-removal: HTAS can offer CO_2-removal units based on technology from Benfield, Giammarco-Vetrocoke, Allied Chemical, and Union Carbide. A large number of CO_2-removal units have been designed by HTAS for clients all over the world.

Methanation: HTAS designs methanation units, using proprietary catalysts (PK-3/PK-3R) typically used for final cleaning of ammonia synthesis gas and hydrogen by removal of CO and CO_2.

A different type of methanation process can be supplied for plants for production of substitute natural gas from coal, fuel oil, etc. This process differs from the conventional in that it operates with very high concentrations of CO and CO_2 at high steam partial pressure. The catalyst used (MCR-type) is completely different from our normal PK-type methanation catalyst.

Ammonia synthesis: HTAS has continuously optimized the ammonia process using various reactor concepts. A significant development has been the introduction of the HTAS radial flow reactor and process. Since its introduction to industry in 1966, 39 radial flow reactors have been started up or are under construction, with capacities in the range of 600 to 1650 tons per day. It is significant that the process can advantageously be used for capacities up to about 3000 tons per day.

A further development by HTAS was the introduction in 1976 of the new Series-200 ammonia synthesis process, by which power consumption and the cost of the plant are further reduced significantly.

Methanol synthesis: Jointly with Nippon Kasei, Japan, HTAS developed a low temperature methanol synthesis process, using our highly thermostable Cu/Cr/Zn catalyst (LMK). The process operates at medium pressure. Alternately, HTAS has developed catalyst and design for a high temperature process based on zinc/chromium catalyst now used in a number of plants; the largest project so far being the Hercules plant in Plaquemine, Louisiana, U.S.A., of 800 tons per day.

Formaldehyde: Jointly with Nippon Kasei HTAS has developed a formaldehyde process based on metal oxide catalyst. The HTAS very active and selective formaldehyde synthesis catalyst type FK has been supplied to a number of plants.

Reducing gas: Tubular reforming is being used also for the production of reducing gas used in steel plants for the direct reduction of iron ore. The process conditions are quite different from synthesis gas reforming for ammonia or methanol because an extremely low steam to carbon ratio is required. HTAS has developed catalysts and a process for the reducing gas production.

Ethanol: HTAS has constructed 11 ethanol plants using as raw material starch, molasses and ethylene. A process is available based on optimized design with low energy consumption and considerable savings in the cost of investment.

Wet sulphuric acid process: Based on a very active catalyst developed in 1976 by HTAS, a process for recovery of sulphur as sulphuric acid from polluting waste gas has been developed. Several projects are in operation and under construction.

Equipment: HTAS has developed a number of specialized equipment designs to suit the processes and the petrochemical industry:

- Waste heat boiler design for reformers, both primary and secondary. (Typical conditions range from 1000°C inlet at 40 atm. with steam pressure at up to 115 atm.).

- Waste heat boiler for ammonia reactor loop: In this case synthesis gas containing 75% H_2 and 25% N_2 at a pressure of about 250 kg/cm^2g and a temperature up to 480°C (conditions at which H_2 and N_2 attack on the materials used must be carefully considered) is used for production of steam at pressures up to 115 kg/cm^2g.

- Electrical process start-up heater based on the Kanthal heating element or heating cables.

- Ammonia disassociation reactor for the production of hydrogen.

EDH/ERS/BSH
26.10.1978

HALDOR TOPSØE A/S

NYMOLLEVEJ 55 . P. O. BOX 213 . DK-2800 LYNGBY . COPENHAGEN . DENMARK . CABLE ADDRESS: HALTOPS
TLLEX: 37 444 HTAS DK . REG. NO. 52 370 . TELEPHONE: (02) 87 81 00

LYNGBY

PROPRIETARY PROCESSES OF OTHER COMPANIES LICENSED BY HALDOR TOPSØE A/S

Besides the HALDOR TOPSØE proprietary processes a number of other processes are available to HTAS for worldwide licensing.

SUPERFOS Chloride-free NPK fertilizer process: This process produces chloride free NPK fertilizer starting from nitric acid, potassium chloride and calcium phosphate rock, and it is based on a continuous ion-exchange process developed and in commercial operation by SUPERFOS A/S. The commercial advantages are a superior chloride-free product, the substitution of potassium sulphate by potassium chloride as feed material, and a final product price that is competitive with the conventional chloride containing NPK fertilizers.

Barge-mounted petrochemical plants for ammonia, methanol and LPG: This concept was developed jointly with Götaverken AB of Sweden in order to provide an economic and flexible answer to the future worldwide requirements of the offshore gas industry. Advantages of the barge-mounted petrochemical plant concept are (1) shorter delivery time due to high degree of mechanisation at the yard, (2) testing of all critical items are completed by HTAS and Götaverken AB at the yard, (3) high quality assembly work under ideal working conditions, (4) mobility of the floating plant

allowing utilization of marginal gas fields both offshore and in coastal areas, (5) marine gas pipeline, gas booster station and terminal can in many instances be avoided, (6) fixed price, and (7) an interesting financial scheme.

Fatty acids and fatty alcohol processes: Based on processes developed and operated in Denmark HTAS offers for licensing industrially competitive processes for the production of fatty acids and fatty alcohols from plant and animal derived oils.

Pesticides: In collaboration with several Danish specialty chemical companies HTAS licenses several processes already in commercial operation for the production of a number of pesticides primarily for agricultural application.

Heavy water process based on ammonia enrichment: HTAS has developed a process for cracking of enriched ammonia at high pressure. This process is incorporated in a French process for the production of deuterium from ammonia synthesis gas. The process is economically attractive when coupled with a medium size or large ammonia plant.

EDH/ERS/BSH
26.10.1978

HALDOR TOPSOE PROPRIETARY DESIGN DATA PACKAGE

FOR

LOW TEMPERATURE SHIFT CATALYST PROCESS

REF. 43

This design data is incorporated into the Shift Section Process Design which is illustrated in the Process Flow Diagrams in the Initial Effort Report IV, Volume 6.

ALLIED CHEMICAL PROPRIETARY DESIGN DATA PACKAGE

FOR

SELEXOL H_2S/CO_2 REMOVAL SYSTEMS

REF. 44

Allied's proprietary Selexol design data is incorporated into the Plant 12 Purification Section Process Design through the utilization of a computer program with physical property data and a design manual as supplied to Bechtel from Allied.

PRELIMINARY GEOTECHNICAL AND GEOHYDROLOGICAL STUDIES

FOR

PROPOSED H-COAL® CONVERSION PLANT

FOR:

ASHLAND SYNTHETIC FUELS, INC.

BY:

DAMES AND MOORE

APRIL 13, 1981

REF. 49

REPORT
PRELIMINARY GEOTECHNICAL AND GEOHYDROLOGICAL STUDIES
PROPOSED H-COAL CONVERSION PLANT
FOR ASHLAND SYNTHETIC FUELS, INC.

JOB NO. 10805-063-12
APRIL 13, 1981

BY:

DAMES & MOORE

HOUSTON

TABLE OF CONTENTS

	Page
INTRODUCTION	1
GENERAL	1
PROPOSED CONSTRUCTION	1
PURPOSE AND SCOPE	2
SITE CONDITIONS	4
LOCATION AND SETTING	4
SITE GEOLOGY	4
SURFACE FEATURES	5
SUBSURFACE CONDITIONS	6
DISCUSSION AND RECOMMENDATIONS	8
GENERAL	8
SOIL IMPROVEMENT AND SITE PREPARATION	9
SHALLOW FOUNDATIONS	11
TANK FOUNDATIONS	13
PILE FOUNDATIONS	14
OTHER CONSIDERATIONS	16
SOLID WASTE DISPOSAL AREA	17
ADDITIONAL INVESTIGATIONS	17
APPENDIX - FIELD INVESTIGATION AND LABORATORY TESTING	

REPORT
PRELIMINARY GEOTECHNICAL AND GEOHYDROLOGICAL STUDIES
PROPOSED H-COAL CONVERSION PLANT
FOR
ASHLAND SYNTHETIC FUELS, INC.

INTRODUCTION

GENERAL

This report presents the results of our preliminary geotechnical and geohydrological studies for the proposed H-Coal Conversion Plant to be located near Cloverport in Breckinridge County, Kentucky. The location of the site is shown on the Vicinity Map, Plate 1. Investigations were performed in two separate areas, the plant site area, including the potential borrow area, and the solid waste disposal area. The location of these areas in relation to each other is shown on the Plot Plan, Plate 2.

PROPOSED CONSTRUCTION

The proposed plant site occupies an area approximately one-half mile wide by over one mile long, and is shown on Plate 3. This plan shows the general location of the main components of the plant; however, it is our understanding that the locations of specific structures and equipment within each component are as yet undecided.

Coal will be unloaded at the barge unloading facilities on the Ohio River, near the northwestern corner of the proposed site. Liquid product will be loaded at a separate dock some 4,000 feet south of the unloading dock. Coal will also be unloaded from rail cars on a siding to be located adjacent to the existing rail line and the proposed conveyor system. A dead-coal storage area, roughly 2,000 feet long by 700 feet wide, will be located north of the process facilities. Process units will include both horizontal and vertical vessels (up to 1,000 tons), boilers, reciprocating and centrifugal compressors (to 30,000 HP), heat exchangers, pumps, and coal mills. Over 25 storage tanks (to 233,000 barrels) are planned for the

processed liquid, sour water, liquid oxygen, fuel oil, boiler feed water, and anhydrous ammonia. Conveyors for the coal, as well as extensive piping for the liquid products and waste material are also planned. Additionally, several support and administrative buildings are included in the project.

A proposed solid waste disposal area is located approximately two miles southeast of the plant site. This area, shown on Plate 4, covers approximately two square miles and is located at the head of Bull Creek.

PURPOSE AND SCOPE

The purpose of our investigation was to provide preliminary recommendations regarding earthwork and foundation design criteria. This information will be used by your designers for feasibility and cost estimating studies. Once these studies have been completed, specific locations of critical equipment made, and imposed loadings calculated, a comprehensive foundation investigation will be performed. Additionally, a preliminary assessment of the proposed solid waste disposal area with respect to soils and geohydrologic requirements outlined in the Resource Conservation and Recovery Act (RCRA) is included.

Dames & Moore performed soil, foundation, and geohydrological investigations within the property boundaries of the proposed plant site in 1974 and 1975 for an earlier proposed facility. A majority of these investigations encompassed the southern half of the proposed process area and extended southward covering approximately one-third of the tankage area. This information has been reviewed and incorporated into our analyses and recommendations.

The scope of work for the present investigation included:

- A field exploration program to evaluate the subsurface conditions at the site and obtain samples for laboratory testing. The results of

the subsurface investigation are presented in the Appendix to this report. Eleven borings were drilled in the plant site, seven borings in a potential borrow area within the plant boundaries, and three borings in the solid waste disposal area. Additionally, 10 shallow, hand-augered probes were advanced in the solid waste area. A description of the soils encountered and other pertinent data are presented in the Log of Borings, also presented in the Appendix.

- An evaluation of the geology of the site area based on existing geologic information, the earlier test boring program, and the present studies.

- An evaluation of the site ground water conditions, including static water levels, hydraulic gradients, soil permeability, direction of flow, and ground water quality. The results of field and laboratory permeability testing and ground water quality analyses are presented in the Appendix.

- A laboratory testing program to classify the soils encountered and to evaluate their chemical, physical and engineering properties for use in analyses of potential soil behavior. The results of the laboratory tests are presented in the Appendix.

- Engineering analysis, discussion and recommendations related to the following items:

  a. Site grading, surface preparation and earthwork criteria, including site improvement techniques and evaluation of fill sources.

  b. Shallow foundations, including allowable bearing capacities and settlement estimates.

  c. Storage tanks, including stability and estimated settlements.

d. Pile foundations, including downward, uplift and lateral capacities for several pile types along with driving behavior, and estimated settlements.

e. Lateral soil pressures for use in designing below grade structures and foundations to resist lateral loads.

f. The suitability of either cellular structures or batter-pile groups for use as breasting dolphins.

g. Comments regarding the suitablity of the solid waste disposal area.

SITE CONDITIONS

LOCATION AND SETTING

The site is located at approximately River Mile 707 on the Ohio River. The nearest towns are Addison and Stephensport, Kentucky, located some 1-1/2 and 4 miles to the northeast and east-northeast, respectively. The town of Cloverport, Kentucky, is located downstream of the facility approximately 7 miles to the south-southwest. The main plant area is approximately 1,500 to 2,000 feet east of the river bank.

SITE GEOLOGY

The dominant features of this portion of the Ohio River valley were formed by glacial activity during the Pleistocene or glacial epoch (beginning about 500,000 to 2,000,000 years ago). The site is located over a wide trench that has been eroded to approximately Elevation 260 feet*. The regional bedrock exposed by the down-cutting of this trench consists mainly of Upper Mississippian fine-grained sandstones and shales, which appear to belong to the Big Clifty Sandstone Member of the Golconda Formation.

---

*All elevations referenced to Mean Sea Level datum.

The deep channel was then filled with alluvial deposits of glacial sands and gravels. These deposits were provided by the most recent glaciation that influenced the Ohio River valley (Wisconsin glacial stage). Their deposition terminated as the ice sheets of the Tazewell glacial substage melted from the Ohio River valley, thus eliminating the source of melt water for the transport of these soils.

The upper silty to clayey soils that represent the surface stratum covering the glacial sands and gravels are also of alluvial deposition, being deposited during the final melting stages of the Wisconsin glaciation. Localized minor deposition as a result of flooding on the Ohio River has occurred periodically since glaciation.

SURFACE FEATURES

Plant Site

At the time of our investigation, most of the area was under cultivation for winter wheat, soybean and corn. The remaining roughly 30 percent of the area is composed of creeks, dry ravines, and heavily vegetated ridges. The ground surface rises in an easterly direction (away from the river) at a slope of approximately 0.4 percent. Ground surface elevations at the borings located within the plant area range from approximately 414 to 427 feet. Surface elevations of the three borings located to the west of Kentucky Highway 144 ranged from Elevation 396 to 399 feet. The ground surface elevations in the proposed borrow area to the east of the plant site ranged from about Elevation 416 to 476 feet.

Town Creek, located to the southeast of the plant facilities, roughly bisects the property. The main body of the creek intersects the northeastern corner of the property and runs in a southwesterly direction to the Ohio River. Tributaries, which are dry ravines in some months, finger away from the main trunk in a northerly direction. Most of the creek runs through an elevated terrace which grades to a lower deposit toward the river.

Solid Waste Disposal Area

The existing ground surface varies from gentle to steep at the site of the proposed solid waste disposal area with steep slopes predominant. The area is located at the head of Bull Creek, which drains the site. Gentle to moderate slopes are generally found along the creek's edge. These slopes are either grassed or under some form of cultivation. The remainder of the area consists of sharply pointed, wooded ridges. A road, graveled at the beginning then changing to dirt, intersects Kentucky Highway 144 and leads into the site. It roughly follows the creek and forks several times.

SUBSURFACE CONDITIONS

Plant Site

The site is overlain with approximately 6 to 18 feet of recent alluvial clayey silts and silty clays. The base of this stratum is generally encountered between Elevations 412 to 403 feet within the plant area proper. However, west of the railroad track and nearer the river, this stratum extends to about Elevation 370 feet.

Below the upper 6 to 12 inches of topsoil, which is abundant with vegetative matter due to cultivation, the soils are medium dense to medium stiff. The stratum grades with varying, but increasing, quantities of very fine to fine sands with depth.

Poorly graded sands extend from beneath the upper soils to the bedrock contact. The sand layer, varying in thickness from about 100 to 130 feet, ranges in relative densities from loose to very dense. Occasional zones of higher silt content were encountered in most borings. The ranges of grain size varied throughout the stratum, ranging from very fine sands to fine gravels; however, for the most part, the materials were poorly graded.

A thick stratum of silty clay to clayey silt was encountered in Borings 108, 109, 110 and 111 at elevations ranging from approximately

390 to 370 feet. This stratum appears to thicken in a southeasterly direction toward Town Creek, and may be the remains of an ancient lake bed. The layer thins out toward the northwest; however, based on the limited data available and the few borings in the area, the extent and thickness of this layer beneath the process areas is unclear at this time.

Generalized soil profiles across the plant site are presented on Plates 5A through 5D.

Bedrock in the main plant area was encountered at elevations ranging from 305 to 260 feet. The bedrock consisted of medium to light gray, fossiliferous limestone overlying light olive gray to light gray siltstone and shale. An approximate bedrock contour map is presented on Plate 6. This figure shows the approximate contact elevations of the bedrock beneath the main plant area. The deepest portion of the alluvial trench approximately follows the existing rail line adjacent to the majority of the process area and then bends slightly toward the southeast extending beneath the tankage area.

Ground water elevations were measured in open standpipe piezometers installed in seven of the plant borings. Static ground water levels ranged from Elevation 386 to 383 feet across most of the site. Due to the large distances separating the borings, it is not possible to accurately define the ground water flow regime. However, we have inferred that there is a slight mounding or ridge near the area of Boring 105 with a gradient extending in two directions, westerly and southeasterly, toward the Ohio River and Town Creek, respectively. The normal pool along this reach of the Ohio River is at Elevation 385 feet, and is controlled by the Cannelton locks.

A perched water table was noted in the piezometer installed in Boring 110. This piezometer is hydraulically connected to the soils above the thick silt and clay stratum previously discussed. The water level in this standpipe was measured at Elevation 398 feet. The extent of this perched condition could not be evaluated from this one location.

Solid Waste Disposal Area

Subsurface conditions in the flatter drainage basin of Bull Creek consists of approximately 25 feet of soil overlying light gray, fossiliferous limestone. The upper soils varied from fine grained silts and clays, predominant in Borings 301 and 302, to mostly clayey coarse to fine sands in Boring 303. Shallow hand-auger probes on the steeper slopes adjacent to the creek valley indicated that a thin mantle of silty clays and clayey silts, ranging from 1 to 5 feet in thickness, overlies the bedrock.

Ground water under artesian pressure was encountered at a depth of approximately 33 feet in Boring 303.

Details of the subsurface soil conditions and their physical and engineering properties are presented on Log of Borings and in the Laboratory Testing section in the Appendix.

DISCUSSION AND RECOMMENDATIONS

GENERAL

Based on the results of our preliminary geotechnical investigation, we believe that it is feasible to develop the site for the proposed facilities. Structures not particularly settlement-sensitive can be supported on shallow foundations (spread footings or large mats) bearing on the natural soil. For some structures, however, site improvement techniques may be necessary. Driven pile foundations may be required for heavy, settlement-sensitive structures.

We estimate that most of the settlement will occur rapidly after imposition of loads during construction. Some long-term settlement should be expected; however, this settlement may be reduced by following proper construction procedures during site preparation.

SOIL IMPROVEMENT AND SITE PREPARATION

Grading

We understand that the high point of finish grade is presently proposed at Elevation 415 feet. In view of the existing topography, considerable grading and earthwork will be necessary to achieve final grade.

The upper 6- to 12-inch topsoil layer with high organic content should be stripped beneath all foundations and facility areas. Any additional soils containing abundant fibrous organic material should also be removed. These soils may be stockpiled and used for architectural fill or should be wasted. The ground surface elevation across a majority of the plant area is presently at or above Elevation 415 feet. We recommend that prior to any fill placement, facility areas be graded to Elevation 415 feet. The soils removed should be stockpiled for subsequent use as compacted fill in the lower areas across the site. We must point out, however, that the silty nature of the near-surface soils may restrict the feasibility of their placement and compaction during wet or inclement weather. This may cause delays in the construction schedule and must be considered by your planners and estimators in rating the tradeoffs between soil improvement schemes. As an alternative, select granular material could be used as fill where necessary.

Prior to any fill placement, exposed soils should be conditioned to approximately their optimum moisture content and compacted using sheepsfoot or segmented wheel rollers. The exposed surface should be compacted to 95 percent of the maximum dry density of the soils (as determined by the composition test ASTM D-1557) within a moisture content range of ±2 percent of optimum. We expect that this relative compaction would be obtained after 4 to 6 passes of the compaction equipment traveling in uniform patterns.

Following compaction of the exposed surface, the stockpiled soils should be conditioned to within ±2 percent of optimum moisture content, placed in loose lifts, not exceeding 8 inches in thickness, and compacted to 95 percent of the maximum dry density using the same compaction equipment and methods discussed previously. If select granular fill is placed, we recommend the use of vibratory roller compactors.

We recommend that soil improvement and site preparation work be performed in sections. Each area should be properly sloped to sumps to remove any precipitation which may collect during construction. Pumps should be located at the sumps to draw off collected water away from the site preparation areas.

Improvement of Natural Soils In-Place

As is discussed in the section Shallow Foundations, the settlement of some structures supported by shallow spread foundations may be unacceptable. Where this is the case, it may be possible to improve the quality of the natural soils, increasing soil strength and reducing settlement potential. A technique which we have found effective on recent similar projects is dynamic consolidation, also referred to as heavy tamping or pounding. In this technique, the soil in a building area is compacted by repeated blows from a heavy weight free falling from a considerable height, using a crane. The weight and height of fall are determined based on the particular compaction requirements. It is possible to achieve compaction to great depth using this technique.

The specific requirements for a dynamic consolidation site improvement program should be addressed later within the scope of future design studies should this alternative be considered.

Excavation and Backfill

Another alternative scheme for site improvement would entail the removal of the surficial silt and clay soil in a building area and the

replacement with compacted structural fill. Shallow spread foundations then would be established in this fill. This would permit the use of higher allowable bearing capacities than for natural soils, and a reduction in settlement. The silty soils excavated during this program could be stockpiled for use as general nonstructural fill for grading, dike, or embankment materials. The general thickness of the near-surface soils varies somewhat throughout the site, but is generally 5 to 20 feet thick.

Prior to any fill placement, the exposed sands (generally between Elevations 405 and 400 feet) should be conditioned to approximately their optimum moisture content and compacted using heavy vibratory equipment. Following compaction of the exposed sands, granular fill could be placed in loose lifts, approximately 10 inches in thickness, and compacted to the previously recommended criteria.

It appears that adequate amounts of suitable granular backfill may be obtained from the borrow area immediately surrounding Boring 202. The near-surface 10(±)-foot silty clay material must first be removed in order to reach the acceptable sandy materials which extend some 15 to 20 feet.

SHALLOW FOUNDATIONS

It is our opinion that most of the proposed plant facilities may be supported on shallow spread or mat foundations with the exception of heavy, settlement-sensitive structures, where pile foundations may better satisfy the structural and/or operational requirements. Shallow foundations for all major plant facilities should be installed on either natural soil, improved natural soil, or compacted structural fill as previously discussed. Where shallow foundations are to be installed on the natural soils which had not been previously conditioned, we recommend the base of these excavations be compacted to the previous criteria prior to footing or mat construction.

We recommend that all shallow foundations be founded at a minimum depth of 3 feet below the final grade. All footings should have a minimum

lateral dimension of at least 3 feet. Due to the large distances separating the borings and the possibility of variable soil conditions of poorer quality than those encountered, we recommend that a maximum net bearing pressure of 2,000 pounds per square foot (psf) be used for the design of spread or mat foundations in natural soil. Maximum net pressures may be increased by 20 percent under short-term loadings, such as wind or test loads. The net bearing pressure is the pressure imposed at the base of the foundation in excess of the adjacent soil overburden pressure.

The allowable bearing pressure for spread foundations in improved natural soil or compacted structural fill would be somewhat greater, on the order of 3,000 psf and 4,000 psf, respectively. Actual values would be established when the specific site improvement technique had been developed.

The estimated settlements for shallow foundations are a function of both footing dimensions and contact pressure. Foundation settlements are generally expected to occur rapidly after imposition of loads. We do not anticipate any significant long-term, creep-type settlement to occur under foundation loads. However, the settlement of shallow foundations in the areas underlain by the thicker clayey stratum (Borings 108, 109, 110, and 111) would occur over a slightly longer time period.

Total foundation settlement consists of immediate elastic settlement and post-construction settlement. Estimated elastic settlements of square footings in natural soil for net applied pressures 500, 1,000 and 2,000 psf are presented on Plate 7. Estimated settlements for large mats under various pressures are presented in the following table:

ELASTIC SETTLEMENT OF MAT FOUNDATIONS
ESTABLISHED ON NATURAL SOIL

Mat Width (ft)	Net Bearing Pressure (psf)	Estimated Elastic Settlement (inches)
30	1,000	0.5 to 1
30	2,000	1 to 2
50	1,000	1 to 2
50	2,000	2 to 3
100	1,000	2 to 3
100	2,000	4 to 6

We expect that most of the settlement will occur during the first few weeks of full foundation loading. Should the site be prepared without removal or improvement of the near-surface silts and clays, approximately an additional one inch of longer term consolidation settlement is expected to occur. This settlement will be less rapid than the previously discussed elastic settlements; however, we would anticipate these settlements to be completed within six months. Except for localized post-construction settlements that could result from densification of looser zones within the supporting soils, no other long-term consolidation is expected.

TANK FOUNDATIONS

We believe that it is feasible to support tanks on built-up pads at grade, on flexible base plates, with tolerable settlements expected. We recommend the edge of the tank be founded on a crushed stone or concrete ringwall, approximately 18 inches wide, extending a minimum of 3 feet below the final grade to prevent edge cutting. The ringwall should be excavated through the constructed tank pad and compacted or poured "neat" against the sides of the excavation.

Elastic settlements of tank foundations have been calculated for tanks of various diameters and bearing pressures. Estimated tank settlements are listed in the following table:

ESTIMATED TANK SETTLEMENTS

Tank Diameter (ft)	Bearing Pressure (psf)	Center Settlement (inches)	Edge Settlement (inches)
50	2,000	2 to 3	1 to 2
50	3,000	3.5 to 4.5	2 to 3
100	2,000	4 to 6	2 to 4
100	3,000	6.5 to 8.5	4 to 6
200	2,000	9 to 11	5.5 to 7.5
200	3,000	14 to 16	8.5 to 10.5

Crowned tank pads will be required to maintain the tanks above the adjacent grade after settlement has occurred. Tank pads should be constructed of clean, granular material obtained from the onsite borrow pit or imported from outside sources. The material should be compacted to 90 percent of the maximum dry density as obtained by the ASTM D-1557 Compaction Test.

PILE FOUNDATIONS

Driven pile foundations may be considered for supporting heavily loaded structures and concentrated, settlement-sensitive structures. Four types of piling have been considered for this preliminary study: 10-inch H-pile, 12.75-inch-diameter steel pipe pile, 12-inch-square precast concrete pile, and mandrel-driven Raymond Step-taper piles.

Driven piles would develop their capacity through a combination of friction and end-bearing in the medium dense to dense sands below depths of

about 50 feet. Estimated axial capacities for single piles are presented on Plate 8. A factor of safety of 2 with respect to structurally imposed loads was used in calculating the allowable downward capacities. Approximately 50 percent of the downward capacity plus the calculated net pile weight can be used for uplift resistance. Tensile reinforcement will be required for uplift loads.

Previous pile driving experience on similar sites along the Ohio River suggests that end-bearing capabilities of the supporting stratum may vary within short distances. Based on this, we recommend that a test program be conducted prior to selecting the type of pile to be used for production. This program would serve as the basis for developing pile driving criteria and evaluating the driveability of the pile types selected, and could be used to verify the design capacities and pile settlement behaviors by performing load tests on selected piles. Settlement for single piles is estimated to be less than one-fourth inch under the allowable design capacities.

Calculated lateral capacities, resulting in a one-half inch deflection of a single pile at the ground surface with a safety factor of about 2, are presented in the following table:

LATERAL CAPACITIES FOR ONE-HALF INCH DEFLECTION

Pile Type	Lateral Load, kips (F.S. = 2) Rigid Pile Support	Lateral Load, kips (F.S. = 2) Flexible Pile Support
10-inch H (with web)	11	4
" (against web)	7	3
12.75-inch pipe	8	4
12-inch-square concrete	9	4
Raymond Step-taper	12	5

OTHER CONSIDERATIONS

Active and passive earth pressure coefficients for near-surface soils are presented in the following table:

EARTH PRESSURE COEFFICIENTS

Soil Type	Active Pressure, K_a	Passive Pressure, K_p	At-Rest Pressure, K_o
Near-surface soils	0.4	2.5	0.6
Compacted granular backfill	0.25	4	0.8

Based on the limited data available from previous investigations, either cellular cofferdams or batter-pile dolphins appear to be acceptable alternatives for waterfront loading and unloading facilities. We recommend, however, that the proposed areas be investigated in greater detail during the next phase of the investigation in order to provide more definitive recommendations.

From discussions with the U.S. Army Corps of Engineers Ohio River Division, we understand the 100-year flood elevation to be 410 feet at River Mile 706. The present surface area inundated by the 100-year flood is shown on Plate 9. The proposed final grade of Elevation 415 feet is, therefore, above the 100-year flood elevation.

Information obtained from previous studies performed at the proposed site recommend a design earthquake of Modified Mercalli (MM) Intensity VII for the area. This would produce a maximum horizontal ground acceleration, at foundation level, of about 0.10g. The number of significant stress cycles, N_c, for an earthquake of this magnitude was assumed to be 10. These values were used for evaluating the stresses induced at different depths for the given design earthquake. This information, along with the results

obtained from grain-size analyses during this investigation as well as the previous investigations, was used in a simplified procedure for evaluating the liquefaction potential of the soils. Based on these results, it is our opinion that the potential for liquefaction at the proposed site is low. We recommend, however, that more detailed analyses and dynamic laboratory testing be performed during subsequent investigations.

SOLID WASTE DISPOSAL AREA

A preliminary evaluation of the solid waste disposal area indicates the area may be acceptable for storing the wastes from a RCRA standpoint, depending upon the constituents of the proposed wastes to be stored. Bedrock is encountered within approximately 25 feet from the surface in the lower areas of the site, and within 1 to 5 feet along the steeper slopes which would form the sides of the area.

Ground water measurements taken in the borings indicate a potentially restrictive depth to ground water which may be a limiting factor for solid waste disposal facilities. However, chemical analyses performed on a sample of the ground water taken from Boring 303 indicate several parameters are in excess of drinking water standards.

The surficial soils are predominately silts and clays with calculated permeabilities on the order of 10^{-6} to 10^{-8} cm/sec. Physical and chemical analyses performed on selected soil samples obtained in the area are presented in the Appendix to this report. Additionally, sodium cation exchange capacities were analyzed for selected samples. The results of these chemical analyses must be compared with the waste constituents to evaluate the suitability of this area for containing the solid waste.

ADDITIONAL INVESTIGATIONS

Once site-specific locations of critical equipment have been made and imposed loadings calculated, we recommend a comprehensive geotechnical

investigation be performed. Specific items delineated in this report which should be investigated in greater detail include the following:

- Offshore borings at both the coal unloading and liquid product loading dock facilities. The results of these investigations can further quantify the decision to use either cellular cofferdams or driven piling for use as breasting dolphins.

- Additional borings in the area between plant coordinates N8500 to N12000 and E6500 to E10000 to evaluate the thickness and extent of the silty clay stratum encountered between Elevations 390 and 370 feet.

- More detailed analyses and dynamic laboratory testing to evaluate the liquefaction potential at the site.

-oOo-

The following Plates and Appendix are attached and complete this report:

Plate 1	Vicinity Map
Plate 2	Plot Plan
Plate 3	Site Plan, Plant Area
Plate 4	Site Plan, Solid Waste Disposal Area
Plates 5A thru 5D	Generalized Soil Profiles
Plate 6	Bedrock Contour Map
Plate 7	Elastic Settlements for Shallow Foundations

Plate 8	Single Pile Axial Capacities
Plate 9	100-Year Flood Boundary
Appendix	Field Investigations and Laboratory Testing

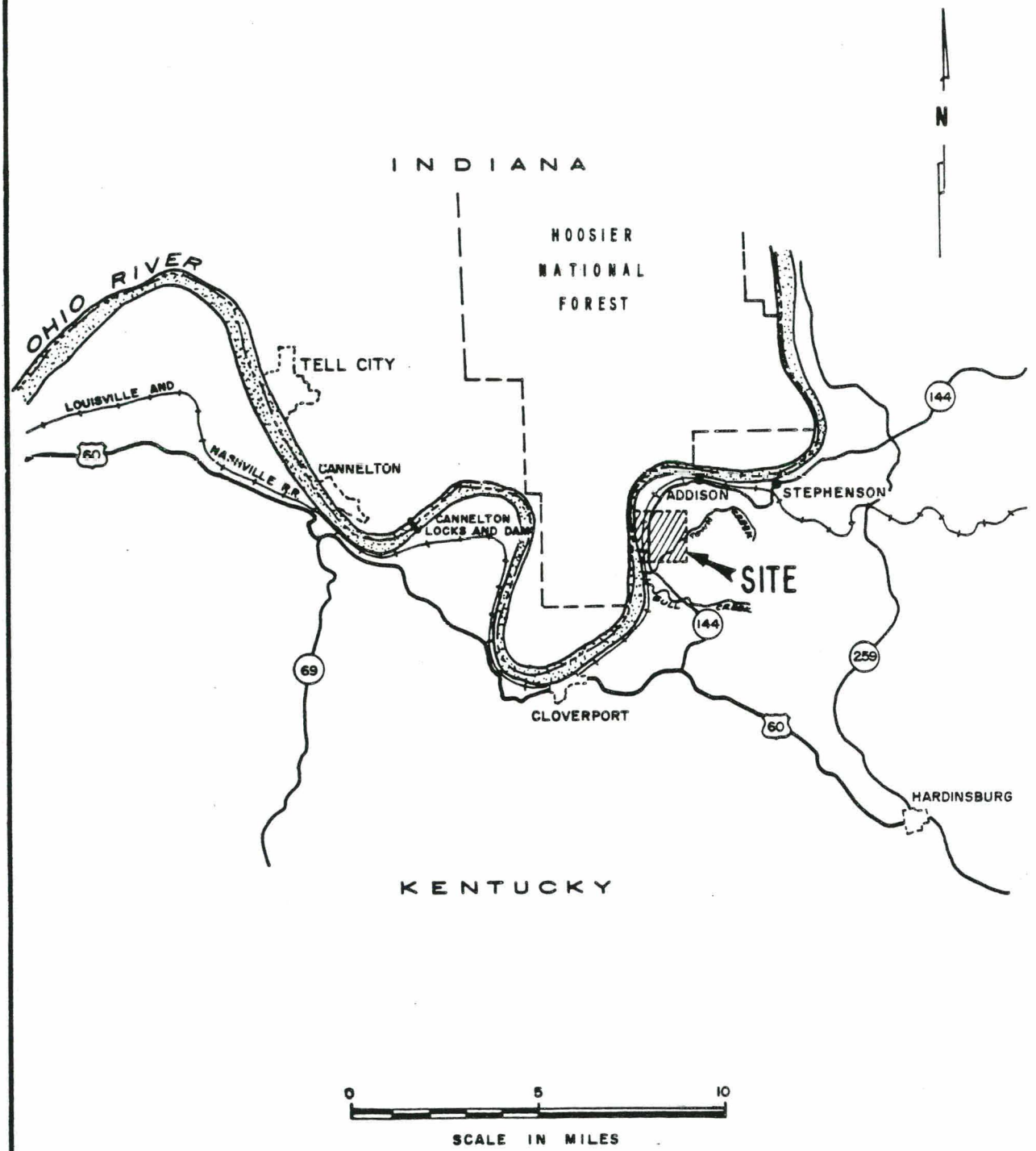
Respectfully submitted,

DAMES & MOORE

Fenley Ryther, Jr.
Partner

Randolph M. Freeman
Project Manager

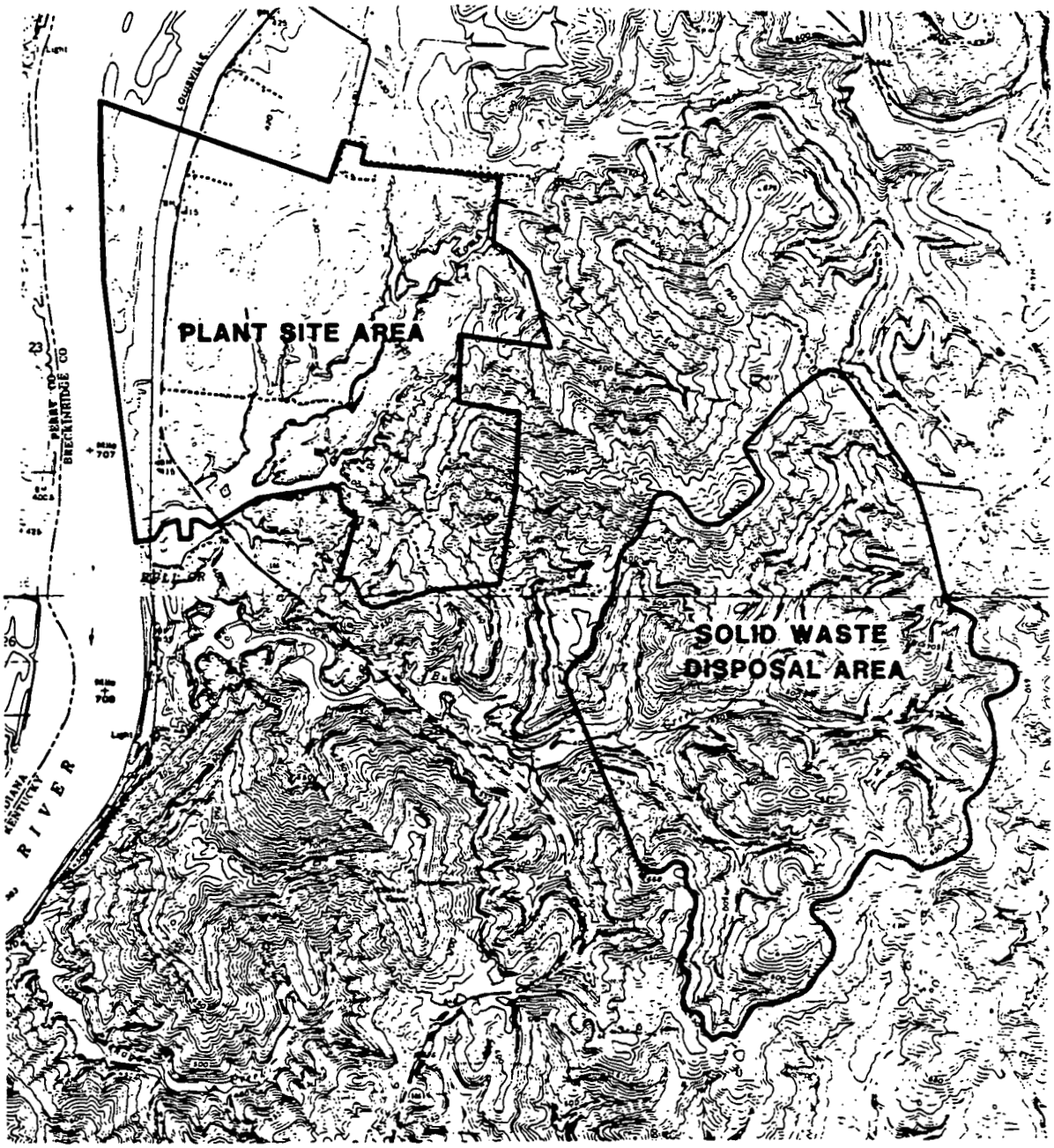
FR:RMF:mrf
Attachments



VICINITY MAP

DAMES & MOORE

PLATE 1



REFERENCE: U.S.G.S. 7.5 MINUTE QUADRANGLE
SHEETS FOR ROME, IND.-KY. (1970)
AND MATTINGLY, KY.-IND. (1970).

PLOT PLAN

DAMES & MOORE

PLATE 2

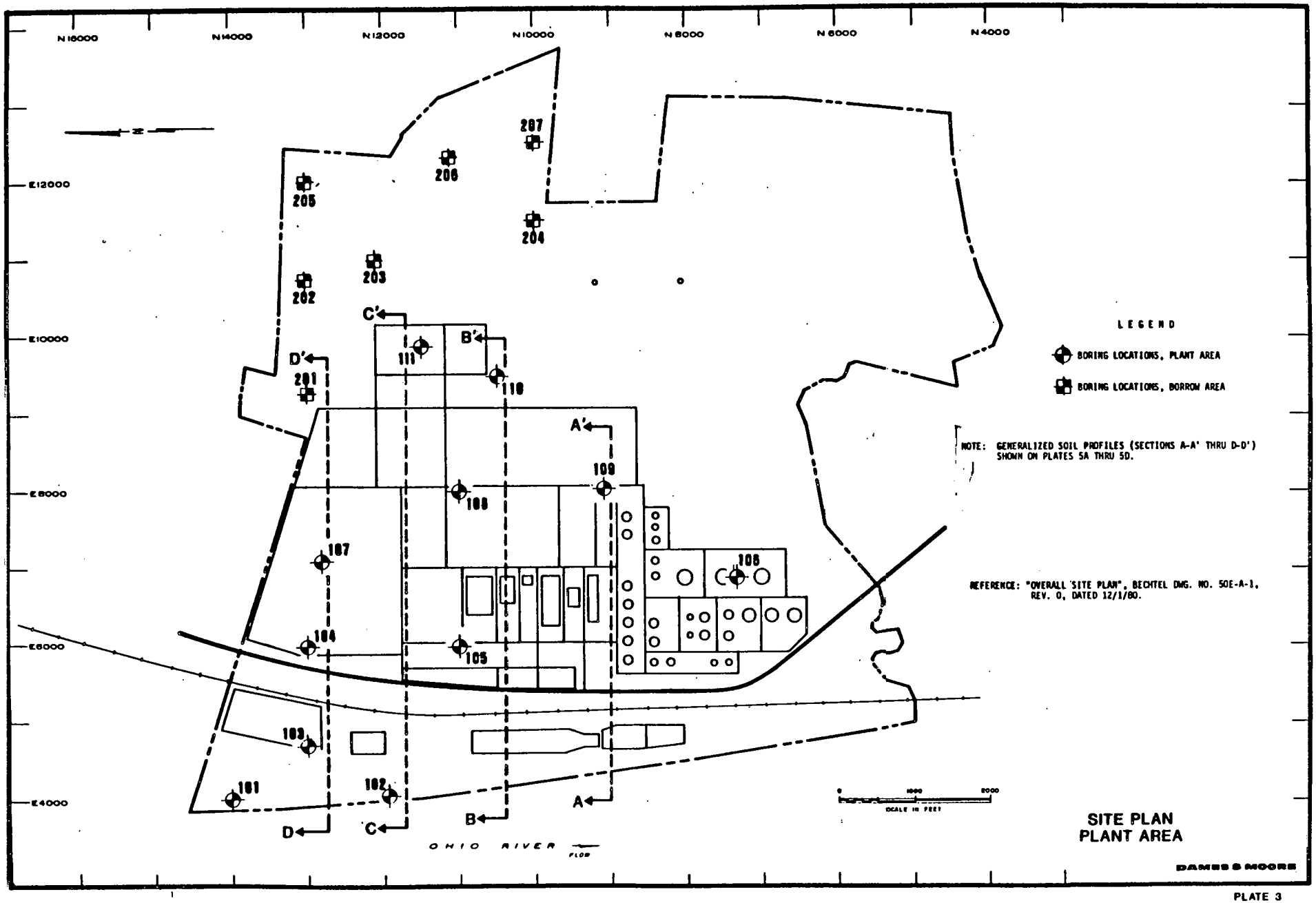
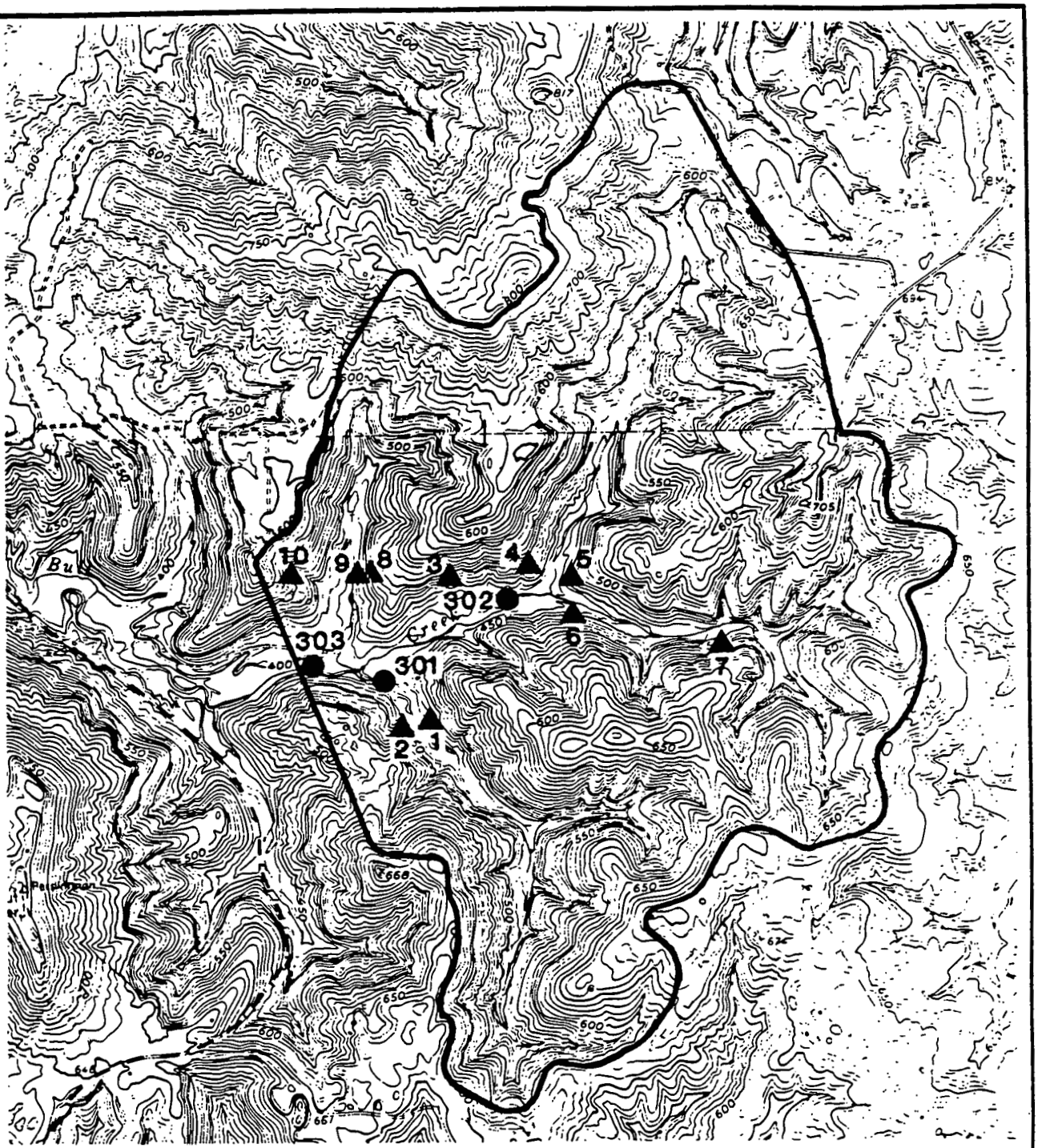

N16000
N14000
N12000
N10000
N8000
N6000
N4000
E12000
E10000
E8000
E6000
E4000
N
207
206
205
204
203
202
201
111
110
109
108
107
106
105
104
103
102
101
A
A'
B
B'
C
C'
D
D'
OHIO RIVER
FLOW
0
1000
2000
SCALE IN FEET
LEGEND
BORING LOCATIONS, PLANT AREA
BORING LOCATIONS, BORROW AREA
NOTE: GENERALIZED SOIL PROFILES (SECTIONS A-A' THRU D-D') SHOWN ON PLATES 5A THRU 5D.
REFERENCE: "OVERALL SITE PLAN", BECHTEL DWG. NO. 50E-A-1, REV. 0, DATED 12/1/80.
SITE PLAN
PLANT AREA
DAMES & MOORE

PLATE 3



0 5000

SCALE IN FEET

REFERENCE: U.S.G.S. 7.5 MINUTE QUADRANGLE SHEETS FOR ROME, IND.-KY. (1970) AND MATTINGLY, KY.-IND. (1970).

LEGEND

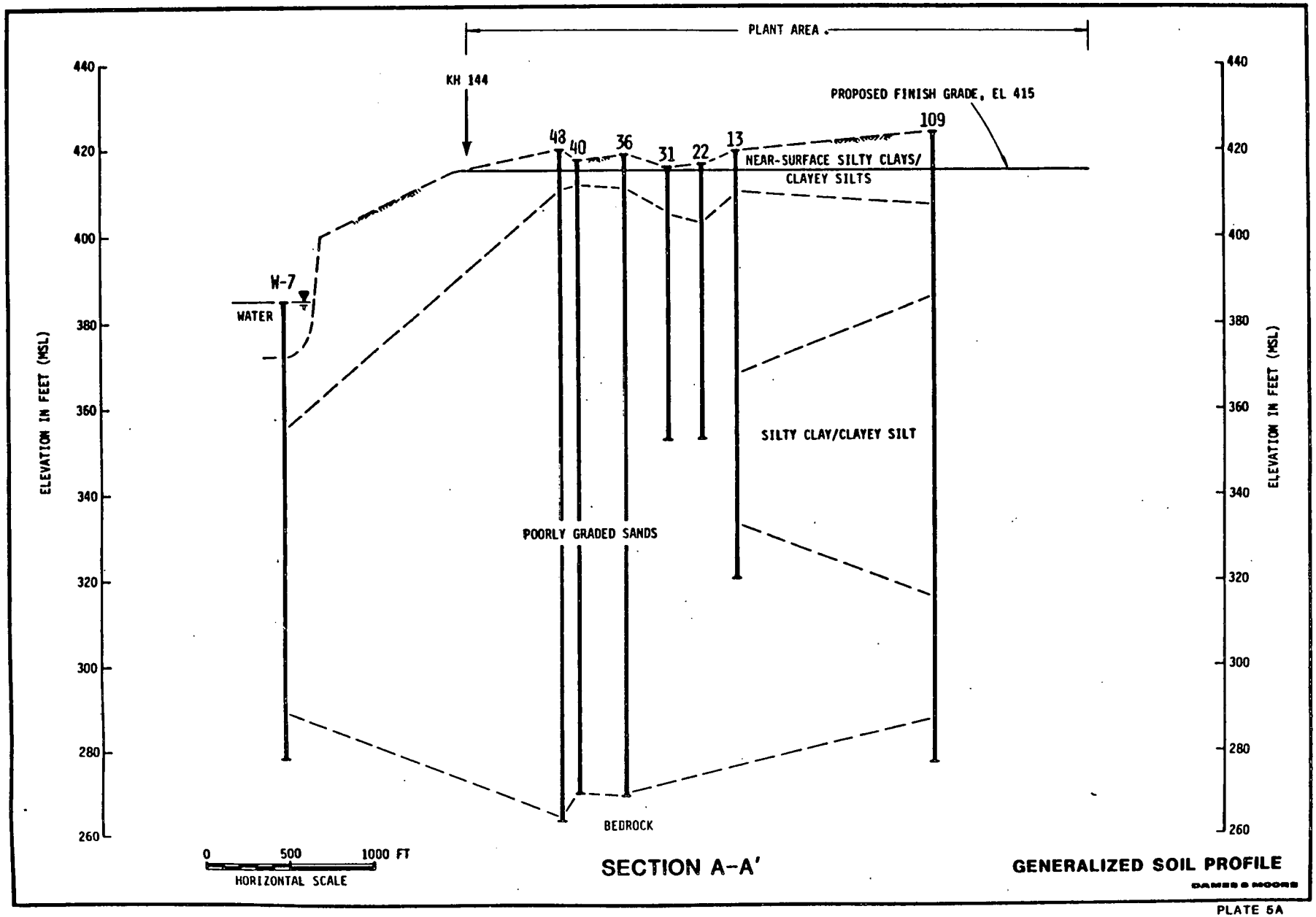
● BORING LOCATION

▲ HAND AUGER LOCATION

SITE PLAN
SOLID WASTE DISPOSAL AREA

DAMES & MOORE

PLATE 4



SECTION A-A'

GENERALIZED SOIL PROFILE

DAMES & MOORE

PLATE 5A

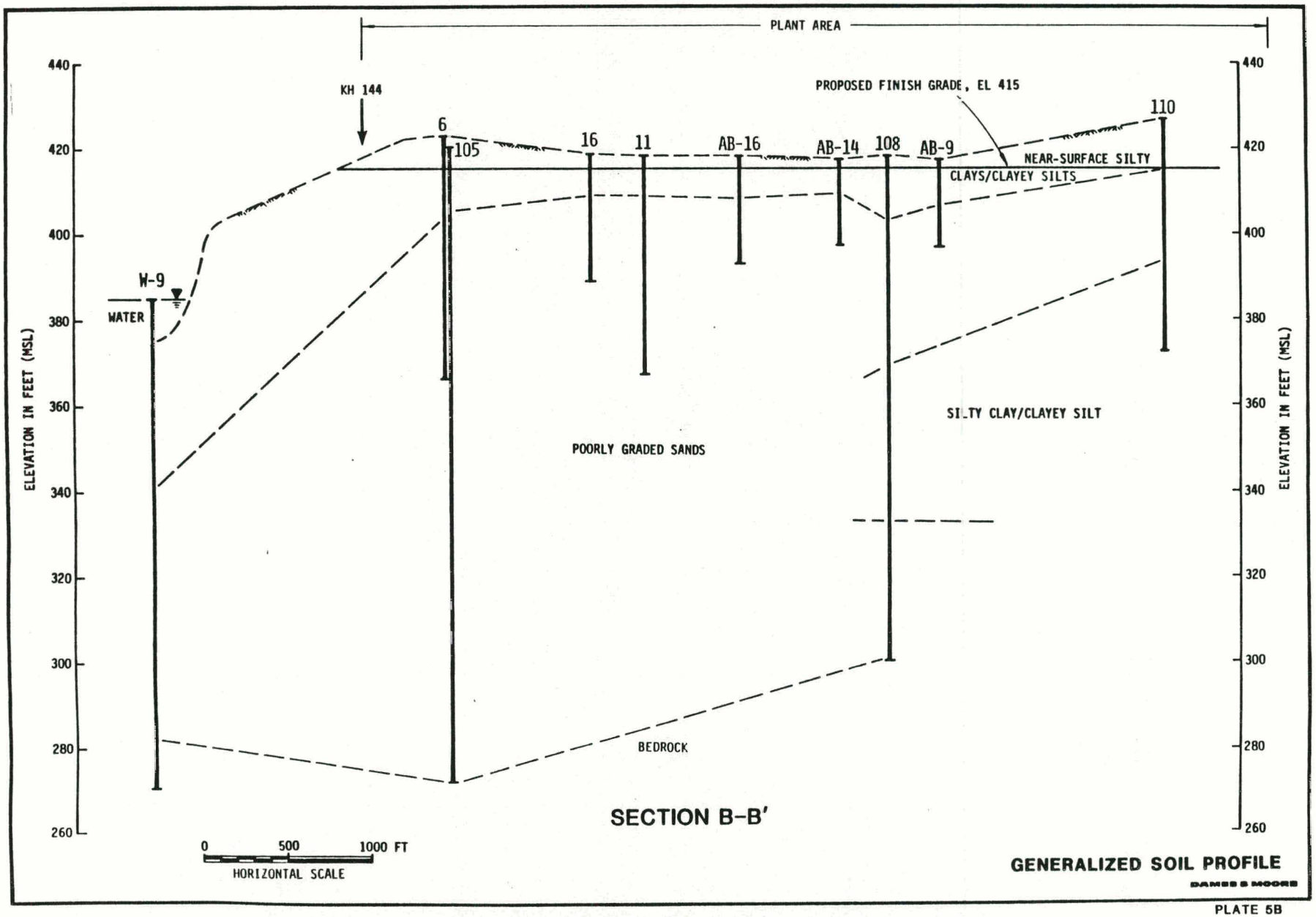
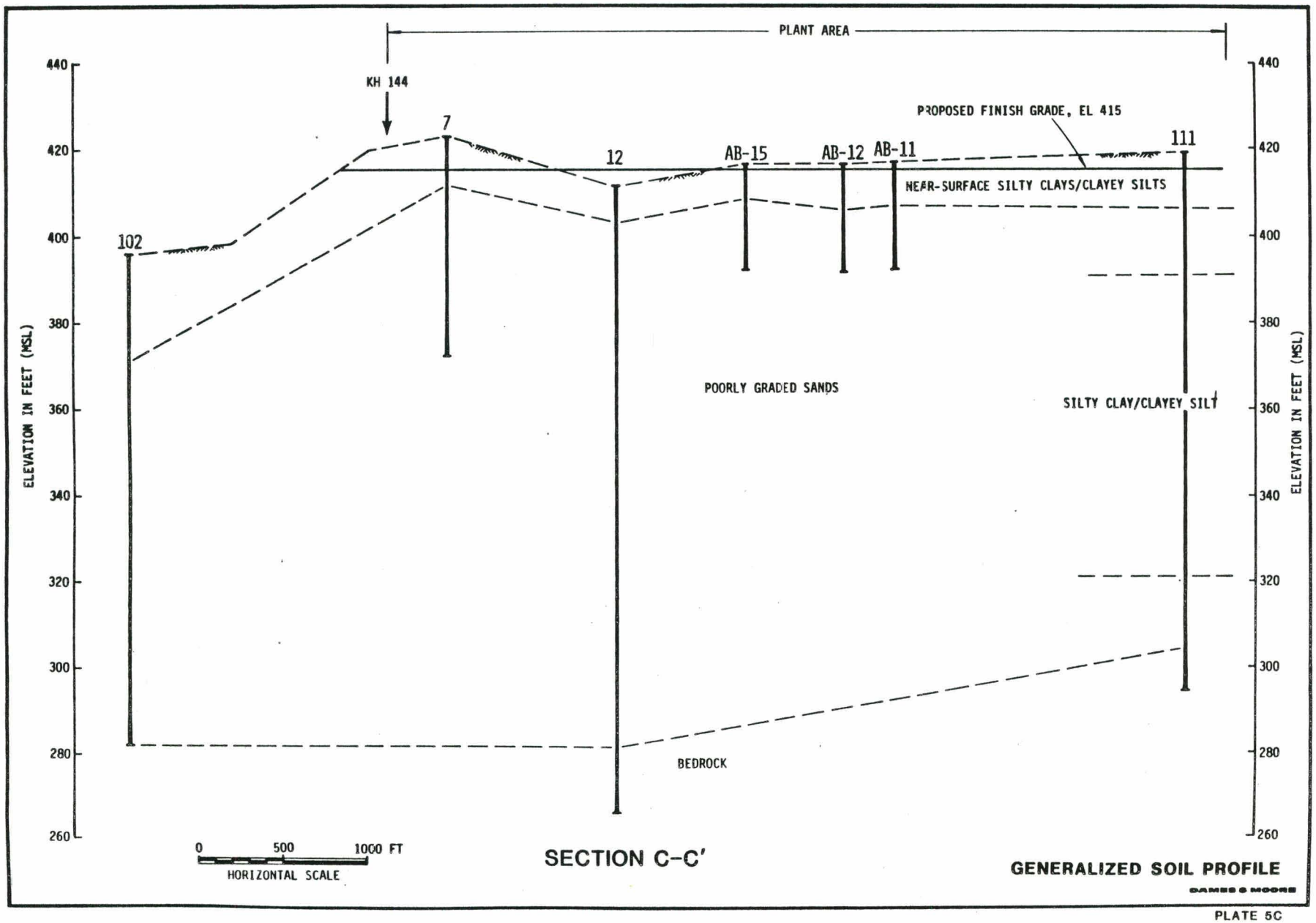

PLANT AREA
KH 144
PROPOSED FINISH GRADE, EL 415
W-9
WATER
6
105
16
11
AB-16
AB-14
108
AB-9
110
NEAR-SURFACE SILTY
CLAYS/CLAYEY SILTS
POORLY GRADED SANDS
SILTY CLAY/CLAYEY SILT
BEDROCK
ELEVATION IN FEET (MSL)
440
420
400
380
360
340
320
300
280
260
0
500
1000 FT
HORIZONTAL SCALE
SECTION B-B'
GENERALIZED SOIL PROFILE
DAMES & MOORE

PLATE 5B



SECTION C-C'

GENERALIZED SOIL PROFILE

DAMES & MOORE

PLATE 5C

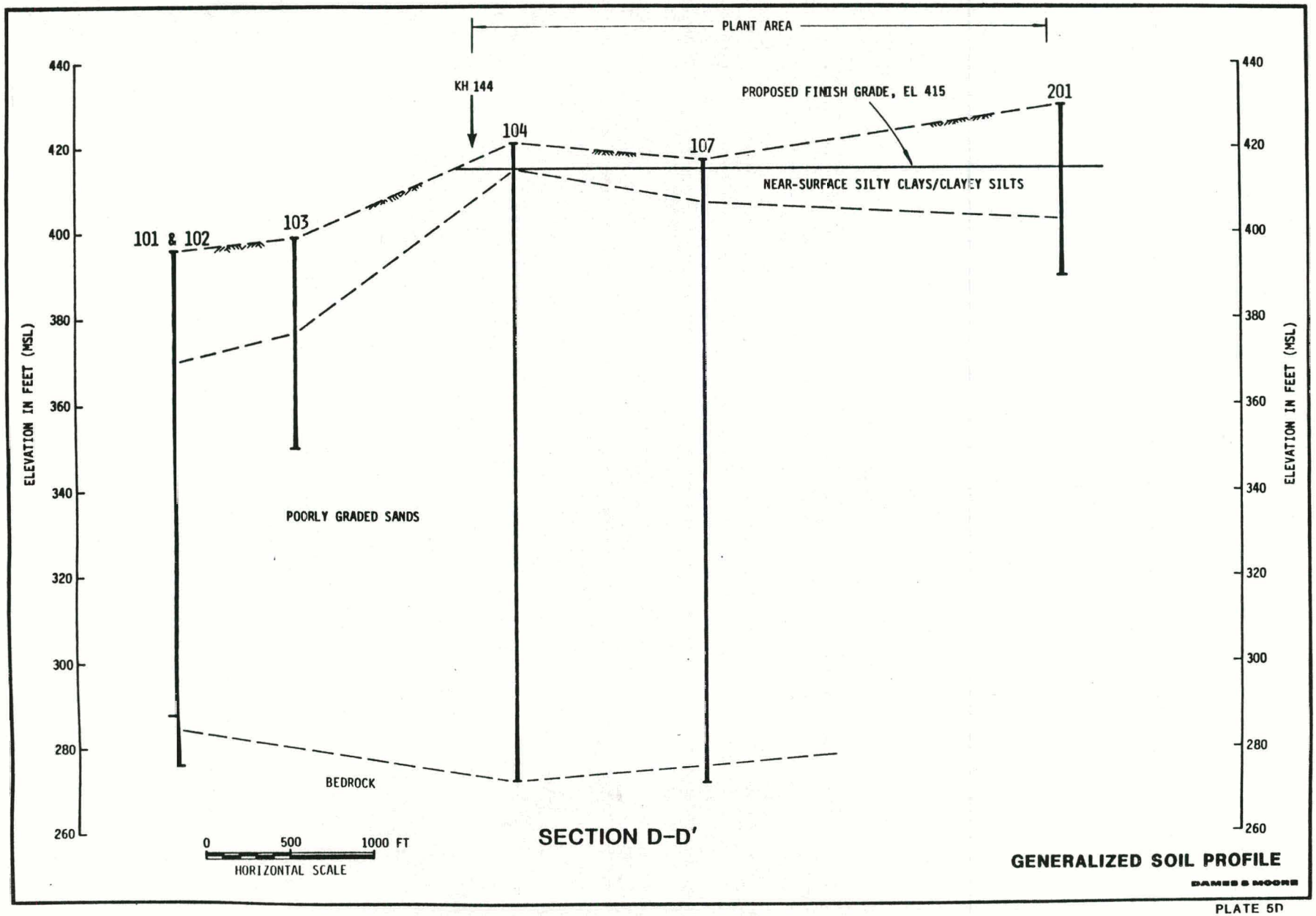
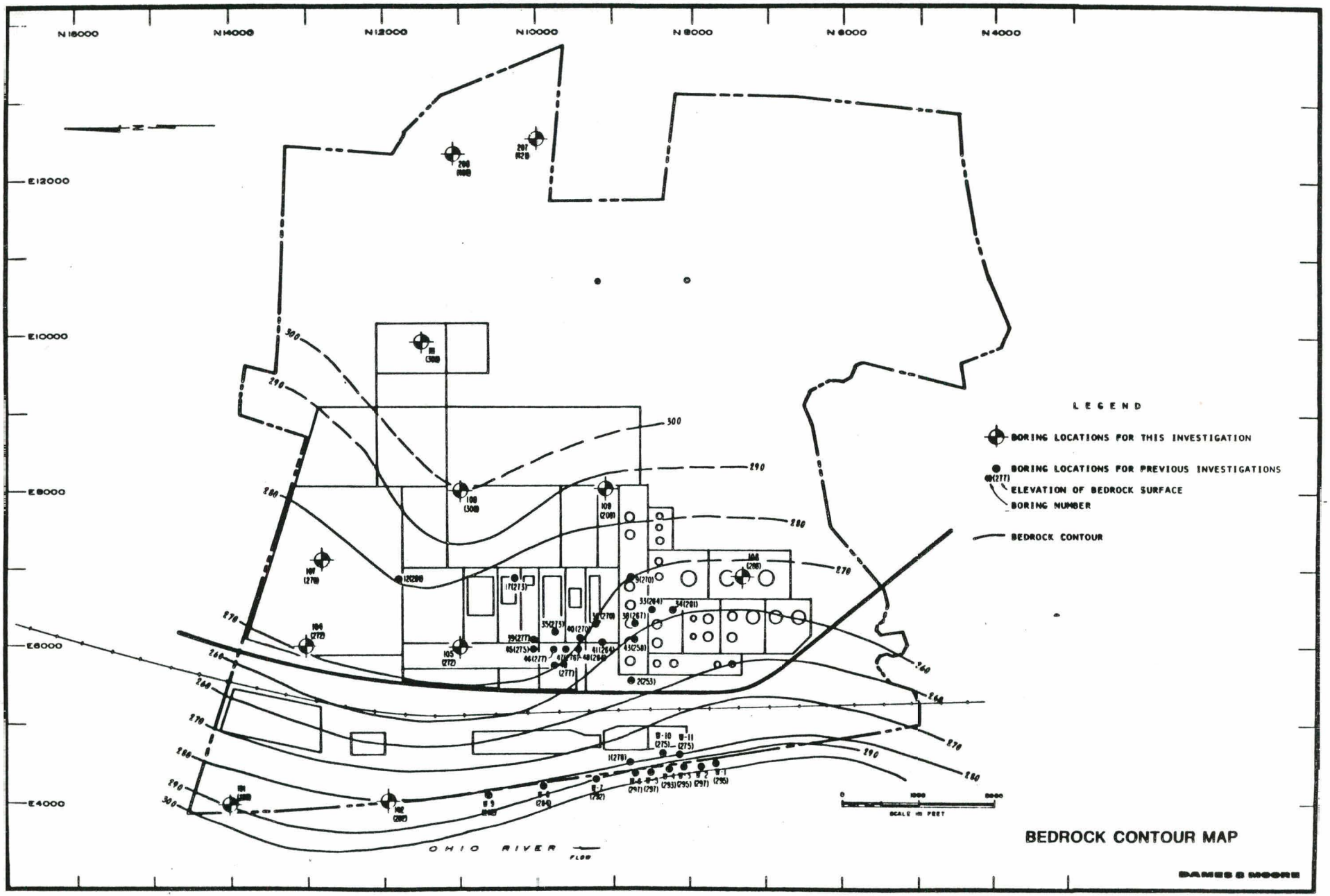
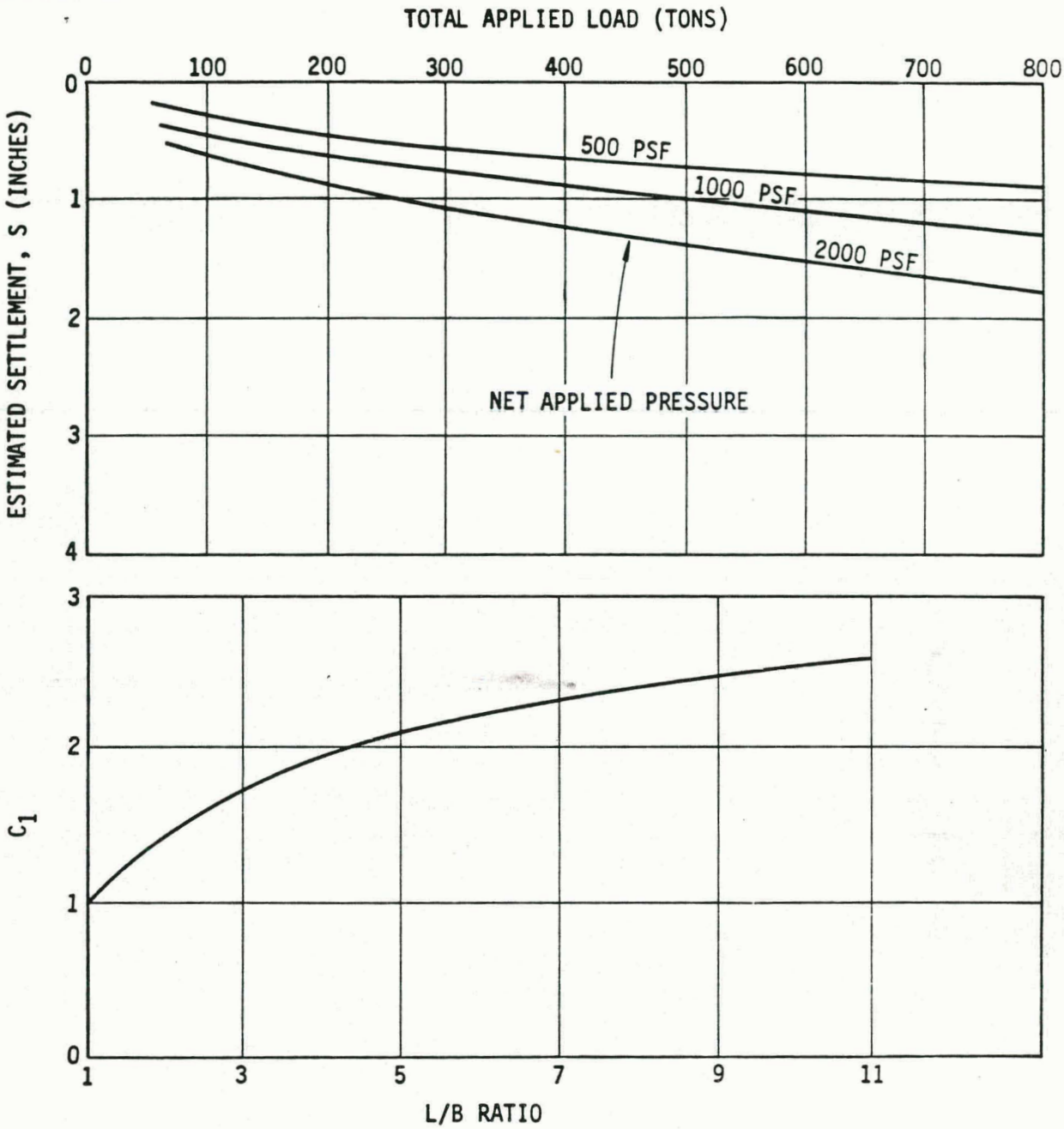

PLANT AREA
KH 144
PROPOSED FINISH GRADE, EL 415
101 & 102
103
104
107
201
NEAR-SURFACE SILTY CLAYS/CLAYEY SILTS
POORLY GRADED SANDS
BEDROCK
ELEVATION IN FEET (MSL)
440
420
400
380
360
340
320
300
280
260
0
500
1000 FT
HORIZONTAL SCALE
SECTION D-D'
GENERALIZED SOIL PROFILE
DAMES & MOORE

PLATE 5D



BEDROCK CONTOUR MAP

PLATE 6

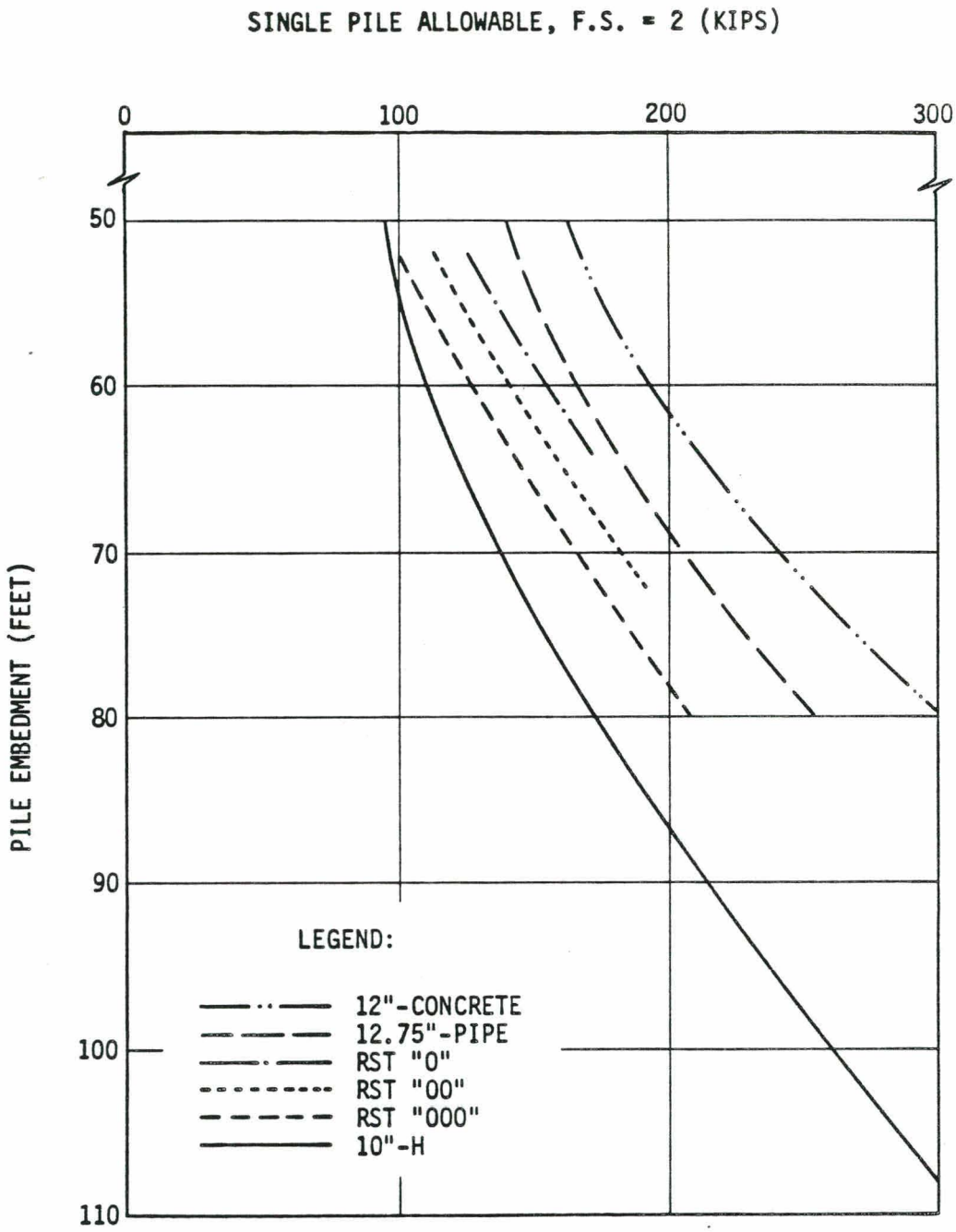


NOTES:

1. $S_1 = C_1 S$
2. L = LENGTH OF FOOTING
3. B = WIDTH OF FOOTING
4. S_1 = SETTLEMENT OF RECTANGULAR FOOTING
5. S = SETTLEMENT OF SQUARE FOOTING
6. C_1 = CORRECTION FACTOR
7. SETTLEMENTS ESTIMATED FOR FOOTINGS FOUNDED IN NATURAL SOIL WITH NO IMPROVEMENT OTHER THAN SURFACE COMPACTION.

ELASTIC SETTLEMENT OF SHALLOW FOUNDATIONS

DAMES & MOORE

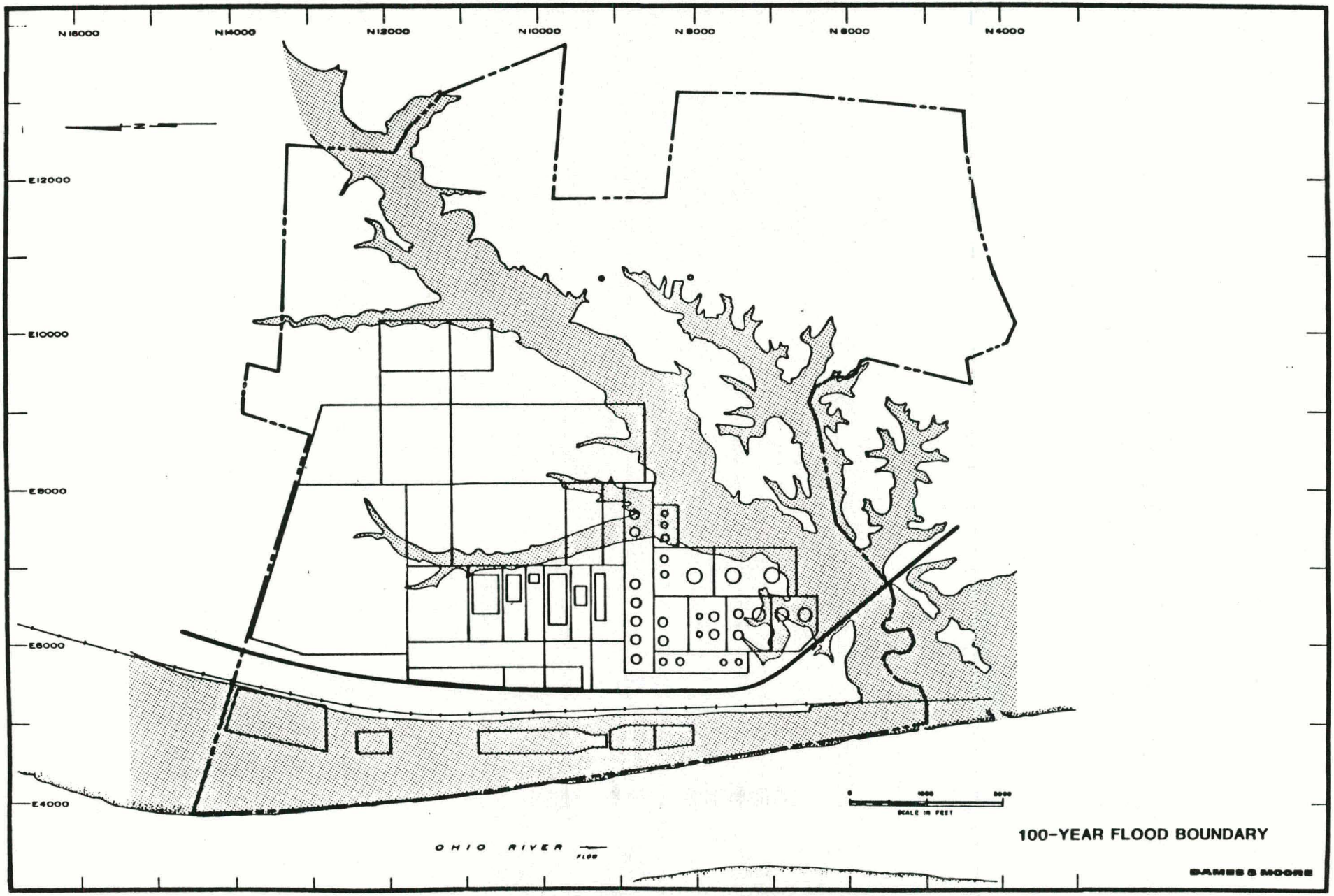


NOTES:

1. THE PILE CAPACITIES SHOWN HAVE A CALCULATED FACTOR OF SAFETY OF 2.5.
2. THE ALLOWABLE CAPACITY MAY BE INCREASED BY 30% FOR TEMPORARY LIVE LOADS.
3. 50% OF THE ALLOWABLE CAPACITY PLUS THE CALCULATED WEIGHT OF THE PILE MAY BE USED FOR AXIAL UPLIFT LOAD.
4. CAPACITIES BASED ON SUPPORTING RESISTANCE OF SOIL, STRUCTURAL CAPACITY OF PILE MATERIAL NOT CONSIDERED.

SINGLE PILE AXIAL CAPACITIES

DAMES & MOORE



100-YEAR FLOOD BOUNDARY

DAMES & MOORE

PLATE 9

APPENDIX

FIELD INVESTIGATION AND LABORATORY TESTING

FIELD INVESTIGATION

The field investigation commenced on December 18, 1980, and was completed on February 26, 1981. Communications were maintained between our field engineers; our Lexington, Kentucky office; and our Houston office.

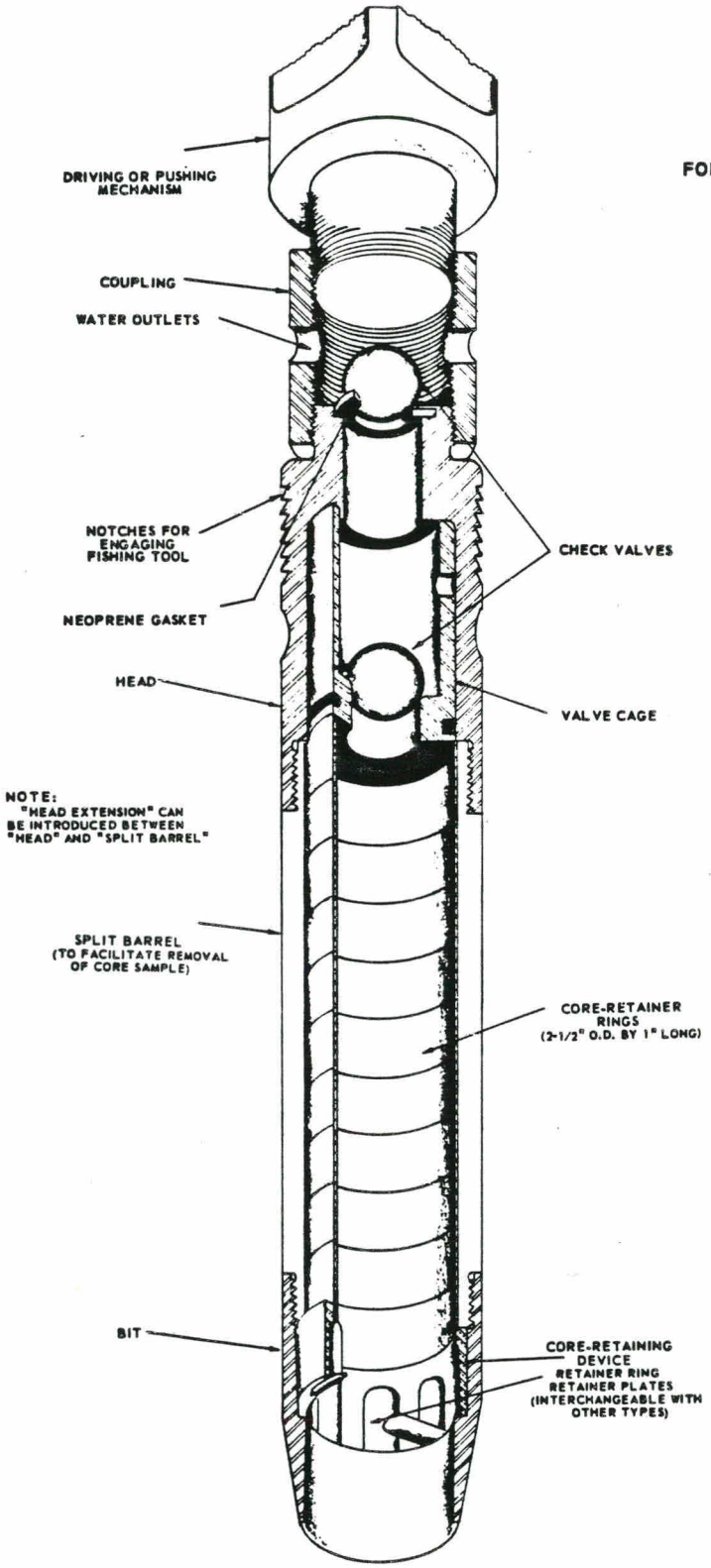
The subsurface conditions were investigated by drilling a total of 18 borings at the plant site area, including 7 borings within a potential borrow area within the plant boundaries, and 3 borings and 10 shallow, hand-auger probes in the solid waste disposal area. Borings were located in the field by Dames & Moore personnel; the location of all borings and hand-augered probes are presented on the Site Plans, Plates 3 and 4. The subsurface conditions encountered are described on the Log of Borings, Plates A-1A through A-1R; the nomenclature utilized on the Boring Logs is described on Plate A-2, Unified Soil Classification System.

All explorations were conducted under the technical supervision of Dames & Moore personnel. The borings were logged and relatively undisturbed samples were obtained using the Dames & Moore Type-U sampler (shown on page A-2) with or without the thinwall attachment, the Dames & Moore Type-O sampler, or 3-inch Shelby tubes. The Dames & Moore samplers were advanced either by pushing or by the force of a 140-pound hammer falling 30 inches. Shelby tube samples were obtained by hydraulically pushing the tube into the soils. A standard split-spoon sampler was also used for performing standard penetration tests (SPT). This sampler was also driven by a 140-pound hammer falling 30 inches. Samples obtained at each boring are indicated graphically on the Log of Borings at the depth from which the sample was extracted.

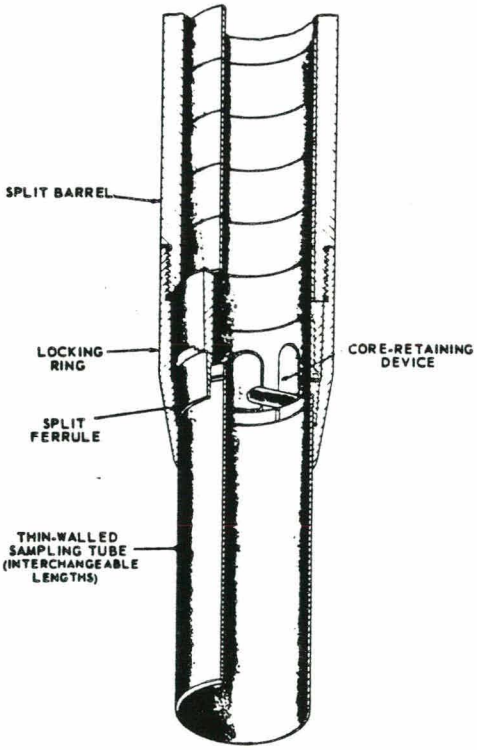
The field investigations carried out in each of the three areas are discussed separately in the following sections.

SOIL SAMPLER TYPE U

FOR SOILS DIFFICULT TO RETAIN IN SAMPLER



ALTERNATE ATTACHMENTS



Borrow Area

The potential borrow area was explored by drilling 7 auger borings near the northeastern corner of the plant area (see Plate 3 for boring locations). A CME-45 truck-mounted drilling rig was used to advance these borings. The borings were drilled to 40 feet or bedrock, whichever was first encountered. Bulk samples were collected at approximately 12- to 15-foot intervals for laboratory examination. Sampling depths from boring to boring were varied to allow for complete coverage of the upper 40 feet.

Plant Area

The subsurface conditions at the plant site were explored by drilling 11 borings. Two of the borings, Borings 103 and 110, were advanced to depths of 49.5 and 55 feet, respectively. The remaining borings were advanced to bedrock, which varied from depths of approximately 108 to 149 feet. Borings in the plant area were advanced by one of three methods: 1) rotary wash, using a skid-mounted Sprague and Henwood 40-CL; 2) continuous flight auger, using a CME-45 truck-mounted rig; or 3) continuous flight, hollow-stem auger, using a CME-55 truck-mounted rig.

Five of the 9 borings advanced to bedrock were cored utilizing a double-tube NX sized core barrel with a Christensen diamond bit. Bedrock was penetrated by a tri-cone bit in the remaining 4 borings.

Slotted PVC standpipe piezometers were installed in Borings 104 through 111. Five-foot perforated screen sections, with a 0.02-inch slot size, were set at selected depths upon completion of drilling each boring. The method of installation consisted of extracting the casing to the desired screen depth. Pea gravel was then poured into the hole, filling it to the bottom of the casing. The screen section and PVC pipe were then inserted into the casing and set upon the base of the pea gravel. The remainder of the casing was then pulled, the annular space between the PVC and soil wall was filled with gravel to within a few feet of the surface, and bentonite pellets were

then dropped into the annulus to form an impervious seal to prevent surface drainage from entering the annulus. The remainder of the annulus was then filled and a steel protector pipe, with cap, to protect the well was cemented to a depth of approximately 2 to 3 feet. The depths at which the piezometers are located are summarized in the following table:

STANDPIPE PIEZOMETERS

Boring	Screened Interval Depth (ft)	Screened Interval Elevation (ft)
104	55 to 60	366 to 361
105	45 to 50	375 to 370
106	45 to 50	370 to 365
107	45 to 50	372 to 367
108	85 to 90	333 to 328
109	100 to 105	324 to 319
110	25 to 30	402 to 397
111	109 to 114	310 to 305

Solid Waste Disposal Area

Subsurface conditions were explored by drilling 3 borings and advancing 10 hand-auger probes at the locations shown on Plate 4. A truck-mounted CME-45 auger rig was used for drilling the 3 borings. Continuous samples were taken in the upper 10 feet using the Dames & Moore Type-U sampler with thinwall attachment. Ten-foot core runs were performed in the bedrock at each boring location. Shallow standpipe piezometers were installed in each of the borings and are summarized in the following table:

STANDPIPE PIEZOMETERS

Boring	Screened Interval Depth (ft)	Screened Interval Elevation (ft)
301	3 to 6	403 to 400
302	14 to 19	404 to 399
303	4 to 9	394 to 389

The locations of the shallow hand probes were selected to include the dominant soil groups delineated on Soil Conservation Service general soil survey maps. Samples were obtained at these locations by pushing or driving Shelby tubes with a hand-operated, 140-pound hammer to the bedrock contact, which varied from a depth of 1 to 5 feet.

FIELD PERMEABILITY TESTS

Falling-head, field permeability tests were performed in three of the completed standpipe piezometers (Borings 109, 110, and 111). Calculated values of permeability from these tests, using Hvorslev's equation, ranged from 2×10^{-4} to 9×10^{-4} cm/sec. These values are extremely low compared to the median value of 2×10^{-2} cm/sec for the entire Ohio River alluvium and for a value of 7×10^{-2} cm/sec cited from the literature for a pump test performed at Hawesville. Further development of the standpipes by continued pumping, followed by subsequent field testing may provide values more in line with these permeabilities.

LABORATORY TESTING

The purpose of our laboratory testing program was to provide sufficient quantitative information to allow evaluation of the physical properties of the subsurface soils encountered and to provide a comparison of these values with results obtained from previous investigations. In order to accomplish

this, identification tests, such as moisture content-dry density, Atterberg limits tests, and grain size analyses, were performed on selected samples. Consolidation and shearing strength tests were also performed to provide values for engineering properties used in evaluating bearing capacities and settlements for shallow foundations as well as pile capacities for driven piling.

Moisture content and total density of selected samples were measured in the laboratory with the dry density computed from this information. The moisture content and dry density of those samples tested is indicated at the appropriate location on the Log of Borings.

Atterberg limits were performed to assist in classification and evaluation of the relative plasticity characteristics of the soils encountered. These results are also presented on the Boring Logs.

Grain size analyses were performed to aid in classification of the granular soils. Results from these tests were used in the liquefaction analyses performed. Test results are presented on Plates A-3A through A-3C.

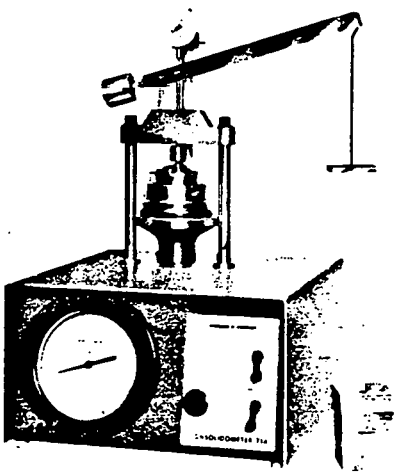
Consolidation tests were performed on samples taken from the near-surface finer grained soils and of the deeper clay stratum. A description of the test procedure is presented on Page A-7, Method of Performing Consolidation Tests. The results of these tests, presented on Plates A-4A and A-4B, were utilized in the settlement analyses.

Shearing strength tests were performed on selected samples of the near-surface silts and clays as well as the deeper granular soils. This information was used in the calculation of bearing and pile capacities. Strain-controlled, unconsolidated-undrained, triaxial compression tests were performed on selected samples. The results of these tests, in terms of one-half the deviator stress, are presented in numerical form on the Log of

METHOD OF PERFORMING CONSOLIDATION TESTS

CONSOLIDATION TESTS ARE PERFORMED TO EVALUATE THE VOLUME CHANGES OF SOILS SUBJECTED TO INCREASED LOADS. TIME-CONSOLIDATION AND PRESSURE-CONSOLIDATION CURVES MAY BE PLOTTED FROM THE DATA OBTAINED IN THE TESTS. ENGINEERING ANALYSES BASED ON THESE CURVES PERMIT ESTIMATES TO BE MADE OF THE PROBABLE MAGNITUDE AND RATE OF SETTLEMENT OF THE TESTED SOILS UNDER APPLIED LOADS.

EACH SAMPLE IS TESTED WITHIN BRASS RINGS TWO AND ONE-HALF INCHES IN DIAMETER AND ONE INCH IN LENGTH. UNDISTURBED SAMPLES OF IN-PLACE SOILS ARE TESTED IN RINGS TAKEN FROM THE SAMPLING DEVICE IN WHICH THE SAMPLES WERE OBTAINED. LOOSE SAMPLES OF SOILS TO BE USED IN CONSTRUCTING EARTH FILLS ARE COMPACTED IN RINGS TO PREDETERMINED CONDITIONS AND TESTED.



DEAD LOAD-PNEUMATIC CONSOLIDOMETER

IN TESTING, THE SAMPLE IS RIGIDLY CONFINED LATERALLY BY THE BRASS RING. AXIAL LOADS ARE TRANSMITTED TO THE ENDS OF THE SAMPLE BY POROUS DISKS. THE DISKS ALLOW DRAINAGE OF THE LOADED SAMPLE. THE AXIAL COMPRESSION OR EXPANSION OF THE SAMPLE IS MEASURED BY A MICROMETER DIAL INDICATOR AT APPROPRIATE TIME INTERVALS AFTER EACH LOAD INCREMENT IS APPLIED. EACH LOAD IS ORDINARILY TWICE THE PRECEDING LOAD. THE INCREMENTS ARE SELECTED TO OBTAIN CONSOLIDATION DATA REPRESENTING THE FIELD LOADING CONDITIONS FOR WHICH THE TEST IS BEING PERFORMED. EACH LOAD INCREMENT IS ALLOWED TO ACT OVER AN INTERVAL OF TIME DEPENDENT ON THE TYPE AND EXTENT OF THE SOIL IN THE FIELD.

Borings at the depth from which the sample was obtained. In addition, a consolidated-undrained, triaxial compression test with pore water pressure measurements was performed on the sample to evaluate the intergranular stresses of the material. The methods of performing triaxial compression tests are described on Page A-9.

Multi-stage direct shear tests were performed on samples of granular material to evaluate their shearing strength characteristics. The results of these tests are also presented in numerical form on the Log of Borings. These tests were performed in accordance with the description provided on Page A-10.

A compaction test was performed on a composite sample of the near-surface soils. This test was performed in accordance with ASTM D-1557 test procedures. The results of this test are presented on Plate A-5.

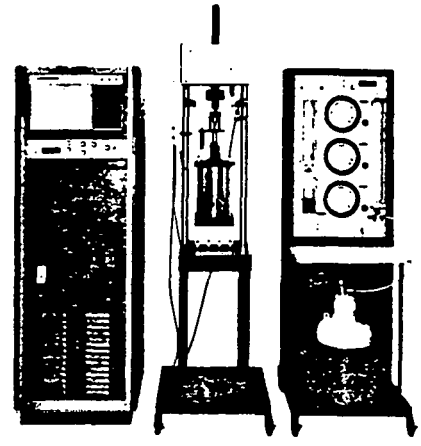
Falling-head permeability tests were performed on selected samples obtained from the borings drilled in the solid waste disposal area. The results of these tests, used in evaluating the relative imperviousness of the natural soils in the proposed solid waste area, are presented in the following table:

FALLING-HEAD PERMEABILITY TESTS
SOLID WASTE DISPOSAL AREA

Boring	Sample Depth (ft)	Surcharge Pressure (psf)	Permeability (cm/sec)
301	2.5	300	1.4×10^{-7}
301	5.8	600	4.3×10^{-6}
301	7.8	750	5.5×10^{-8}
302	4.5	550	5.1×10^{-8}
303	2.5	300	8.6×10^{-8}
303	5.5	650	8.7×10^{-8}

METHODS OF PERFORMING UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS

THE SHEARING STRENGTHS OF SOILS ARE DETERMINED FROM THE RESULTS OF UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS. IN TRIAXIAL COMPRESSION TESTS THE TEST METHOD AND THE MAGNITUDE OF THE CONFINING PRESSURE ARE CHOSEN TO SIMULATE ANTICIPATED FIELD CONDITIONS.



TRIAXIAL COMPRESSION TEST UNIT

UNCONFINED COMPRESSION AND TRIAXIAL COMPRESSION TESTS ARE PERFORMED ON UNDISTURBED OR REMOLDED SAMPLES OF SOIL APPROXIMATELY SIX INCHES IN LENGTH AND TWO AND ONE-HALF INCHES IN DIAMETER. THE TESTS ARE RUN EITHER STRAIN-CONTROLLED OR STRESS-CONTROLLED. IN A STRAIN-CONTROLLED TEST THE SAMPLE IS SUBJECTED TO A CONSTANT RATE OF DEFLECTION AND THE RESULTING STRESSES ARE RECORDED. IN A STRESS-CONTROLLED TEST THE SAMPLE IS SUBJECTED TO EQUAL INCREMENTS OF LOAD WITH EACH INCREMENT BEING MAINTAINED UNTIL AN EQUILIBRIUM CONDITION WITH RESPECT TO STRAIN IS ACHIEVED.

YIELD, PEAK, OR ULTIMATE STRESSES ARE DETERMINED FROM THE STRESS-STRAIN PLOT FOR EACH SAMPLE AND THE PRINCIPAL STRESSES ARE EVALUATED. THE PRINCIPAL STRESSES ARE PLOTTED ON A MOHR'S CIRCLE DIAGRAM TO DETERMINE THE SHEARING STRENGTH OF THE SOIL TYPE BEING TESTED.

UNCONFINED COMPRESSION TESTS CAN BE PERFORMED ONLY ON SAMPLES WITH SUFFICIENT COHESION SO THAT THE SOIL WILL STAND AS AN UNSUPPORTED CYLINDER. THESE TESTS MAY BE RUN AT NATURAL MOISTURE CONTENT OR ON ARTIFICIALLY SATURATED SOILS.

IN A TRIAXIAL COMPRESSION TEST THE SAMPLE IS ENCASED IN A RUBBER MEMBRANE, PLACED IN A TEST CHAMBER, AND SUBJECTED TO A CONFINING PRESSURE THROUGHOUT THE DURATION OF THE TEST. NORMALLY, THIS CONFINING PRESSURE IS MAINTAINED AT A CONSTANT LEVEL, ALTHOUGH FOR SPECIAL TESTS IT MAY BE VARIED IN RELATION TO THE MEASURED STRESSES. TRIAXIAL COMPRESSION TESTS MAY BE RUN ON SOILS AT FIELD MOISTURE CONTENT OR ON ARTIFICIALLY SATURATED SAMPLES. THE TESTS ARE PERFORMED IN ONE OF THE FOLLOWING WAYS:

UNCONSOLIDATED-UNDRAINED: THE CONFINING PRESSURE IS IMPOSED ON THE SAMPLE AT THE START OF THE TEST. NO DRAINAGE IS PERMITTED AND THE STRESSES WHICH ARE MEASURED REPRESENT THE SUM OF THE INTERGRANULAR STRESSES AND PORE WATER PRESSURES.

CONSOLIDATED-UNDRAINED: THE SAMPLE IS ALLOWED TO CONSOLIDATE FULLY UNDER THE APPLIED CONFINING PRESSURE PRIOR TO THE START OF THE TEST. THE VOLUME CHANGE IS DETERMINED BY MEASURING THE WATER AND/OR AIR EXPELLED DURING CONSOLIDATION. NO DRAINAGE IS PERMITTED DURING THE TEST AND THE STRESSES WHICH ARE MEASURED ARE THE SAME AS FOR THE UNCONSOLIDATED-UNDRAINED TEST.

DRAINED: THE INTERGRANULAR STRESSES IN A SAMPLE MAY BE MEASURED BY PERFORMING A DRAINED, OR SLOW, TEST. IN THIS TEST THE SAMPLE IS FULLY SATURATED AND CONSOLIDATED PRIOR TO THE START OF THE TEST. DURING THE TEST, DRAINAGE IS PERMITTED AND THE TEST IS PERFORMED AT A SLOW ENOUGH RATE TO PREVENT THE BUILDUP OF PORE WATER PRESSURES. THE RESULTING STRESSES WHICH ARE MEASURED REPRESENT ONLY THE INTERGRANULAR STRESSES. THESE TESTS ARE USUALLY PERFORMED ON SAMPLES OF GENERALLY NON-COHESIVE SOILS, ALTHOUGH THE TEST PROCEDURE IS APPLICABLE TO COHESIVE SOILS IF A SUFFICIENTLY SLOW TEST RATE IS USED.

AN ALTERNATE MEANS OF OBTAINING THE DATA RESULTING FROM THE DRAINED TEST IS TO PERFORM AN UNDRAINED TEST IN WHICH SPECIAL EQUIPMENT IS USED TO MEASURE THE PORE WATER PRESSURES. THE DIFFERENCES BETWEEN THE TOTAL STRESSES AND THE PORE WATER PRESSURES MEASURED ARE THE INTERGRANULAR STRESSES.

METHOD OF PERFORMING DIRECT SHEAR AND FRICTION TESTS

DIRECT SHEAR TESTS ARE PERFORMED TO DETERMINE THE SHEARING STRENGTHS OF SOILS. FRICTION TESTS ARE PERFORMED TO DETERMINE THE FRICTIONAL RESISTANCES BETWEEN SOILS AND VARIOUS OTHER MATERIALS SUCH AS WOOD, STEEL, OR CONCRETE. THE TESTS ARE PERFORMED IN THE LABORATORY TO SIMULATE ANTICIPATED FIELD CONDITIONS.

DIRECT SHEAR APPARATUS WITH ELECTRONIC RECORDER

EACH SAMPLE IS TESTED WITHIN THREE BRASS RINGS, TWO AND ONE-HALF INCHES IN DIAMETER AND ONE INCH IN LENGTH. UNDISTURBED SAMPLES OF IN-PLACE SOILS ARE TESTED IN RINGS TAKEN FROM THE SAMPLING DEVICE IN WHICH THE SAMPLES WERE OBTAINED. LOOSE SAMPLES OF SOILS TO BE USED IN CONSTRUCTING EARTH FILLS ARE COMPACTED IN RINGS TO PREDETERMINED CONDITIONS AND TESTED.

DIRECT SHEAR TESTS

A THREE-INCH LENGTH OF THE SAMPLE IS TESTED IN DIRECT DOUBLE SHEAR. A CONSTANT PRESSURE, APPROPRIATE TO THE CONDITIONS OF THE PROBLEM FOR WHICH THE TEST IS BEING PERFORMED, IS APPLIED NORMAL TO THE ENDS OF THE SAMPLE THROUGH POROUS STONES. A SHEARING FAILURE OF THE SAMPLE IS CAUSED BY MOVING THE CENTER RING IN A DIRECTION PERPENDICULAR TO THE AXIS OF THE SAMPLE. TRANSVERSE MOVEMENT OF THE OUTER RINGS IS PREVENTED.

THE SHEARING FAILURE MAY BE ACCOMPLISHED BY APPLYING TO THE CENTER RING EITHER A CONSTANT RATE OF LOAD, A CONSTANT RATE OF DEFLECTION, OR INCREMENTS OF LOAD OR DEFLECTION. IN EACH CASE, THE SHEARING LOAD AND THE DEFLECTIONS IN BOTH THE AXIAL AND TRANSVERSE DIRECTIONS ARE RECORDED AND PLOTTED. THE SHEARING STRENGTH OF THE SOIL IS DETERMINED FROM THE RESULTING LOAD-DEFLECTION CURVES.

FRICTION TESTS

IN ORDER TO DETERMINE THE FRICTIONAL RESISTANCE BETWEEN SOIL AND THE SURFACES OF VARIOUS MATERIALS, THE CENTER RING OF SOIL IN THE DIRECT SHEAR TEST IS REPLACED BY A DISK OF THE MATERIAL TO BE TESTED. THE TEST IS THEN PERFORMED IN THE SAME MANNER AS THE DIRECT SHEAR TEST BY FORCING THE DISK OF MATERIAL FROM THE SOIL SURFACES.

Chemical analyses were performed on selected soil and ground water samples from both the plant and solid waste disposal areas. The results of these tests are presented in the tables at the end of this Appendix.

-oOo-

The following Tables and Plates are attached and complete this Appendix:

Table A-1	Ground Water Quality Analyses
Table A-2	Chemical Testing of Soil, Plant Site Area
Table A-3	Physical and Chemical Properties of Selected Samples from Hand-Auger Probes, Solid Waste Disposal Area
Table A-4	Mineralogical Analyses (Semi-Quantitative), Solid Waste Disposal Area
Table A-5	Cation (Sodium) Exchange Capacity, Solid Waste Disposal Area
Plates A-1A thru A-1R	Log of Borings
Plate A-2	Unified Soil Classification System
Plates A-3A thru A-3C	Gradation Curves
Plates A-4A and A-4B	Consolidation Test Data
Plate A-5	Compaction Test Data

TABLE A-1

GROUND WATER QUALITY ANALYSES

	BORING 105	BORING 303
Total Coliform (per 100 ml)	<2	>16
Fecal Coliform (per 100 ml)	<2	<20
pH (S.U.)	7.45	7.70
Density (g/cc)	0.99	1.00
Odor (TON)	32	1
Turbidity (NTU)	190	1,800.0
Color (CU)	40	750
Taste	Not determined due to bacterial contamination	
	mg/L	mg/L
Total Suspended Solids	376	17,500
Total Dissolved Solids	116	3,150
TOC	27	70
Ammonia as N	0.82	3.90
Nitrate	0.55	<0.02
Cyanide	0.002	<0.002
Fluoride	0.36	7.70
Sulfate	5	23.00
Ortho-Phosphate	0.41	0.96
Chloride	2	748.0
Hardness as $CaCO_3$	69	211
Alkalinity	61	772
Total Nitrogen	18.90	12.60
Aluminum	119.0	784.000
Arsenic	0.004	0.0410
Barium	1.90	1.370
Boron	<0.20	0.725
Beryllium	<0.004	<0.004
Bismuth	<0.010	<0.010
Bromine	0.036	2.400
Cadmium	0.005	0.140
Cobalt	<0.005	0.617
Chromium	0.615	1.160
Copper	1.442	0.504
Iron	37.00	352.000
Germanium	<0.02	<0.02
Mercury	<0.0002	<0.0008
Lanthanum	<0.006	<0.006
Magnesium	9.40	104.00
Manganese	0.22	5.590

TABLE A-1 (Cont.)

	BORING 105	BORING 303
	mg/L	mg/L
Molybdenum	0.014	0.004
Nickel	0.470	0.570
Lead	0.134	1.050
Rubidium	<0.010	<0.010
Antimony	<0.005	0.063
Selenium	<0.0025	0.003
Tin	<0.25	0.379
Titanium	0.080	<0.030
Uranium	<0.010	<0.01
Vanadium	0.060	<0.001
Tungsten	<0.01	<0.01
Zinc	0.70	1.760
Zirconium	<0.005	<0.005
Silver	0.003	0.002
	pCi/L	pCI/L
Thorium	<5	ND**
Radium	<15	"
	µg/L	µg/L
Phenols (1)	8	<3.0
Aliphatic Hydrocarbons	26,000	8,000.0
Arylamines	<0.1	<0.1
Mono and Polycyclic Hydrocarbons (2)	<0.01	<0.01
Sulfur Compounds		
Thiophenes and Mercaptans (3)	13	<3.0
Chlororganics (4)	13	0.13
Chloramine	<100.0	<100.0

**ND - Not detectable - slightly higher background radiation.
(1) Phenols were determined by GC as Phenol.
(2) Sixteen PAH's and 3 monocyclic compounds utilized as standards.
(3) Sulfur compounds compared to mercapto ethanol for detection limits.
(4) Chlororganics compared to Lindane.

NOTE: Analyses performed by Howard Laboratories, Inc., Dayton, Ohio.

TABLE A-2

CHEMICAL TESTING OF SOIL
PLANT SITE AREA

Boring	Depth (ft)	Soil pH	Sulfate (ppm)	Resistivity (ohm-cm)
105	7	5.9	<50	50,000
105	10.5	4.7	<50	70,000
108	3.5	4.8	<50	80,000
108	7.5	4.6	<50	55,000
108	10.5	4.6	<50	75,000
109	6.5	4.8	<50	100,000
111	8.5	4.8	<50	50,000

TABLE A-3

PHYSICAL AND CHEMICAL PARAMETERS OF SELECTED SAMPLES FROM HAND-AUGER PROBES, SOLID WASTE DISPOSAL AREA

Parameter	Hand-Auger Probe 3	Hand-Auger Probe 6	Hand-Auger Probe 10
Moisture (% of dry wt)	24.8	20.6	23.3
Wet Unit Wt. (pcf)	122.6	134.7	123.7
Dry Unit Wt. (pcf)	98.2	111.7	100.3
Liquid Limit (%)	35	30	29
Plastic Limit (%)	25	24	21
Plasticity Index	10	6	8
Permeability (cm/sec)	5.2×10^{-7}	7.1×10^{-7}	2.6×10^{-7}
Water (paste) pH	4.3	4.3	5.6
SMP Buffer pH	5.9	6.5	6.9
Moisture (% of dry wt)	23.1	21.8	23.6
Organic Matter (% of dw)	0.5	0.3	0.4
Sulfate (% of dw)	0.30	0.06	0.09
Total Iron (% of dw)	3.13	2.39	2.39
Total Arsenic (% of dw)	0.0012	0.0013	0.0010
Total Barium (% of dw)	0.0040	0.0035	0.0044
Total Calcium (% of dw)	0.12	0.40	0.17
Total Chromium (% of dw)	0.0016	0.0014	0.0012
Total Lead (% of dw)	0.0015	0.0011	0.0014
Total Silver (% of dw)	0.00004	0.00002	0.00002
Total Mercury (% of dw)	0.000004	0.000004	0.000002
Total Selenium (% of dw)	<0.00002	<0.00002	<0.00002

NOTE: Analyses performed by Commonwealth Technology, Inc., Lexington, Kentucky

TABLE A-4

MINERALOGICAL ANALYSES
(SEMI-QUANTITATIVE)
SOLID WASTE DISPOSAL AREA

Mineral	Hand-Auger Probe		
	3	6	10
Kaolinite	>40%	>50%	>50%
Mica (Illite)	>30%	<10%	>20%
Montmorillonite	<10%	<20%	<10%
Hydroxy-Al Montmorillonite	<15%	<15%	>15%
Quartz	< 5%	< 5%	< 5%
Feldspar	--	< 1%	--

NOTE: Analyses performed by Commonwealth Technology, Inc., Lexington, Kentucky

TABLE A-5

CATION (SODIUM) EXCHANGE CAPACITY
SOLID WASTE DISPOSAL AREA

Parameter	Hand-Auger Probe		
	3	6	10
Exchangeable K (meq/100 gm)	0.30	0.20	0.02
Exchangeable Mg (meq/100 gm)	1.73	0.56	0.32
Exchangeable Ca (meq/100 gm)	7.63	4.55	8.77
Cation Exchange Capacity (meq/100 gm)	21	17	24
Base Saturation (%)	43	31	39

NOTE: Analyses performed by Commonwealth Technology, Inc., Lexington, Kentucky

BORING 101

SURFACE ELEVATION 396.3'
COORDINATES N14000, E4000

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SYMBOLS	DESCRIPTION
										P	T	0	CL	DARK BROWN SILTY CLAY WITH TRACE OF FINE SAND (VERY STIFF)
										P	U	5	CL	DARK BROWN SILTY CLAY WITH TRACE OF ORGANICS (HARD)
										22	S	10	CL	GRADING BROWN WITH TRACE OF FINE SAND
										P	T		SC	BROWN SILTY CLAYEY FINE SAND
	DS/Mg	2500 3500	1390 2050		103	22				P	U	15	SC	
G.S.				0.6						7	S	20	SP	BROWN FINE TO MEDIUM SAND WITH TRACE OF SILT AND CLAY (LOOSE)
										22/6"	T	25	SP	BROWN MEDIUM SAND WITH THIN LENSES OF CLAY WITH OCCASIONAL COARSE SAND AND FINE GRAVEL (LOOSE-MEDIUM DENSE)
G.S.	DS/Mg	3500 5000	2900 4400	3.8	109	14				11	U	30	SP	GRADING WITH COARSE SAND AND MEDIUM GRAVEL
										8	U	35	GC	BROWN FINE MEDIUM GRAVEL WITH CLAY
										7	S	40	GC	
G.S.				2.6						20	S	45	GP	BROWN AND GRAYISH FINE COARSE GRAVEL WITH SOME COARSE SAND (MEDIUM DENSE)
										25	S	50	GP	
										15	S	55	GP	(MEDIUM DENSE)
												60	GP	
												65	GP	
												70	GP	

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 101 (cont'd)

SURFACE ELEVATION 396.3'
COORDINATES N14000, E4000

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET
										29	S	70
G.S.				0.3						36	S	75
										101	S	80
										111	S	85
										32	S	90
										33	S	95
G.S.				1.3						79	S	100
												105
												110
												115
												120
												125
												130
												135
												140

SAMPLING

SYMBOLS

SP

LS

RQD = 59

DESCRIPTION

BROWN FINE TO MEDIUM SAND WITH TRACE OF CLAY (VERY DENSE)

GRADING WITH TRACE OF SILT. CLAY GRADING OUT

GRADING VERY DENSE

GRADING WITH TRACE OF COARSE SAND (MEDIUM DENSE)

GRADING DENSE

DARK GRAY LIMESTONE, FOSSILIFEROUS, WITH SHALE STREAKS AND PARTINGS - INCLINED BEDDING

THIN LIMESTONE LENSE

BORING TERMINATED AT A DEPTH OF 115.5 FEET ON 2/19/81
CASING USED TO DEPTH OF 100.0 FEET

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 102

SURFACE ELEVATION 396.1'
COORDINATES N11939, E4007

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										P	ST
										P	ST
										P	ST
										P	ST
										P	ST
										10	S
G.S.				3.3						5	S
										10	S
										16	S
										7	S
										10	S
										30	S
G.S.				0.7						14	S
										30	S

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70

SAMPLING

SYMBOLS	DESCRIPTION
CL/ML	BROWN SILTY CLAY TO CLAYEY SILT WITH ORGANICS (MEDIUM STIFF)
	BROWN SILTY CLAY, WITH ORGANICS, SMALL ROOT HOLES PRESENT (MEDIUM STIFF)
CL	
	BROWN SILTY CLAY TO CLAYEY SILT (MEDIUM STIFF/MEDIUM DENSE)
CL/ML	
	GRADES WITH POCKETS OF FINE SAND
	BROWN SILTY FINE TO MEDIUM FINE SAND WITH CLAY (LOOSE-MEDIUM DENSE)
SC	
SP	BROWN MEDIUM TO FINE SAND WITH LITTLE SILT (VERY LOOSE)
SC	BROWN CLAYEY SILTY FINE SAND (LOOSE-MEDIUM DENSE)
SP	BROWN MEDIUM SAND WITH TRACE SILT
SC	BROWN CLAYEY SILTY FINE SAND (MEDIUM DENSE)
SM	SILTY FINE TO COARSE SAND WITH SOME FINE GRAVELS
SP	LIGHT BROWN FINE COARSE SAND WITH OCCASIONAL FINE TO MEDIUM GRAVEL. TRACE OF SILT AND CLAY
SM	BROWN FINE TO MEDIUM SAND WITH TRACE OF SILT AND CLAY OCCASIONAL FINE GRAVEL (LOOSE-MEDIUM DENSE)
GP	BROWN AND GRAY FINE MEDIUM GRAVEL WITH SOME COARSE SAND
SM	BROWN SILTY FINE MEDIUM SAND (DENSE)
SP	FINE MEDIUM SAND WITH OCCASIONAL FINE MEDIUM (MEDIUM DENSE)
	GRADING DENSE

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 102 (cont'd)

SURFACE ELEVATION 396.1'
COORDINATES N11939, E4007

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										26	S
										30	S
										30	S
										13	S
G.S.				2.2						18	S
										31	S
										19	S
										44	S

DEPTH IN FEET: 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140

SAMPLING

SYMBOLS

SP

SP

LS

RQD = 25

DESCRIPTION

GRADING GRAY

GRADING COARSE GRAVEL

GRADING LIGHT BROWN

GRADING WITH SOME SILT AND CLAY FRACTION

BROWN MEDIUM SAND WITH TRACE SILT AND FINE GRAVEL (DENSE)

GRADING GRAY (VERY DENSE)

OLIVE GRAY LIMESTONE, FOSSILIFEROUS, WITH OLIVE GRAY SHALE STREAKS AND PARTINGS

BORING TERMINATED AT A DEPTH OF 120.2 FEET ON 2/20/81.
CASING USED TO A DEPTH OF 110.0 FEET.

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

FILE 10805-063-12, 5070

BORING 103

SURFACE ELEVATION 399.3'
COORDINATES N13000, E4700

OTHER TESTS	STRENGTH TEST RESULTS			% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			SAMPLING	
	TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)				LL (%)	PL (%)	PI (%)	BLOW COUNT	SAMPLE TYPE
										8	S
										P	ST
										10	S
										9	S
										P	ST
										6	S
										1	S
										3	S
										4	S
										22	S
										6	S

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70

SAMPLING

SYMBOLS	DESCRIPTION
ML	DARK GRAYISH BROWN CLAYEY SILT WITH TRACE OF ROOTS (MEDIUM STIFF)
	GRADES TO DARK YELLOWISH BROWN WITH MORE CLAY (STIFF)
SM/ML	YELLOWISH BROWN SILTY FINE SAND (LOOSE)
GW	GRAY AND BROWN FINE TO COARSE SAND AND GRAVEL WITH TRACE SILT (LOOSE)
SW/GW	BROWN AND GRAY FINE TO COARSE SAND WITH LITTLE TO SOME GRAVEL (VERY LOOSE)
	GRADING WITH LESS GRAVEL
	GRADES WITH MORE COARSE SAND
	GRADING WITH MORE GRAVEL (MEDIUM DENSE)
	GRADING WITH LESS GRAVEL (LOOSE)

BORING TERMINATED AT A DEPTH OF 49.5 FEET ON 12/22/80
WATER ENCOUNTERED AT A DEPTH OF 22.5 FEET ON 12/22/80.

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST - SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 104

SURFACE ELEVATION 421.5'
COORDINATES N13000, E4700

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										18	S
										6	U
										7	U
										13	S
										P	S
										34	S
										31	S
										32	S
										51	S
										56	S
										34	S
										65	S
										82	S

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70

SAMPLING

SYMBOLS — DESCRIPTION

CL — LIGHT BROWN SILTY CLAY WITH TRACE OF FINE SAND

SW — BROWN FINE TO COARSE SAND WITH SOME FINE GRAVEL AND TRACE OF SILT (VERY LOOSE)

MULTI-COLORED MEDIUM TO COARSE SAND WITH SOME FINE TO COARSE GRAVEL (MEDIUM DENSE)

GRADING WITH INCREASING MEDIUM COARSE SAND

GRADING WITH OCCASIONAL FINE GRAVEL (DENSE)

SP — GRADING WITH INCREASING COARSE SAND

GRADING WITH MEDIUM SAND (VERY DENSE)

GRADING WITH TRACE SILT

GRADING WITH MEDIUM TO COARSE SAND (DENSE)

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 104 (cont'd)

SURFACE ELEVATION 421.5'
COORDINATES N13000, E4700

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLING	SYMBOLS	DESCRIPTION
										25	S	70	■		BROWNISH GRAY SILTY FINE MEDIUM SAND (MEDIUM DENSE)
										34	S	75	■	SM	GRADES TO LIGHT BROWN WITH TRACE OF ORGANIC MATERIAL PRESENT (DENSE)
										53	S	80	□		
										9	S	85	■		GRAYISH BROWN SAND TO MEDIUM SAND WITH TRACE OF COARSE SAND (LOOSE)
										43	S	90	■		GRADING WITH TRACE OF SILT (DENSE)
										43	S	95	■		
												100			
												105			
										27	S	110	■	SP	GRADING WITH MEDIUM COARSE SAND (MEDIUM DENSE) GRADING DARK GRAY WITH FINE SAND AND SILT
												115			GRADING VERY DENSE
										53	S	120	□		
												125			
												130			
												135			
										-	S	140	■	SW	MULTI-COLORED MEDIUM TO COARSE SAND WITH FINE TO MEDIUM GRAVEL

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 104 (cont'd)

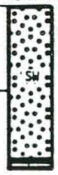
SURFACE ELEVATION 421.5'
COORDINATES N13000, E4700

OTHER TESTS	STRENGTH TEST RESULTS			% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			SAMPLING	
	TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)				LL (%)	PL (%)	PI (%)	BLOW COUNT	SAMPLE TYPE

DEPTH IN FEET: 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, 200, 205, 210

SAMPLING

SYMBOLS | DESCRIPTION



BEDROCK

BORING TERMINATED AT A DEPTH OF 149.5 FEET ON 2/21/81
CASING USED TO A DEPTH OF 135.0 FEET
STANDPIPE PIEZOMETER SCREENED FROM 55 TO 60 FEET
WATER LEVEL MEASURED AT A DEPTH OF 37.1 FEET ON 2/26/81.

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

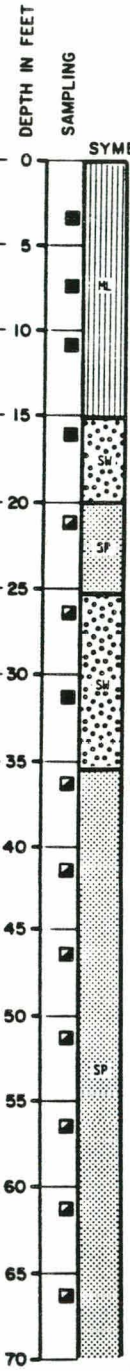
LOG OF BORING

DAMES & MOORE

BORING 105

SURFACE ELEVATION 420.1'
COORDINATES N11000, E6000

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										P	U
pH RES SULF										P	U
pH RES SULF	TX/UU	1350	3130		98	25				P	U
										P	U
										7	S
										5	S
G.S.				6.6						9	S
										8	S
										15	S
										19	S
										39	S
										24	S
G.S.				0.3						26	S
										15	S



SYMBOLS	DESCRIPTION
ML	BROWN CLAYEY SILT WITH TRACE OF FINE SAND
SW	DARK BROWN SILTY FINE TO COARSE SAND WITH OCCASIONAL FINE GRAVEL (VERY LOOSE)
SP	DARK BROWN AND GRAY MEDIUM COARSE SAND WITH OCCASIONAL FINE TO MEDIUM GRAVEL. TRACE OF FINE SAND AND SILT (VERY LOOSE)
SW	DARK GRAY FINE MEDIUM SAND WITH SOME COARSE SAND OCCASIONAL FINE TO MEDIUM GRAVEL (LOOSE)
SP	GRADING BROWN (MEDIUM DENSE)
	GRADING WITH MEDIUM TO COARSE SAND (DENSE)
	GRADING GRAY AND BROWN (MEDIUM DENSE)

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 105 (cont'd)

SURFACE ELEVATION 420.1'
COORDINATES N11000, E6000

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLING	SYMBOLS	DESCRIPTION
										26	S	70	◪		GRADING TO DARK BROWN MEDIUM SAND
										16	S	75	◪		GRADING WITH FINE SAND AND TRACE OF SILT
										28	S	80	◪		
												85			
G. S.				0.7						40	S	90	◪		GRADING WITH MEDIUM SAND (DENSE)
												95		SP	
										36	S	100	◪		
												105			
										41	S	110	◪		GRADING WITH FINE TO MEDIUM SAND
												115			
												120			
												125			
												130			BROWN MEDIUM SAND WITH FINE GRAVEL
												135		SP	
												140			

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

FILE 10805-063-12, 5070

BORING 105 (cont'd)

SURFACE ELEVATION 420.1'
COORDINATES N11000, E6000

OTHER TESTS	STRENGTH TEST RESULTS			% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			SAMPLING		DEPTH IN FEET	SAMPLING	SYMBOLS	DESCRIPTION
	TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)				LL (%)	PL (%)	PI (%)	BLOW COUNT	SAMPLE TYPE				
												140		SP	
												145		LS	BEDROCK
												150			
												155			
												160			
												165			
												170			
												175			
												180			
												185			
												190			
												195			
												200			
												205			
												210			

BORING TERMINATED AT A DEPTH OF 148 FEET ON 2/25/81
CASING USED TO A DEPTH OF 111.0 FEET
STANDPIPE PIEZOMETER SCREENED FROM 45 TO 50 FEET.
WATER LEVEL MEASURED AT A DEPTH OF 34.0 FEET ON 2/26/81

KEY

- INDICATES UNDISTURBED SAMPLE
- INDICATES DISTURBED SAMPLE
- INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

U - DAMES & MOORE "U" BIT
T - DAMES & MOORE THIN-WALL
P - DAMES & MOORE PISTON
S - STANDARD SPLIT-SPOON
ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

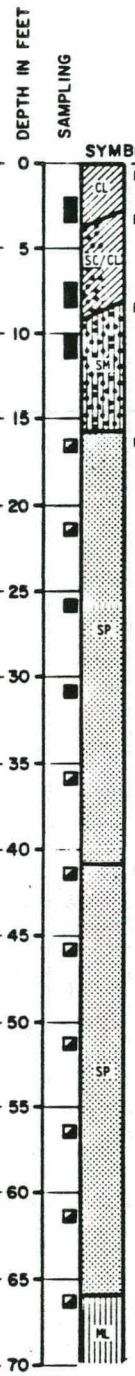
LOG OF BORING

DAMES & MOORE

BORING 106

SURFACE ELEVATION 414.5'
COORDINATES N 7319, E6877

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										P	ST
										P	ST
										P	ST
										8	S
G.S.				0.6						32	S
										U	P
										U	P
										13	S
G.S.				0.7						8	S
										15	S
										18	S
										19	S
G.S.				0.2						28	S
										11	S



DESCRIPTION

BROWN FINE SANDY SILTY CLAY (MEDIUM STIFF)

BROWN VERY CLAYEY FINE TO MEDIUM SAND TO SANDY CLAY (MEDIUM STIFF)

BROWN SILTY FINE TO MEDIUM SAND (MEDIUM DENSE)

GRADES MEDIUM TO COARSE, WITH LESS FINES

BROWN MEDIUM COARSE SAND TRACE OF FINE GRAVEL (LOOSE)

GRADING WITH SOME FINE SAND AND INCREASING GRAVEL (DENSE)

BROWN FINE TO MEDIUM SAND (LOOSE)

GRADING WITH TRACE OF COARSE SAND (MEDIUM DENSE)

GRADING DARK BROWN

GRADING WITH INCREASING MEDIUM SAND OCCASIONAL COARSE SAND

LIGHT BROWN CLAYEY FINE SANDY SILT (STIFF)

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

FILE 10805-063-12, 5070

BORING 106 (cont'd)

SURFACE ELEVATION 414.5'
COORDINATES N7319, E6877

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET
										23	U	70
										25	S	75
G.S.				1.7						30	S	80
										86	S	85
										64	S	90
										66	S	95
										94	S	100
										46	S	105
												110
												115
												120
												125
												130
												135
												140

SAMPLING

SYMBOLS DESCRIPTION

ML

BROWN FINE MEDIUM SAND WITH TRACE OF COARSE SAND (MEDIUM DENSE)

SP

GRADING DARK BROWN

DARK BROWN SILTY FINE MEDIUM SAND (VERY DENSE)

SM

BEDROCK

BORING TERMINATED AT A DEPTH OF 127.0 FEET ON 2/24/81
CASING USED TO A DEPTH OF 110.5 FEET
STANDPIPE PIEZOMETER SCREENED FROM 45 TO 50 FEET
WATER LEVEL MEASURED AT A DEPTH OF 29.8 FEET ON 2/26/81

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 107

SURFACE ELEVATION 417.1'
COORDINATES N12800, E7100

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SYMBOLS	DESCRIPTION
												0	ML	BROWN SILTY CLAY WITH SOME FINE SAND AND ORGANICS PRESENT
	TX/UU	3000	3230		105	21				27	T		CL	BROWN SILTY CLAY WITH TRACE OF FINE SAND (VERY STIFF)
	TX/UU	1000	1580		98	15				22	U	5	ML	BROWN FINE SANDY SILT (MEDIUM DENSE)
														GRADING WITH FINE MEDIUM GRAVEL
CONSOL					94	29				21	T	10	SP	BROWN FINE MEDIUM SAND WITH FINE MEDIUM GRAVEL (LOOSE-MEDIUM DENSE)
														GRADING WITH INCREASING GRAVEL AND SOME CLAY (DENSE)
										37	S	15		
										30	U	20	SP	BROWN MEDIUM TO COARSE SAND WITH SOME FINE GRAVEL AND SILT (MEDIUM DENSE)
G.S.				6.1						65	U	25	SP	BROWN AND GRAY MEDIUM COARSE SAND WITH TRACE OF FINE GRAVEL (DENSE)
										31	S	30		
														GRADING WITH INCREASING FINE MEDIUM GRAVEL
G.S.	DS/Mg	4000 6000	4070 5620	3.9	116	15				39	S	35	SP	
										33	U	40		
G.S.	DS/Mg	5000 7000	5320 6800	4.3	117	10				88	U	45		
										42	S	50		GRADING VERY DENSE
										26	U	55	SM	LIGHT BROWN SILTY VERY FINE SAND (MEDIUM DENSE)
										20	S	60		MEDIUM DENSE
G.S.	DS/Mg	6000 8000	5160 6440	4.6	103	21				56	U	65	SP	BROWN AND GRAY FINE TO MEDIUM SAND WITH SOME SILT AND TRACE OF CLAY (DENSE)
												70		

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

FILE 10805-063-12, 5070

BORING 107 (cont'd)

SURFACE ELEVATION 417.1'
COORDINATES N12800, E7100

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLING	SYMBOLS	DESCRIPTION
										39	U	70	■		
												75			
										26	S		◪		
										P	S	80	◪		
										32	S	85	◪		GRADING WITH INCREASING MEDIUM SAND
														SP	
												90			
										84	U	95	□		
G.S.	DS/Mg	8000 10000	6670 7870	4.9	107	18				89	U	100	■		
												105			
										83	S	110	◪		BROWN SANDY CLAY FINE MEDIUM GRAVEL (VERY DENSE)
														GC	
												115			
										105	S	120	◪		BROWN FINE MEDIUM SAND WITH TRACE OF FINE GRAVEL (VERY DENSE)
												125			
										45		130	□	SP	GRADING DENSE
												135			
															GRADING TO BROWN AND GRAY MEDIUM COARSE SAND WITH INCREASING GRAVEL
										38	S	140	◪		

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 107 (cont'd)

SURFACE ELEVATION 417.1'
COORDINATES N12800, E7100

OTHER TESTS	STRENGTH TEST RESULTS			% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			SAMPLING	
	TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)				LL (%)	PL (%)	PI (%)	BLOW COUNT	SAMPLE TYPE

DEPTH IN FEET: 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, 200, 205, 210

SAMPLING: RQD = 0

SYMBOLS	DESCRIPTION
SP SS	LIGHT GRAY TO RUST SANDSTONE, HIGHLY FRACTURED

BORING TERMINATED AT A DEPTH OF 145.0 FEET ON 2/20/81
CASING USED TO A DEPTH OF 110.0 FEET
STANDPIPE PIEZOMETER SCREENED FROM 45 TO 50 FEET
WATER LEVEL MEASURED AT A DEPTH OF 32.3 FEET ON 2/26/81

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

FILE 10805-063-12, 5070

BORING 108

SURFACE ELEVATION 418.0'
COORDINATES N11000, E8000

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SYMBOLS	DESCRIPTION
												0		YELLOWISH BROWN CLAYEY SILT WITH TRACE VERY FINE SAND (STIFF)
pH RES SULF										13	S		ML	
	TX/UU	2000	2770		102	22				14/6"	T	5		
pH RES SULF										14	S			GRADING WITH MORE FINE SAND
												10		LIGHT BROWN FINE SANDY SILT WITH TRACE OF CLAY (LOOSE)
pH RES SULF										10	S		ML	
												15		
										35	S			LIGHT BROWN MEDIUM TO COARSE SAND WITH SOME FINE GRAVEL (DENSE)
													SW	GRADING WITH SOME SILT AND CLAY
G.S.				8.0						22	S	20		BROWN AND GRAY COARSE SAND WITH SOME FINE GRAVEL (DENSE)
												25		
										49	U		SP	
												30		
										26	S			LIGHT BROWN FINE TO MEDIUM SAND WITH TRACE OF SILT (MEDIUM DENSE)
												35		
	TX/UU	4800	1590		99	26								GRADES WITH SILT AND CLAY LENSES
												40	SP	
												45		
G.S.				4.2						24	S	50		BROWN FINE SILTY SAND TO SANDY SILT WITH TRACE OF CLAY
												55		
										64	S			GRADING GRAY
										-	S	60	SM/ML	
										36	S	65		
	TX/CU/PP	6500	3400		103	22				P		70		

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST - SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 108 (cont'd)

SURFACE ELEVATION 418.0'
COORDINATES N11000, E8000

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										P	
										24	S
										47	S
										64	S
G.S.				2.5						100/2"	S
										61	S
										31	S
G.S.				0.5						33	S

DEPTH IN FEET: 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140

SAMPLING

SYMBOLS

DESCRIPTION

BROWN SILTY FINE SANDY CLAY

BROWN AND GRAY FINE TO COARSE SAND WITH SOME FINE GRAVEL (VERY DENSE)

BROWN MEDIUM SAND WITH TRACE OF COARSE SAND AND FINE MEDIUM GRAVEL (VERY DENSE)

GRADING DENSE

BEDROCK

BORING TERMINATED AT A DEPTH OF 118.0 FEET ON 2/5/81
CASING USED TO A DEPTH OF 99.0 FEET
STANDPIPE PIEZOMETER SCREENED FROM 84.5 TO 89.5 FEET
WATER LEVEL MEASURED AT A DEPTH OF 33.3 FEET ON 2/26/81

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 109

SURFACE ELEVATION 423.7'

COORDINATES N9101, E8041

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SYMBOLS	DESCRIPTION
										14/6"	T	0	ML	DARK YELLOWISH BROWN CLAYEY SILT AND SOME VERY FINE SAND WITH OCCASIONAL MOTTLING OF BLACK ORGANIC MATTER (STIFF)
CONSOL pH RES SULF					99	26	29	26	3	31	U	5		GRADING VERY STIFF
										9	S	10	ML	DARK YELLOWISH BROWN SILT AND VERY FINE SAND (MEDIUM STIFF)
	TX/UU	2000	1640		97	25				9/6"	T	15		
G.S.				4.4						9	U	20	SP	BROWN FINE TO COARSE SAND WITH SOME GRAVEL AND TRACE OF SILT (VERY LOOSE)
										34	S	25	GM	LIGHT BROWN MEDIUM TO COARSE SAND AND SOME FINE TO COARSE GRAVEL (DENSE)
										27/6"	T	30	SP	LIGHT BROWN FINE TO MEDIUM SAND (LOOSE)
										46	U	35	SP/GP	BROWN FINE TO COARSE SAND AND GRAVEL (MEDIUM DENSE)
										20	S	40	CH	BROWN CLAY WITH OCCASIONAL VERY THIN SEAMS OF YELLOWISH BROWN SILTY CLAY (STIFF)
										19/6"	T	45	ML SP	LIGHT YELLOWISH BROWN SILT AND VERY FINE SAND YELLOWISH BROWN FINE TO MEDIUM SAND WITH TRACE COARSE SAND AND FINE GRAVEL (LOOSE)
										15	U	50	SM	DARK GRAY SILTY FINE TO MEDIUM SAND, TRACE COARSE SAND WITH SOME FINE GRAVEL (LOOSE)
										16	U	55	CL	LIGHT BROWN SILTY CLAY (STIFF)
										7	S	60	ML	LIGHT BROWN CLAYEY SILT (MEDIUM STIFF)
													ML	BROWN FINE SANDY SILT (STIFF)
										30	T	65		GRADING WITH SOME CLAY
												70	ML	DARK GRAY FINE SANDY SILT WITH TRACE OF CLAY (STIFF)

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:

THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 109 (cont'd)

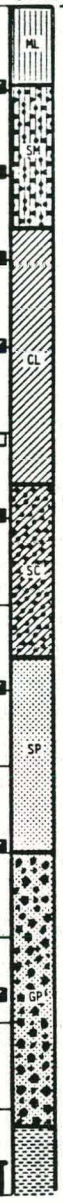
SURFACE ELEVATION 423.7'
COORDINATES N9101, E8041

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										16	S
										33	T
										73	U
										21	S
										75	U
	TX/UU	9000	8500		114	17				50	T
										42	S
										57	S
										207	S
										25	S

DEPTH IN FEET: 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140

SAMPLING

SYMBOLS



DESCRIPTION

DARK GRAY SILTY FINE SAND (MEDIUM DENSE)

GRAY SILTY CLAY (HARD)

GRADES WITH MOTTLED BROWN SILTY CLAY (STIFF)

OLIVE BROWN CLAYEY FINE SAND

LIGHT BROWN FINE SAND WITH TRACE SILT (DENSE)

GRADES TO BROWNISH GRAY

GRAY SANDY FINE GRAVEL WITH SOME COARSE SAND (VERY DENSE)

DARK GRAY SHALE, VERY FISSILE, WITH OLIVE GRAY SILTY ZONES AND RED STRIATIONS

(CONTINUED ON NEXT PAGE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 109 (cont'd)

SURFACE ELEVATION 423.7'
COORDINATES N9101, E8041

OTHER TESTS	STRENGTH TEST RESULTS			% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			SAMPLING	
	TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)				LL (%)	PL (%)	PI (%)	BLOW COUNT	SAMPLE TYPE

DEPTH IN FEET: 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, 200, 205, 210

SAMPLING: RQD = 8

SYMBOLS | DESCRIPTION

BORING TERMINATED AT A DEPTH OF 147.0 FEET ON 1/28/81
CASING USED TO A DEPTH OF 118.0 FEET
STANDPIPE PIEZOMETER SCREENED FROM 100 TO 105 FEET
WATER LEVEL MEASURED AT A DEPTH OF 40.5 FEET ON 2/20/81

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

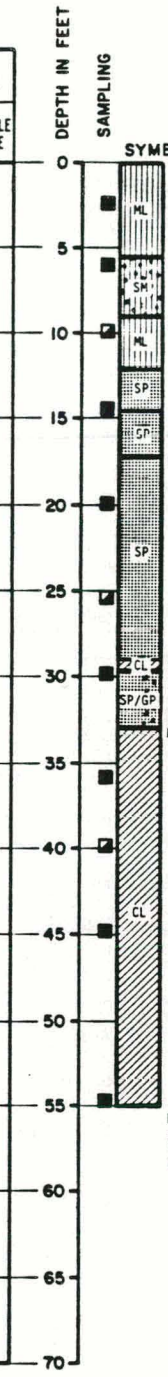
DAMES & MOORE

BORING 110

SURFACE ELEVATION 426.8'

COORDINATES N10500, E9500

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										37	T
										20	U
										11	S
G.S.	TX/UU	1900	2400	7.5	88	8				14/6"	T
G.S.	TX/UU	2600	3740	5.1	116	12				49	U
										41	S
										23/6"	T
CONSOL					91	32	44	24	20	17	U
										15	S
	TX/UU	4000	1960		101	23				18/6"	T
										78	U



SYMBOLS DESCRIPTION

- YELLOWISH BROWN SILT AND VERY FINE SAND MOTTLED WITH BLACK ORGANIC MATTER (VERY STIFF)
- YELLOWISH BROWN SILTY FINE SAND (LOOSE)
- LIGHT BROWN CLAYEY SILT WITH SOME VERY FINE SAND (STIFF)
- LIGHT BROWN FINE TO COARSE SAND (MEDIUM DENSE)
- LIGHT BROWN FINE SAND WITH LITTLE MEDIUM TO COARSE SAND (MEDIUM DENSE)
- LIGHT BROWN FINE TO COARSE SAND WITH SOME GRAVEL (MEDIUM DENSE)
- GRADES WITH LESS GRAVEL AND MORE FINE TO COARSE SAND (DENSE)
- DARK GRAY SILTY CLAY
- YELLOWISH BROWN FINE TO COARSE SAND AND GRAVEL WITH TRACE OF SILT
- REDDISH YELLOW AND DARK GRAY SILTY CLAY (STIFF)
- GRADING TO DARK GRAY
- GRADES WITH THIN SEAMS OF DARK GRAY VERY FINE SAND

BORING TERMINATED AT A DEPTH OF 55.0 FEET ON 1/20/81

STANDPIPE PIEZOMETER SCREENED FROM 25 TO 30 FEET

WATER LEVEL MEASURED AT A DEPTH OF 28.3 FEET ON 2/26/81

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:

THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 111

SURFACE ELEVATION 419.5'
COORDINATES N11496, E9901

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SYMBOLS	DESCRIPTION
										7	S	0	ML	YELLOWISH BROWN FINE SANDY SILT WITH TRACE ROOTS AND WOOD PIECES (MEDIUM STIFF)
										P	S			
												5		
pH RES SULF										8	S			
												10		
										11	S		SW	BROWN AND GRAY FINE TO MEDIUM SAND WITH LITTLE FINE TO COARSE GRAVEL (LOOSE)
												15		
										P	S			
												20		
										6	S			
												25		
										14	S			GRAYISH BROWN CLAYEY SAND (LOOSE)
												30		
												35		
										21	S		CL	GRADES TO DARK GRAY (VERY STIFF)
CONSOL					102	25	29	22	7	79	T	40		
										58	U	45		GRADES TO DARK GRAY SILTY CLAY
												50		DARK GRAY LAMINATED SILTY CLAY AND CLAYEY SILT (VERY STIFF)
										29	S			GRADES WITH LESS SILT
										77	U	55		
	TX/UU	6000	3080		104	22				41	T	60	CL/ML	
										13	S	65		GRADES WITH OCCASIONAL SMALL POCKETS OF DARK GRAY SILT (STIFF)
												70		

(CONTINUED ON FOLLOWING PLATE)

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

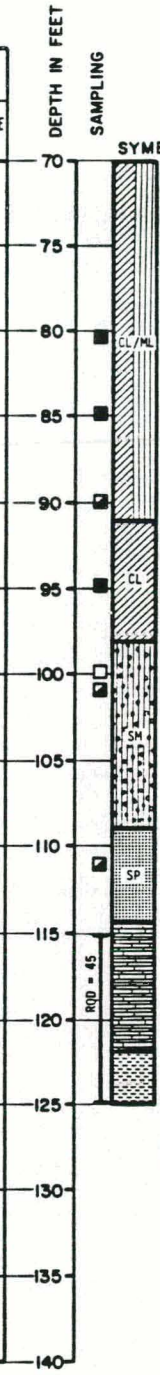
DAMES & MOORE

BORING 111 (cont'd)

SURFACE ELEVATION 419.5'

COORDINATES N11496, E9901

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
	TX/UU	7500	3140		100	24				62	T
										96	U
										34	S
										25/6"	T
										100/4"	U
										94	S
										56	S



SYMBOLS DESCRIPTION

GRADES TO MEDIUM STIFF

DARK GRAY SILTY CLAY WITH THIN LAYERS OF YELLOWISH BROWN VERY FINE SAND (STIFF)

DARK GRAY SILTY FINE TO MEDIUM SAND WITH TRACE FINE GRAVEL (VERY DENSE)

YELLOWISH BROWN FINE TO VERY FINE SAND WITH TRACE OF SILT (VERY DENSE)

GRAY LIMESTONE, FOSSILIFEROUS

OLIVE GRAY SILTSTONE WITH SHALE PARTINGS

BORING TERMINATED AT A DEPTH OF 125.0 FEET ON 1/15/81

STANDPIPE PIEZOMETER SCREENED FROM 109-114 FEET

WATER LEVEL MEASURED AT A DEPTH OF 34.3 FEET ON 2/28/81

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:

THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

LOG OF BORINGS

BORROW AREA

BORING: 201

COORDINATES: N13,000 E9300

ELEVATION: 430.1'

DEPTH (FEET)	SAMPLE	SOIL TYPE	DESCRIPTION
0-10		ML	BROWN CLAYEY SILT WITH VERY FINE SAND
	1		
10-40		SM	BROWN SILTY FINE SAND WITH MEDIUM TO COARSE SAND
	2		
	3		GRADES WITH LESS FINES
	4		

AUGER BORING COMPLETED AT 40' ON 12/20/80
GROUND WATER NOT ENCOUNTERED

BORING: 202

COORDINATES: N13,000 E10,760

ELEVATION: 422.5'

DEPTH (FEET)	SAMPLE	SOIL TYPE	DESCRIPTION
0-7		CL	BROWN SILTY CLAY
		SM	BROWN SILTY FINE SAND WITH SOME MEDIUM TO COARSE SAND, TRACE FINE GRAVEL
	1		
	2		
	3	CL	DARK GRAY SILTY CLAY WITH POCKETS OF FINE SAND
			GRADES WITH LESS FINES
	4		
	5		GRADES WITH MORE CLAY

AUGER BORING COMPLETED AT 40' ON 12/21/80
GROUND WATER ENCOUNTERED AT 16'

LOG OF BORINGS

BORROW AREA

BORING: 203

COORDINATES: N12,082 E10,996

ELEVATION: 416.3'

DEPTH (FEET)	SAMPLE	SOIL TYPE	DESCRIPTION
0-40'		CL	BROWN SILTY CLAY
	1		
	2		
	3		
			COLORS DARK GRAY
	4		

AUGER BORING COMPLETED AT 40' ON 12/21/80
GROUND WATER NOT ENCOUNTERED

BORING: 204

COORDINATES: N10,000 E11,500

ELEVATION: 426.6'

DEPTH (FEET)	SAMPLE	SOIL TYPE	DESCRIPTION
0-40	1	CL	BROWN SILTY CLAY
	2		COLORS GRAY WITH TRACE TO LITTLE FINE SAND
	3		
	4		

AUGER BORING COMPLETED AT 40' ON 12/21/80
GROUND WATER ENCOUNTERED AT 13', STABILIZED AT 3'

DAMES & MOORE

LOG OF BORINGS

BORROW AREA

BORING: 205

COORDINATES: N13,000 E12,000

ELEVATION: 429.1'

DEPTH (FEET)	SAMPLE	SOIL TYPE	DESCRIPTION
0-40		CL/ML	BROWN SILTY CLAY TO CLAYEY SILT
	1		
	2		GRADES WITH FINE SAND
	3		
	4		

AUGER BORING COMPLETED AT 40' ON 12/20/80
GROUNDWATER ENCOUNTERED AT 28'

BORING: 206

COORDINATES: N 11,092 E12,325

ELEVATION: 476.1'

DEPTH (FEET)	SAMPLE	SOIL TYPE	DESCRIPTION
0-7	1	CL	BROWN SILTY CLAY

AUGER BORING COMPLETED AT 7' ON 12/21/80
BEDROCK AT 7'
GROUND WATER NOT ENCOUNTERED

DAMES & MOORE

PLATE A-1N

LOG OF BORINGS

BORROW AREA

BORING: 207

COORDINATES: N10,000 E12,500

ELEVATION: 444.0'

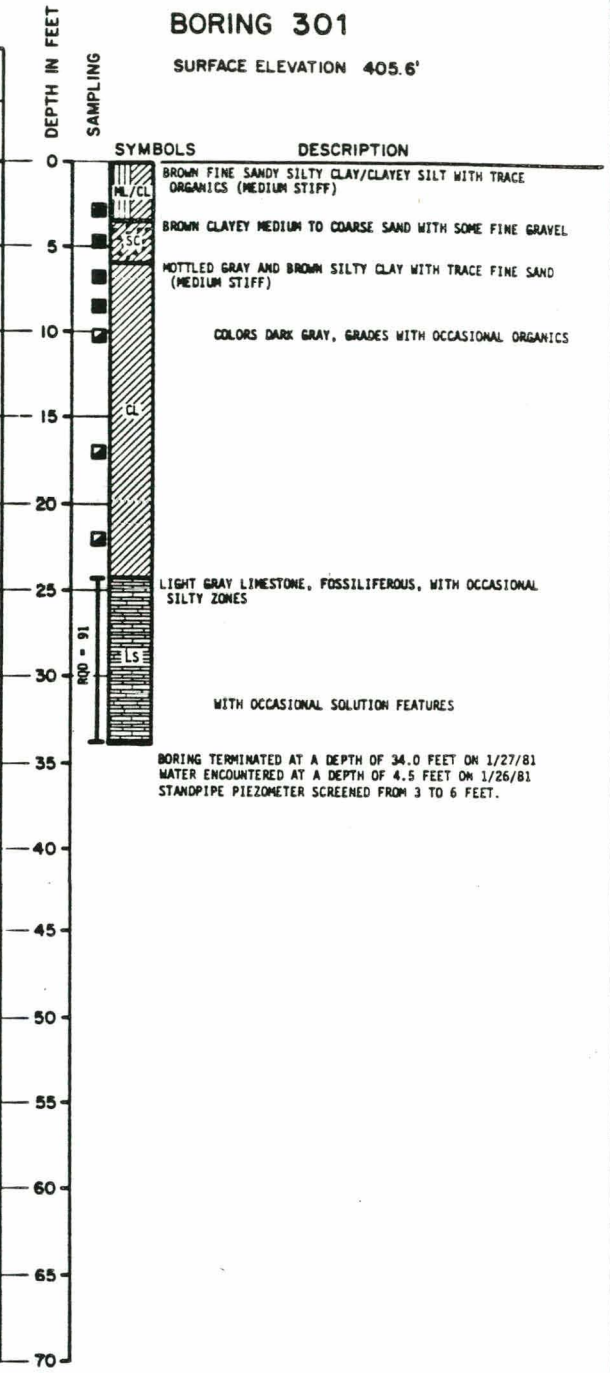
DEPTH (FEET)	SAMPLE	SOIL TYPE	DESCRIPTION
0-23		CL	BROWN SILTY CLAY
	1		

AUGER BORING COMPLETED AT 23' ON 12/21/80
BEDROCK AT 23'
GROUNDWATER NOT ENCOUNTERED

BORING 301

SURFACE ELEVATION 405.6'

OTHER TESTS	STRENGTH TEST RESULTS			% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			SAMPLING	
	TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)				LL (%)	PL (%)	PI (%)	BLOW COUNT	SAMPLE TYPE
PERM $k=1x10^{-7}$ cm/sec					99	24				P	T
										P	T
PERM $k=4x10^{-6}$ cm/sec					95	29	45	21	24	P	T
PERM $k=5x10^{-8}$ cm/sec					97	23	39	18	21	P	T
										-	S
										-	S
										-	S



KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:

THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 302

SURFACE ELEVATION 417.5'

OTHER TESTS	STRENGTH TEST RESULTS: TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)	% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LL (%)	PL (%)	PI (%)	SAMPLING: BLOW COUNT	SAMPLE TYPE
										P	T
PERM					101	24	31	19	12	40	T
k=5x10^{-8}cm/sec										18/6" -	U S
										-	S
										-	S
										-	S
										-	S
										-	S

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70

SAMPLING

SYMBOLS	DESCRIPTION
	BROWN FINE SANDY SILTY WITH TRACE BLACK ORGANIC MATTER (MEDIUM DENSE)
	GRADES WITH ZONE OF FINE GRAVEL AND CEMENTED NODULES
	GRAVEL GRADES OUT
	BROWN TO GRAY SILTY CLAY/CLAYEY SILT WITH SOME FINE SAND
	GRAY SILTY FINE SAND WITH SOME FINE GRAVEL
	GRAY FINE SANDY CLAY WITH SOME GRAVEL (VERY STIFF)
	GRADES WITH INCREASING FINE GRAVEL
	LIGHT GRAY LIMESTONE
	WITH SOLUTION FEATURES
	WITH LARGE CALCITE VEINS (UP TO 1 INCH)

BORING TERMINATED AT A DEPTH OF 40.3 FEET ON 1/28/81
WATER ENCOUNTERED AT A DEPTH OF 15.5 FEET ON 1/27/81
STANDPIPE PIEZOMETER SCREENED FROM 14 TO 19 FEET.

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUN

NOTE:
THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

BORING 303

SURFACE ELEVATION 398.0'

OTHER TESTS	STRENGTH TEST RESULTS			% PASSING NO 200 SIEVE	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			SAMPLING	
	TYPE OF TEST	CONFINING PRESSURE (psf)	PEAK SHEAR STRENGTH (psf)				LL (%)	PL (%)	PI (%)	BLOW COUNT	SAMPLE TYPE
PERM $k=9x10^{-8}$cm/sec				100	24		31	19	12	P P	U T
PERM $k=9x10^{-8}$cm/sec				93	29		29	19	10	P	T
										11	S
										8	S
										9	S
										40/4"	S

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70

SAMPLING

SYMBOLS

DESCRIPTION

BROWN CLAYEY SILT WITH TRACE VERY FINE SAND AND TRACE BLACK ORGANIC MATTER (MEDIUM DENSE)

GRADING WITH MORE CLAY

BROWN VERY CLAYEY COARSE TO FINE SAND WITH A THIN LAYER OF CLAYEY SILT/SILTY CLAY

GRADES WITH SOME FINE GRAVEL

WITH A 1 FOOT LAYER OF GRAY CLAY AT 10.5 FEET

DARK GRAY SOFT SHALE WITH OCCASIONAL CLAY ZONES

LIGHT GRAY LIMESTONE, FOSSILIFEROUS, WITH OCCASIONAL SILTY ZONES

WITH OCCASIONAL VERTICAL FRACTURES

WATER UNDER ARTESIAN CONDITIONS

BORING TERMINATED AT A DEPTH OF 36.0 FEET ON 1/28/81
WATER ENCOUNTERED AT A DEPTH OF 4.5 FEET ON 1/28/81
STANDPIPE PIEZOMETER SCREENED FROM 4 TO 9 FEET.

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- S - STANDARD SPLIT-SPOON
- ST-SHELBY TUBE

NOTE:

THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.

LOG OF BORING

DAMES & MOORE

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

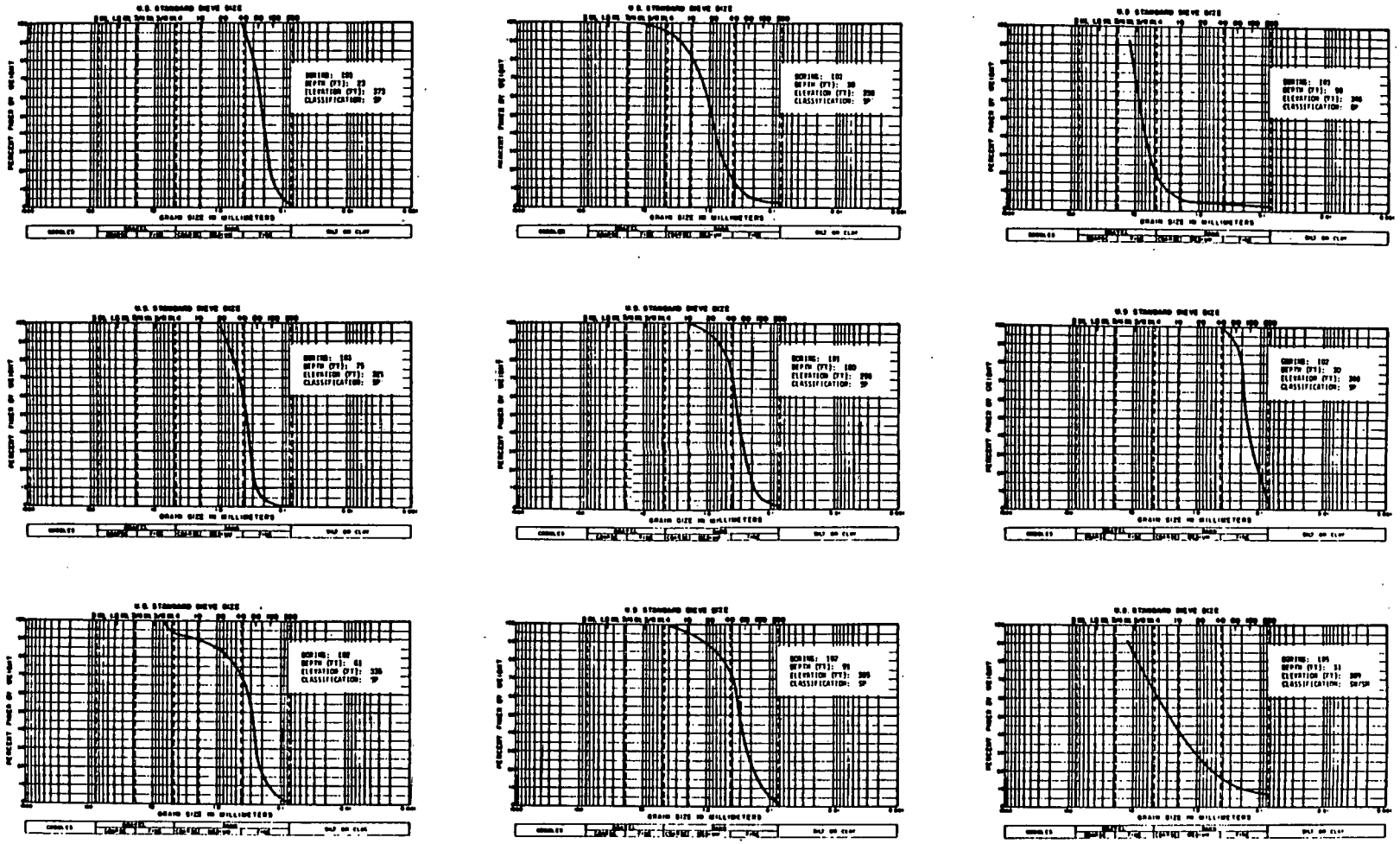
NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

FORM NO. 467.3 (4-78)

DAMES & MOORE

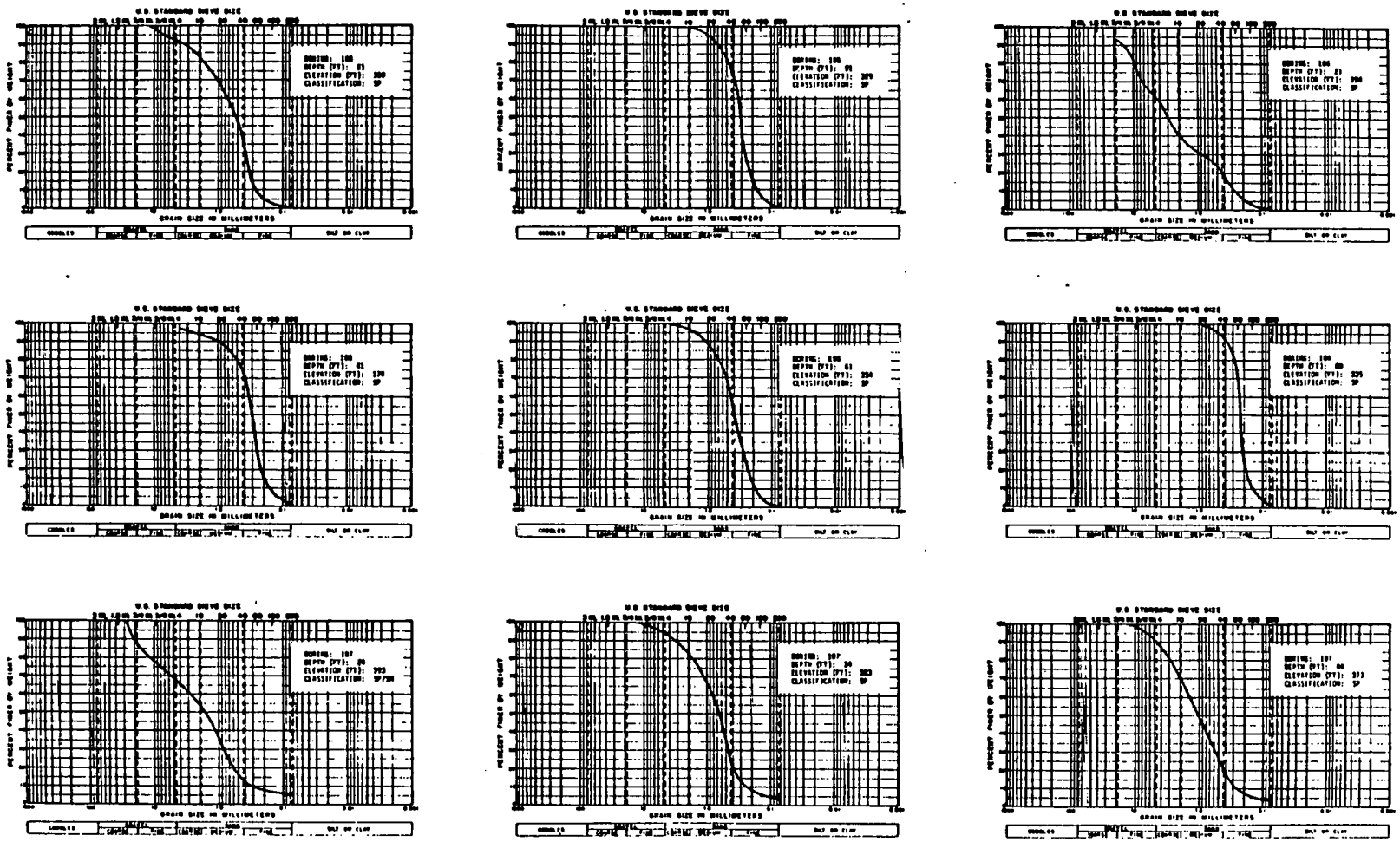
PLATE A-2



GRADATION CURVES

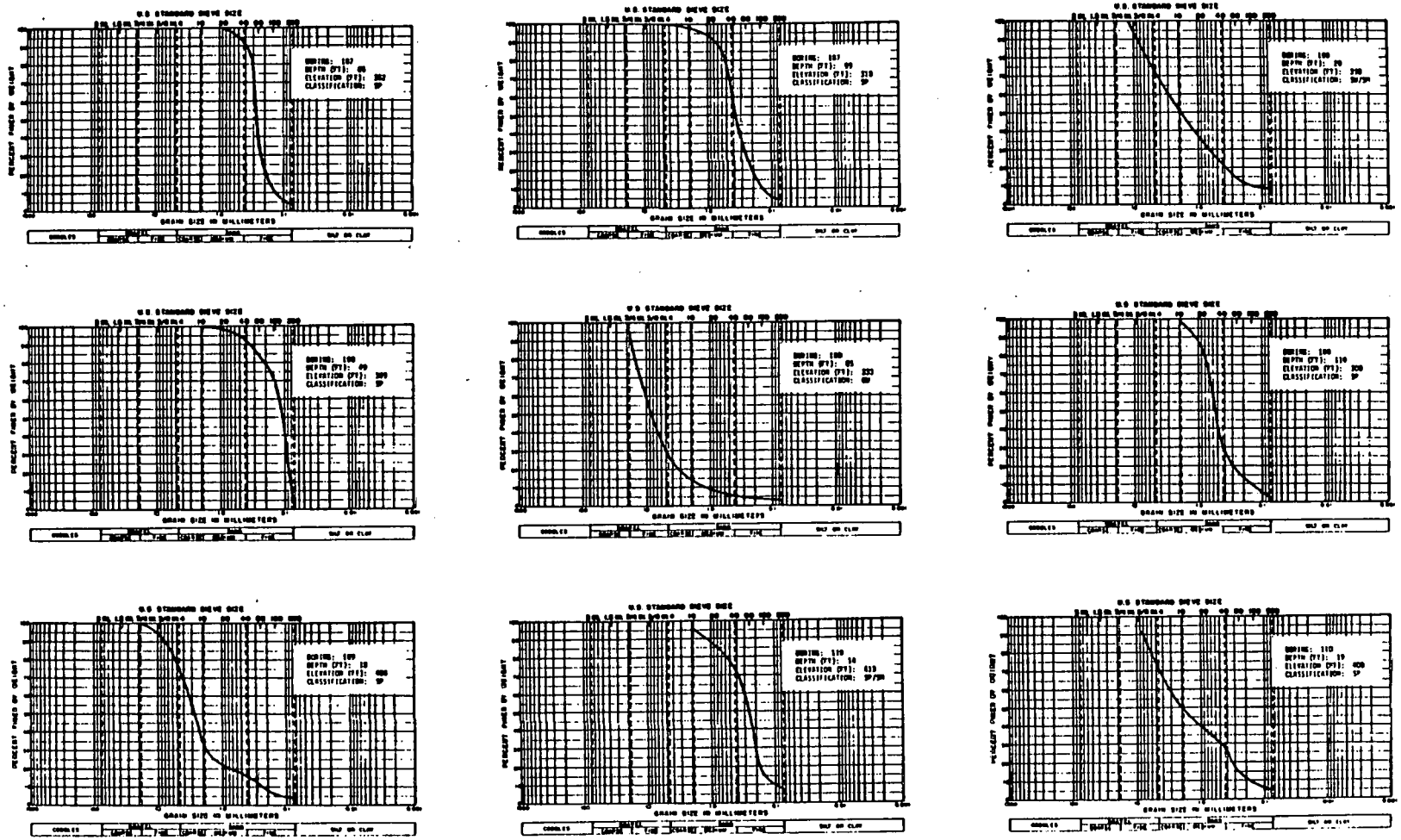
DAMES & MOORE

PLATE A-3A



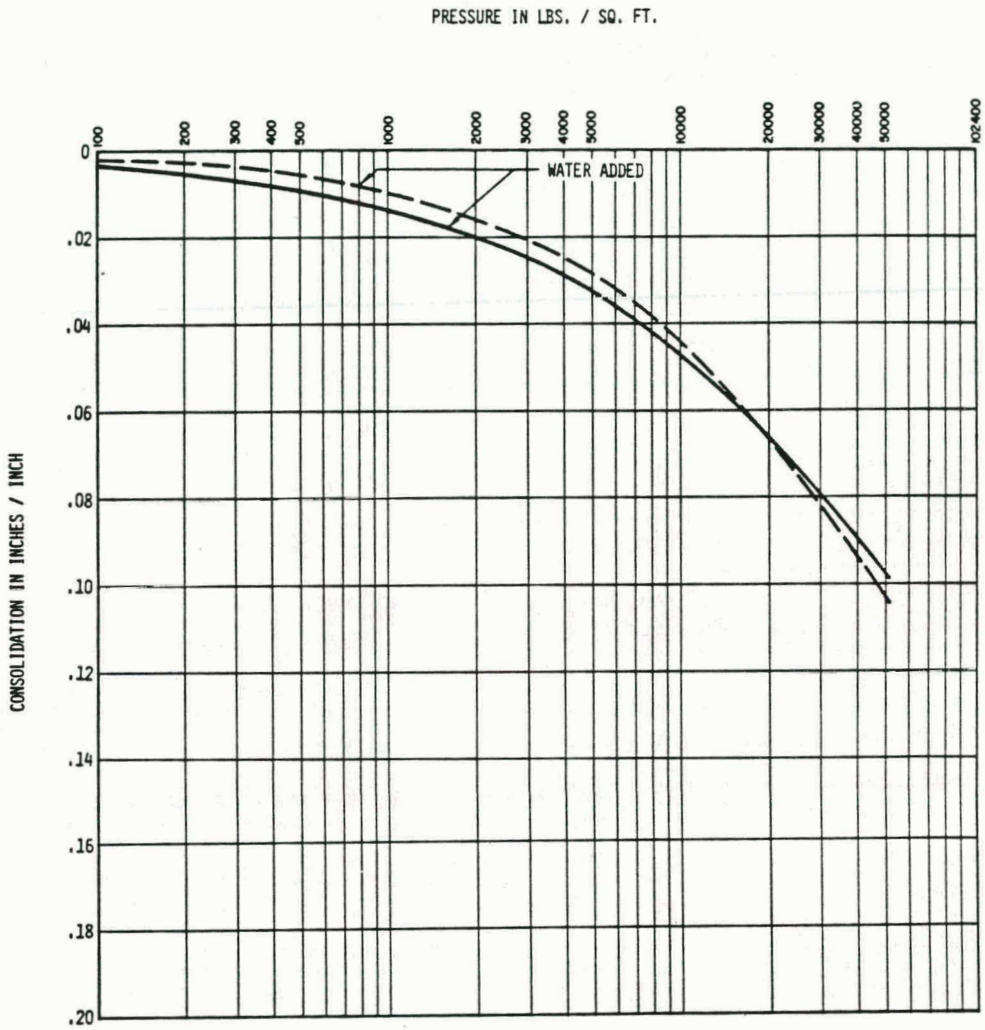
GRADATION CURVES

DAMES & MOORE



GRADATION CURVES

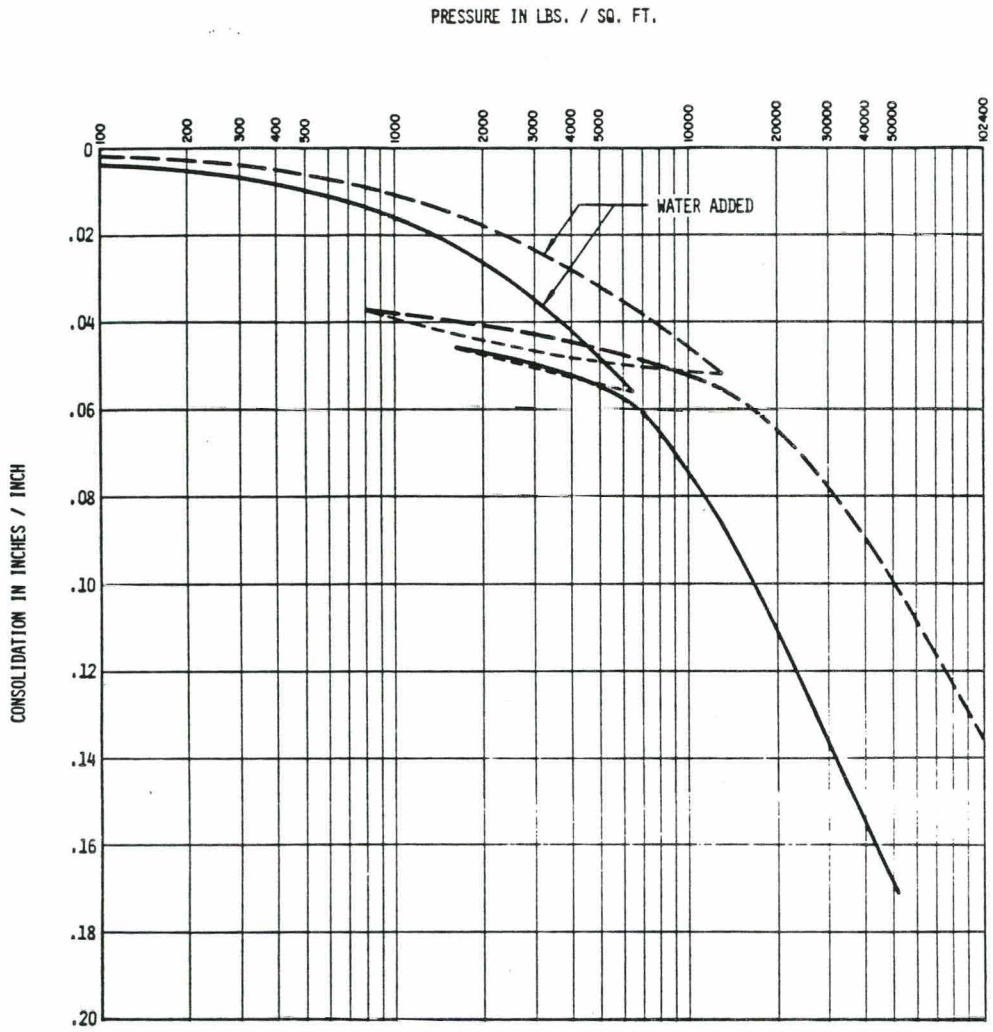
DAMES & MOORE



BORING NUMBER	DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	KEY
107	9.5	29	94	———
109	6.5	26	99	— — —

CONSOLIDATION TEST DATA

DAMES & MOORE

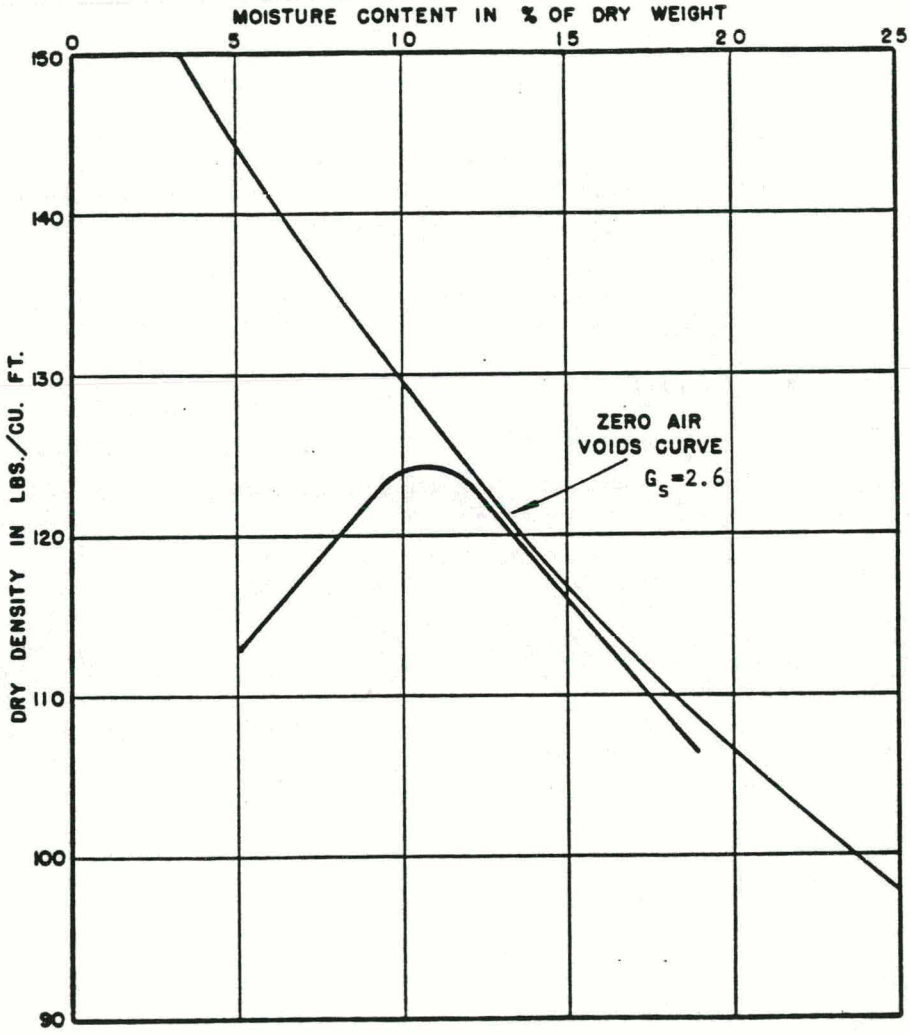


BORING NUMBER	DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	KEY
110	35.5	32	91	———
111	39	25	102	— — —

CONSOLIDATION TEST DATA

DAMES & MOORE

SOIL BROWN SILTY CLAY/CLAYEY SILT
LOCATION BRECKENRIDGE, KY.
OPTIMUM MOISTURE CONTENT 10.7%
MAXIMUM DRY DENSITY 124 PCF
METHOD OF COMPACTION ASTM D1557(A)
LL = 28, PL = 21, PI = 7



COMPACTION TEST DATA

(COMPOSITE SAMPLE OF NEAR SURFACE SOILS)

DAMES & MOORE