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MASTER

SOLVENT REFINED COAL (SRC) PROCESS
OPERATION OF SOLVENT REFINED COAL PILOT PLANT
Wilsonville, Alabama

QUARTERLY TECHNICAL PROGRESS REPORT
for the period

April - June 1979

Prepared by

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NOMENCLATURE

SYMBOLS AND ABBREVIATIONS

α (alpha)	average specific cake resistance
approx	approximate
ASTM	American Society for Testing and Materials
avg	average
AWIC	Alabama Water Improvement Commission
AWS	acetone-washed solids
BP	boiling point
BR	boiling range
btm(s)	bottom, bottoms
Btu	British thermal unit(s)
°C	degrees Celsius (Centigrade)
cc	cubic centimeter(s)
CCDC	Conoco Coal Development Company
CF	capacity factor
CI	cresol insoluble(s)
cm/sec^2	centimeters per second per second
coeff	coefficient
col	column
comp	composite
conc	concentrate, concentrated, concentration
cons	consumed
conv	conversion
corr	corrected
cp	centipoise(s)
CSD	Critical Solvent Deashing
cum	cumulative
cu ft/min	cubic feet per minute
cyc	cycle(s)
dia	diameter
DOE	United States Department of Energy
EEI	Edison Electric Institute
EOD	equivalent orifice diameter
EP	end point
EPRI	Electric Power Research Institute
ERDA	Energy Research and Development Administration
est	estimated
Eq	equation
°F	degrees Fahrenheit
Fe/S	iron to sulfur atomic ratio
filt	filtered; filtrate; filtration
FPS	feet per second
Frac	fractionation
ft	foot (feet)
ft^{-1}	reciprocal foot (feet)
ft/lb_m	foot (feet) per pound mass
ft/sec^2	feet per second per second
ft^2	square foot (feet)
ft^3	cubic foot (feet)
ft-lb	foot-pound(s)
g	acceleration due to gravity (32.2 ft/sec^2)
gal	gallon(s)
gm	gram(s)

gm/cc	grams per cubic centimeter
gm/gm	gram per gram
gph	gallons per hour
gpm	gallons per minute
H/C	hydrogen-to-carbon atomic ratio
HP	high pressure, horsepower
hr	hour(s)
hr^{-1}	reciprocal hour(s)
HRI	Hydrocarbon Research Institute
HVB	High Volatile Bituminous
HVSB	High Volatile Subbituminous
IBP	initial boiling point
ID	inside diameter
in.	inch(es)
K	vapor-liquid equilibrium constant
KM	Kerr-McGee
Ky	Kentucky
lab	laboratory
L/D	length-to-diameter ratio
lb	pound(s)
lb/ft^2	pounds per square foot
lb/ft^3	pounds per cubic foot
lb/hr	pounds per hour
$lb/hr\text{-}ft^2$	pounds per hour per square foot
$lb/hr\text{-}ft^3$	pounds per hour per cubic foot
LP	low pressure
LSRC	Light Solvent Refined Coal
lt	light
lt org	light organic
M	thousand(s)
mA	milliampere(s)
MAF	moisture and ash-free
MASF	moisture, ash, and solvent-free
max	maximum
MB	material balance
MCIF	moisture and cresol-insolubles-free
MF	moisture-free
mg/gm	milligram per gram
mid	middle
min	minimum, minutes
ml	milliliter(s)
mm	millimeter(s)
MM	million(s)
moist	moisture
mol %	mole per cent
mol wt	molecular weight
MP	melting point
MW	molecular weight
NA	not available
ND	not detected
NMR	nuclear magnetic resonance
no.	number
OD	outside diameter
OF	overflow
OH	overhead

OR	oxygen removed
org	organic(s)
OSR	organic sulfur removal
ovhd	overhead
P	pressure
PA	preasphaltene(s)
P & M	Pittsburg and Midway Coal Mining Company
$p(H_2)$	hydrogen partial pressure
ppm	parts per million
prod	product; produced
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
qtr	quarter
°R	degrees Rankine
R & D	research and development
ref.	reference
R_m	filter medium resistance
rpm	revolutions per minute
S	sulfur
scf	standard cubic foot (feet) at 525 °R and one atmosphere pressure
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
SCS	Southern Company Services, Incorporated
sec	second
sec^{-1}	reciprocal seconds
SG	specific gravity
SLS	solid-liquid separation
SN	sample number
solv	solvent
SOR	start of run
sp gr	specific gravity
spec	specification
sq ft	square foot (feet)
SRC	solvent refined coal
SRT	short residence time
SS	stainless steel
std	standard
TBP	true boiling point
temp	temperature
THF	tetrahydrofuran
TI	terphenyl insoluble(s)
tpd	tons per day
tr	trace
UC	unreacted coal
UCC	undissolved carbon compounds
USF	United States Filter Corporation
vac	vacuum
visc	viscosity
vol	volume
vs	versus
w/	with
wt	weight
wgtd	weighted
wt %	weight per cent

@	at
ΔH_R	heat of reaction
Δt	temperature differential
ΔP	pressure differential
$<$	less than
$>$	more than
$\approx$	about, approximately equal to
Σ	sigma (sum)

EQUIPMENT DESIGNATIONS

B	boiler, heater
C	compressor
D	dryer
DE	density element
DIT	density indicator transmitter
DP	differential pressure
DPCV	differential pressure control valve
DPSH	differential pressure switch
DPT	differential pressure transmitter
E	exchanger
F	filter
FIC	flow indicator and controller
FR	flow recorder
FV	flow valve
GC	gas chromatograph
GLC	gas/liquid chromatograph
HV	hand valve
LSH	high level switch
LSL	low level switch
K	product cooler or flare
KM	Kerr-McGee
LV	letdown valve
LS	level switch
P	pump
PSH	high pressure switch
PSV	pressure safety valve
PV	pressure valve
R	reactor
SS	stainless steel
SV	safety valve
T	tower; timer
TC	thermocouple
TR	temperature recorder
V	vessel
XV	filter cycle program operated valve

COAL IDENTIFICATION

- Period: 1 April through 20 May 1979

Company:	Pyro Mining Company
State:	Kentucky
Mine:	Pyro
Seam:	No. 9
Abbreviated identity:	Ky 9

- Period: 20 May through 30 June 1979

Company:	Lafayette Coal Company
State:	Kentucky
Mine:	Lafayette
Seam:	No. 9
Abbreviated identity:	Ky 9

Blank

ABSTRACT

Operating conditions and experimental results obtained during the second quarter of 1979 at the Solvent Refined Coal (SRC) pilot plant in Wilsonville, Alabama, are presented and discussed.

Kentucky 9 coal was processed. The coal was obtained from the Pyro Mining Company and the Lafayette Coal Company.

Material balances were completed for four of the six runs attempted during the quarter. Tests were conducted in the following operating modes:

- Using 75% of the dissolver volume
- Bypassing the dissolver completely
- Introducing part of the feed gas after the slurry preheater
- Withdrawing slurry from the dissolver bottoms

The Kerr-McGee Critical Solvent Deashing (CSD) unit produced SRC containing 0.01 to 0.87% ash when operating at feed rates up to 350 lb/hr. The median daily ash level in the product was 0.13%; and total deashing solvent losses averaged 7.1% of the feed. Recovery of SRC ranged from 75.9 to 82.8%.

I. INTRODUCTION

In March 1972, the Southern Company System and the Edison Electric Institute (EEI) jointly began a pilot-scale study of key steps in the solvent refining process for making low-sulfur and low-ash solid fuel from coal. Southern Company Services, Inc., representing the Southern Company System, provides project management.

In April 1973, the Electric Power Research Institute (EPRI) assumed the functions of utility industry project supervision formerly performed by EEI. The United States Energy Research and Development Administration (ERDA), now Department of Energy (DOE), became a co-sponsor in 1976.

The six-ton-per-day solvent refined coal (SRC) pilot plant at Wilsonville, Alabama, was designed, constructed, and is being operated by Catalytic, Inc. Operation with coal began in January 1974. This report presents a summary of activities during the second calendar quarter of 1979. Earlier work has been documented in preceding monthly, quarterly, and annual Technical Progress Reports.

Objectives of the Wilsonville SRC program for 1979 are:

- To continue evaluating promising solid-liquid separation processes, including:

  <u>Critical Solvent Deashing</u>:

  - improve overall performance
  - establish the effects of pilot plant and CSD operating conditions on yield and performance
  - establish a data base for process scale-up: heat transfer, solids settling rates, solvent losses, and solvent stripping requirements

  <u>USF Vertical-Leaf Filter</u>:

  - investigate performance in both precoat and non-precoat modes

- To provide technical support for an SRC-I Demonstration Plant Program, with emphasis upon determination and control of long-term stability of the process, yield structures, hydrogen consumption, process solvent balance, and product specifications.

- To improve the equipment and operations, with emphasis upon solidifying SRC by liquid phase prilling.

- To evaluate potential improvements in the SRC process, including:

  - CSD third stage solvent and LSRC recovery

  - process variables

  - equipment requirements

Processing Kentucky 6 and 11 coal (begun in September 1978) was concluded on 29 January 1979. Processing Kentucky 9 coal (which has been specified for a planned 6,000 tpd SRC-I demonstration plant) was begun on 1 February.

Kentucky 9 coal from the Pyro mine of the Pyro Mining Company was processed until 20 May, after which coal from the Lafayette Coal Company mine was used.

To fulfill the objectives for 1979, a series of runs (starting with Run 155) was designed in which the following variables would be investigated:

- Dissolver volume (coal residence time)

- Dissolver pressure

- Coal feed slurry concentration

- Coal feed rate

- Feed gas rate to preheater

- Feed gas bypass rate

- Withdrawal of solids from the dissolver

- Dissolver product cooler bypass

Runs 155 through 160 have been described earlier (Ref. 1). Runs 161 through 166 are covered in this report.

II. SUMMARY

In the Solvent Refined Coal (SRC) process, pulverized coal is slurried with an internally generated recirculating solvent. Hydrogen is added to the slurry which is heated and fed to a dissolver. Effluent from the dissolver is flashed and the gas is scrubbed to remove hydrogen sulfide and carbon dioxide. Makeup hydrogen is added and the scrubbed gas is recycled.

In one operating mode, undissolved coal solids are filtered from the SRC solution, and the filtrate is distilled to separate the solvent and SRC fractions. In an alternate operating mode, the unfiltered SRC slurry is distilled to separate the solvent; and the ash-laden SRC fraction is extracted with a deashing solvent at conditions near the critical temperature and pressure of that solvent. The SRC is removed from the heavy ash concentrate as a separate phase. The deashing solvent is then recovered from each phase and recycled.

The ash-free SRC is solidified by cooling. The solvent is fractionated to remove the low-boiling (350-450°F) fraction, which is used for filter cake washing in the filtration mode of operation. In the Critical Solvent Deashing (CSD) mode, the wash solvent is not recycled. The high-boiling (450-900°F) solvent fraction is recycled to the reaction system. In the CSD mode, a Light SRC (LSRC) fraction can be extracted from the SRC product and blended with the recycle process solvent.

A. REACTION SECTION

During the second quarter of 1979, the effects of reaction conditions on CSD system performance were studied. In Runs 161 and 162, dissolver pressure was the variable. Solids were continuously withdrawn from the dissolver at a rate of 5-10% of the feed slurry input. Coal conversions were 93-94% of the MAF coal in the solids withdrawal and dissolver outlet samples, but there was more sulfur in the SRC sampled at the solids withdrawal point.

Part of the feed gas was bypassed around the preheater in Run 163. Dissolver pressure was maintained the same as in Run 161, and solids were again withdrawn continuously. Coal conversions ranged between 92-94% of the MAF coal for both runs.

In Run 164, a short residence time (SRT) experiment, LSRC was added to the makeup solvent to comprise either 15% or 25% of the solvent in the feed. Conversion was 91% of the MAF coal at the higher LSRC concentration.

Run 165 conditions were comparable to those for Run 162, except that solids were not withdrawn during Run 165. (This run was made to improve the hydrogen-donor capability of the solvent). Only a slight increase in hydrogen-donor capability was noted, however, before the run was terminated.

In Run 166, the dissolver product cooling was minimized. Other operating parameters were the same as in Run 165. Coal conversions for the two runs were comparable. There was less sulfur in the SRC sampled from V110 than from the dissolver bottoms.

B. CRITICAL SOLVENT DEASHING (CSD) SECTION

Five runs were conducted in the Kerr-McGee CSD mode during the quarter. Raising the pressure in the reaction section appeared to improve SRC recovery, and allowing solids to accumulate in the dissolver also increased SRC recovery. A higher asphaltene-to-preasphaltene ratio seems to further improve SRC recovery.

Component balances completed during the lined-out operating periods show more cresol insoluble coal in the products than was fed to the CSD unit. The change in the amount of cresol insoluble coal appears to be affected by the CSD first-stage temperature. When the first stage temperature is reduced, the quantity of cresol insoluble coal in the products increases.

During the quarter, 98% of the ash fed to the unit was recovered in the ash concentrate from the CSD first stage.

SRC recoveries varied from 75.9 to 82.3%, depending upon reaction section conditions and CSD unit operating conditions. The asphaltene recovery averaged about 90%.

The loss of deashing solvent was relatively high during the quarter. Solvent loss to the products (SRC, LSRC and ash concentrate) averaged 3.44% of the CSD feed. Total solvent loss averaged 7.1% of the CSD feed.

III. PROCESS DESCRIPTION

A. COAL SLURRY PREPARATION

Figure 1 is a schematic flowsheet of the Wilsonville SRC pilot plant. Pulverized coal (95% of which is smaller than 200 mesh or 74 x 74 microns), is slurried with a process-generated solvent in V101A Slurry Blend Tank and transferred to V101B Slurry Feed Tank where it is agitated and recirculated to maintain a uniform suspension. P102B Slurry Circulating Pump recirculates the slurry and also supplies material to P103A or B Slurry Preheater Feed Pump. The boiling range of solvent used to prepare the coal slurry is 450 to 900°F.

Hydrogen-rich feed gas is normally added to the coal slurry upstream of the preheater inlet. The feed gas stream consists of scrubbed recycle gas plus sufficient makeup hydrogen to bring the gas to the desired composition (usually 85% hydrogen by volume).

The stream consisting of coal slurry and feed gas flows upward in B102 Slurry Preheater through a 600-ft long helical coil of 1.25-in. schedule 160, 316 SS pipe. The coil is heated by an oil burner located in the bottom of the preheater.

B. COAL DISSOLUTION

The coal slurry and gas mixture leaving the preheater flow upward through R101 Dissolver. The dissolver is 23 ft high and one foot in diameter, centrifugally cast of high-chrome stainless steel. It can be operated at 800 to 875°F, 1,400 to 2,500 psig, and can provide residence times of 15 to 60 minutes. Outlets are located at the 25, 50, 75, and 100% volume levels to permit changes in residence times. Effluent from the dissolver is cooled to 600 to 650°F by E102 Dissolver Product Cooler.

Recent improvements made to the dissolver include a distributor plate in the bottom (September 1977); a solids density monitoring system (November 1977); and a solids withdrawal system (February 1978). The solids withdrawal system may be operated continuously or intermittently to control solids accumulation. The solids are conveyed to V103 through a 3/4-in. line.

C. HIGH PRESSURE GAS AND SLURRY SEPARATION

The vapor and slurry phases are separated in V103 High Pressure Separator. Vapor from the separator is cooled to about 150°F by E103 High Pressure Cooler and is then passed into

V104 High Pressure Vent Separator. Water and organic compounds condensed in E103 are fed through LV430 Letdown Valve to V105 Solvent Decanter. Vapor from V104 includes unreacted hydrogen, light hydrocarbon gases, hydrogen sulfide and carbon oxides.

D. FILTER FEED PREPARATION

Slurry from V103 is flashed through LV415A or B High Pressure Letdown Valve to V110 Flash Tank. The 115 psig vapor goes to E107 Flash Condenser. The V110 liquid phase flows to V111 Reclaim Tank which serves as a feed reservoir for the batch filtration system. Noncondensed vapors from E107 and vapors from V104 are vented from V105 to K110 Flare. Organic liquids from E107 and V104 are separated from the water phase in V105.

E. FILTRATION

In the filtration mode of operation, undissolved solids are currently removed from the coal solution by F125 USF Pressure-Leaf Filter. A schematic flow diagram of this filtration system is shown in Figure 2. Formerly, a Funda Pressure-Leaf Filter had been used. The USF unit accommodates four vertical, circular filter leaves with metal wire screens having a total effective filtration area of 87.2 ft^2. The filter operates at 480 to 580°F and 150 to 200 psig, with a maximum pressure drop of 100 psi between the slurry inlet and filtrate outlet.

The following batch filtration operations are automatically controlled by a programmer:

- precoating/no precoating
- filtration
- washing
- cake blowing
- depressurization
- vacuum flash drying
- cake discharging
- repressurization
- sluicing

High-boiling "process" solvent is used in precoat makeup and deposition. The washing step uses low boiling range (350 to 450°F) "wash" solvent. Nitrogen is used for cake blowing and repressurization.

F. MINERAL RESIDUE PROCESSING

After depressurization, the pressure in the filter is reduced to 1-2 psia for 10 minutes. Most of the residual wash solvent in the filter cake flashes to K115 Dryer Vent Gas Scrubber where it is condensed by a circulating stream of cold solvent. The cake, now containing less than 5% residual solvent, is cooled and discharged into storage drums. The recovered solvent is pumped to V111 Reclaim Tank.

G. VACUUM FLASH SYSTEM

Filtered SRC solution flows to V120 Vacuum Preheater Surge Drum. P116A or B pumps the solution through B103 Vacuum Preheater to T102 Vacuum Column where it flashes as it enters. The primary function of T102 is to separate SRC from organic liquid boiling at temperatures up to 900°F. Liquid SRC is withdrawn from the bottom, solvent fractions from trays 3 to 8, and vapors from the overhead of T102. The overhead then passes through a vacuum jet precondenser and condensed light organic vapors are pumped to V164 Feed Tank and then to T104.

T102, three feet in diameter, contains valve trays, tunnel cap trapout trays, and Koch-Sulzer packing. Overhead pressure is maintained at 0.3 to 1.5 psia by an overhead two-stage jet, K111 (with pre- and after-condensers). The column feed is heated in B103 to maintain a bottom temperature of approximately 600°F. A portion of the liquid SRC is recirculated and mixed with the material from V120.

H. PRODUCT SOLIDIFICATION

Liquid SRC from T102 is fed to the vibrating water-cooled trays of K125 Product Cooler. Two trays provide a total surface area of 30 ft^2. The SRC solidifies into brittle sheets which shatter into small fragments. The fragmented SRC is conveyed to storage.

I. CRITICAL SOLVENT DEASHING (CSD)

The Kerr-McGee CSD process is a substitute for the filtration step described above. A schematic flow diagram of the CSD unit is shown in Figure 3. The V111 material is diverted through B103 to T102; the bottoms concentrate from T102 is transferred to the CSD system, which separates the feed into ash concentrate (first stage), deashed SRC (second stage), and Light SRC containing solvent, which can be added to the recycle solvent (third stage). The separations are made using a proprietary deashing solvent operating in the region of its critical temperature and pressure. Under these conditions, most of the SRC fractions are dissolved. Deashing is accomplished in two steps. The ash-containing feed, mixed with solvent at critical conditions, flows to the first-stage settler where the mineral matter and unreacted coal separate as a heavy phase which is withdrawn from the bottom of the settler. Solvent is stripped from the mass and the solids (ash) become a free-flowing powder which is discharged. The overhead is heated to reduce the density of the solvent in the second-stage. By inverse solubility, the ash-free SRC (heavy phase material) settles and is removed as the underflow. Solvent is stripped for recycle. The second-stage overhead undergoes a third-stage separation into deashing solvent for recycle (overhead) and Light SRC to process solvent storage (underflow).

When the CSD unit is in operation, V131B becomes the process solvent surge tank, receiving the third-stage Light SRC and the T105 bottoms fraction. V131A tank and the filter surge vessels are bypassed. In-process solvent inventory is approximately fifty per cent less in the CSD operating mode than in the filtration mode.

J. GAS RECOVERY AND RECOMPRESSION

Vapor from V104 High Pressure Vent Separator contains 60 to 80 mol % hydrogen, plus hydrocarbon gases, hydrogen sulfide, and carbon dioxide. The hydrogen sulfide and carbon dioxide are removed by a dilute solution of caustic soda in T101 Hydrogen Scrubber. The exit gas from T101 is scrubbed with water in V106 Recycle Hydrogen Water Scrubber to remove entrained caustic.

Scrubbed recycle gas is blended with pure hydrogen to provide a feed gas with the required hydrogen concentration. Excess scrubbed gas is vented to K110 Flare. C104 Fresh Hydrogen Compressor brings pure hydrogen from storage to C102 Hydrogen Recycle Compressor which boosts the feed gas stream to the inlet pressure of B102 Slurry Preheater.

K. LIGHT SOLVENT RECOVERY

Organic liquid from V105 Solvent Decanter and the condensed overhead from T102 are combined in V164 and fed to T104 Light Solvent Recovery Column. Components boiling below 350°F are condensed and collected in V170 Light Organics Storage Tank. Liquids boiling at 350°F or higher are combined in V160 with material withdrawn from T102 trays 3 and 8.

T104, six inches in diameter, contains two 5-ft sections. The top section contains 1/4-in. "Pro-Pak" packing, and the bottom section is packed with 5/8-in. SS Pall rings. The bottom contains an internal reboiler coil which is heated by Dowtherm. Reboiler duty is 104,000 Btu/hr, and overhead condenser duty is 30,000 Btu/hr.

L. SOLVENT FRACTIONATION

The material from V160 is heated to 220°F by the T105 bottom product stream and is then fed to T105 Fractionation Column. It may enter at tray 10, 12, 14, or 16, depending upon the feed composition.

The T105 bottoms, having a boiling range of 450 to 900°F, is sent to V131 for use as recycle process solvent. The overhead has a boiling range of 350 to 450°F and is recycled to the filter section for use in filter cake washing.

T105 contains 20 valve trays. Heat is supplied by a Dowtherm reboiler, E173. The overhead vapor is condensed by a fan cooler, E170. The reboiler design duty is 3.3 MM Btu/hr and the overhead condenser duty is 2.9 MM Btu/hr.

M. SOLVENT STORAGE

The following solvent storage is provided:

- V123 Process Solvent Storage, startup and makeup;
- V131A Recovered Solvent Tank, recycle process solvent (boiling range 450 to 900°F);
- V131B Process Solvent Surge Tank, recycle process solvent plus CSD third stage (Light SRC);
- V124B Wash Solvent Storage Tank (350 to 450°F boiling range solvent); and
- V124A Light Oil Product Tank, light organic liquid and excess wash solvent as total organic liquid by-product (boiling range normally below 350°F).

IV. OPERATIONS AND RESULTS

A. RUN SUMMARY

1. SRC Process

During the second quarter of 1979, coal was fed to the SRC pilot plant for 1,700 hours or 77.8% of the total period. All runs (161 through 166) were made with Kentucky 9 coal (413.3 tons from the Pyro mine and 129.0 tons from the Lafayette mine). Operating data are presented in Tables 1 through 10. A summary log of operations is given in Appendix A.

A summary of operating conditions for the six runs conducted during the quarter follows:

Run	161	162	163	164[a]	165	166
Starting date, 1979	29 Mar	12 Apr	1 May	2 June	14 June	21 June
Dissolver Volume, ft^3	13.6	13.6	13.6	Bypass	13.6	13.6
Coal Feed Rate, MF lb/hr	515	515	515	235	450	515
Slurry Concentration, % MF	38.5	38.5	38.5	33	38.5	38.5
Gas Feed Rate, scfh	10,000	10,000	10,000[b]	1,000-2,000	10,000	10,000
Dissolver Pressure, psig	1,700	2,100	1,700	2,400[c]	2,100	2,100-1,700
Dissolver Temperature, °F	825	825	825[d]	885[c]	825	825
Solids Withdrawal	Yes	Yes	Yes	---	No	Yes

(a) Short Residence Time (SRT) run.
(b) Split feed, approximately half before and half after the preheater.
(c) B102 outlet.
(d) Preheater outlet controlled at 850-885°F.

Material balances were made during lined-out periods in Runs 161, 162, 163, and 164. Operating conditions for these material balance periods were:

Run	161C, E	162A	163A,B	164
Coal rate, MF lb/hr	498	494	498	241
Concentration, % MF coal	38.5	38.4	38.7	35.3
Gas rate, Mscf/ton MF coal				
To B102 inlet	39.8	41.3	18.5	14.7
To B102 outlet	0	0	18.5	0
Hydrogen in feed gas, mol %	81.7	84.1	81.3	84.6
Temperature, R101 outlet, °F	825	825	827	-
Temperature, B102 outlet, °F	796	776	848	885
Pressure, psig	1,700	2,100	1,700	2,400
Process solvent, % <450°F	4.1	7.2	6.3	31.1
Dissolver volume, %	75	75	75	0

Results for the material balance periods were:

Run	161C, E	162A	163A, B	164
Conversion, % MAF coal	93.4	94.0	93.3	90.9
Hydrogen consumption, % MAF coal (a)	2.7	2.9	3.0	1.4
SRC yield, % MAF coal	65.1	58.8	56.7	61.8
Sulfur in SRC, %	0.85	0.85	0.82	1.0
Process solvent inventory change	Gain	Gain	Gain	Gain
Solvent microautoclave conversion, %				
short method	71.9	74.7	67.9	66.4
long method	68.9	71.8	73.5	60.0

(a) From SRC unit.

- Run 161

  This was the seventh in a parametric series of runs to determine the effects of dissolver conditions on Critical Solvent Deashing (CSD) unit performance. A total of five 24-hr material balances ("A" through "E") was completed. The "C" and "E" periods were subsequently selected as the most typical.

- Run 162

  R101 Dissolver pressure was raised to 2,100 psig at 0001 hr on 12 April. There was a brief power failure when the run started and another the next day. Five B102 Slurry Preheater flameouts occurred due to faulty burner controls. Concurrently, a thermowell at the heater outlet developed a leak and forced a temporary shutdown.

  The run was resumed on 21 April at 0505 hr. Solids recovered from the dissolver blowdown (109 lb) were reintroduced in the slurry feed.

  A 24-hr material balance was started at 0001 hr on 26 April. Operating conditions were maintained until 1 May at 1830 hr to allow time for improving SRC recovery in the CSD unit.

- Run 163

  During this run, a portion of the feed gas was introduced at the preheater outlet. The gas rate was varied as required to maintain the dissolver outlet temperature at 825°F.

Problems with B102 Slurry Preheater burner controls forced an interruption of coal feed at 0725 hr on 3 May. Further delay was caused by a leak at R101 Dissolver bottom flange.

A high-pressure sample obtained at the B102 Slurry Preheater outlet on 10 May indicated 87.6% coal conversion (MAF basis). A 24-hr material balance (163A MB) period was started at 1200 hr on 11 May.

Control of the dissolver temperature was improved by changing the control procedure on 17 May. At this time, a steady flow of feed gas was established through the preheater, allowing a steady preheater outlet temperature of 850°F to be maintained. Dissolver temperature was then controlled by the rate of addition of cold hydrogen at the preheater outlet.

Kentucky 9 coal from the Lafayette mine replaced that from the Pyro mine on 20 May. A high-pressure sample obtained at the B102 Slurry Preheater outlet on 25 May gave 93.2% coal conversion (MAF basis).

A material balance (163B MB) was started at 0001 hr on 27 May. P180 pump problems made it necessary to end this balance at 1200 hr on 27 May. The run was terminated on 30 May to prepare the plant for a dissolver bypass run, and 386 lb of solids were blown down from the dissolver.

- Run 164 (SRT)

  Coal feed was started at 0940 hr on 2 June with 15% LSRC in the slurry. A change to 25% LSRC was made at 0600 hr on 3 June. A pressure control problem in the CSD unit necessitated switching B102 to solvent feed at 1635 hr. Coal feed was resumed on 4 June at 0600 hr. A 24-hr material balance was started at 2100 hr. Soon after completion of the material balance (2222 hr), the run was terminated because of a high differential pressure across B102 Slurry Preheater.

- Run 165

  One objective of Run 165 was to rehydrogenate the process solvent to improve its hydrogen-donor capability. A second objective was to evaluate the modified USF filter.

Coal feed was started at 0300 hr on 14 June. Only ten cycles were completed before the filter was shut down due to high cresol insolubles in the filtrate. A lack of fuel oil (caused by an independent truckers' strike) forced termination of the run at 1835 hr on 17 June.

- Run 166

  Coal feed was started at 2130 hr on 21 June. The objective was to determine the effects of bypassing the E102 Dissolver Product Cooler on plant operation and CSD unit SRC recovery. Solvent rehydrogenation (hydrogen-donor capability improvement) was a concurrent objective.

  The addition of sodium carbonate to each coal slurry batch (40 lb per tote bin) was begun on 28 June at 1120 hr, in an effort to inhibit corrosion in the distillation section of the plant.

  Run 166 was still in progress when the quarter ended.

2. Kerr-McGee Critical Solvent Deashing (CSD) Process

The CSD unit was operated on bottoms feed from T102 for 1,082 hours, or 63.6% of the time coal was fed to the SRC pilot plant. A total of 153.6 tons was processed at rates as high as 350 lb/hr.

Operating data are summarized in Tables 2, 3, 4, and 10. Table 11 presents analyses of the CSD and CSD SRC product. Table 30 shows CSD ash concentrate analyses.

- Run 161

  During the April portion of this run, the CSD unit operated at daily average feed rates of 242 to 350 lb/hr. Recovery of SRC (by normalized material balance) was 70.8 to 80.5% from 7-11 April.

- Run 162

  A broken feed line interrupted operations on 14 April. Liquid SRC was leaking into the heat transfer medium. Deashing was resumed on 19 April, and continued through a material balance on 26 April. Normalized material balance recovery of SRC on 26 April was 82.8%.

- **Run 163**

  A 24-hr material balance was begun on 12 May. Plugging of the first stage on 16 May caused an interruption of 95.3 hours. A second material balance (started on 27 May) was terminated after 12 hours, when both feed pumps to the CSD unit failed. During the run, the first stage temperature was lowered stepwise in an unsuccessful effort to increase the SRC recovery. Throughout the run, the normalized material balance recoveries ranged from 64.8 to 86.6% for a mean of 75.6% (median of 74.2%).

- **Run 164**

  A 24-hr material balance, 2100-2100 hr on 4-5 June, was completed. SRC recovery was 77.4% by normalized material balance calculation.

- **Run 165**

  The CSD unit was down for maintenance.

- **Run 166**

  Acceptance of feed from the SRC unit was begun at 0910 hr on 24 June. All of the SRC product was within specification except for that produced on 27 and 30 June, which had average ash contents of 0.25 and 0.27%, respectively.

B. COAL COMPOSITION AND SLURRY PREPARATION

Coal from the Pyro mine was fed to the SRC plant until 20 May. Lafayette mine coal has been processed since that date. (Both coals are from the Kentucky 9 seam). The coal had been washed, dried, pulverized, and screened prior to receipt at Wilsonville. Its particle size was such that less than 5% was retained on a 200-mesh screen.

Analyses of the coal processed during the second quarter are presented in Table 12. Hydrogen-to-carbon atomic ratios (H/C) and volatile matter from these analyses were:

Mine	Period	H/C	Volatile matter, %	Pyritic Sulfur	Total Sulfur
Pyro	161 MB	0.79	27.8	1.61	3.55
Pyro	162 MB	0.79	29.6	1.17	3.27
Pyro	163A MB	0.82	28.1	1.61	3.36
Lafayette	164 MB	0.80	27.3	-	2.94
Lafayette	166A MB[(a)]	0.86	32.3	0.81	3.07

(a) 17-18 July, included for comparison.

THF microautoclave conversion test results for the coal were:

Period	Run	Coal	THF Conversion, %[a]
9-10 April 1979	161 MB	Ky 9 (Pyro)	81.8
26-27 April 1979	162 MB	Ky 9 (Pyro)	80.8
11-12 May 1979	163 MB	Ky 9 (Pyro)	77.6
4-5 June 1979	164 MB	Ky 9 (Lafayette)	75.1
17-18 July 1979[b]	166A MB	Ky 9 (Lafayette)	74.9

(a) Long method: 750°F, 30 minutes, 2:1 solvent-to-coal.
(b) Included for comparison.

Petrographic maceral analysis of Kentucky 9 coal (Pyro mine) (Ref. 1) was:

Maceral analysis, %	
Vitrinites	94.4
Fusinites	1.7
Semi-fusinites	2.3
Macrinites	0.2
Micrinites	0.3
Exinite	1.1
Resinite	-

Except for short residence time Run 164, the coal slurries were at a nominal 38.5% solids concentration.

Specific gravity data for coal slurries were:

Coal	Kentucky 9			
Date, 1979	12 April		9 May	
Concentration, wt %	38.5		38.5	
Temp, °F	60	150	60	150
Sp gr	1.116	1.104	1.116	1.091

Slurry viscosity data at 38.5% concentration were:

Temp, °F	Shear Rate, sec^{-1}	Viscosity, cp May	Viscosity, cp June
80	20.4	205	150
	10.2	220	155
150	20.4	50	55
	10.2	60	60
200	20.4	33	45
	10.2	40	50
250	20.4	23	25
	10.2	25	30

C. PREHEATING AND DISSOLVING

1. Hydrogen Gas Feed Mode

In this mode, all of the hydrogen feed gas is introduced at the preheater inlet and the preheater outlet temperature is adjusted to maintain a constant dissolver outlet temperature.

Table 13 summarizes slurry preheater operating data for Runs 161, 162, 163, and 164. Thermocouple locations are shown in Figure 4.

a. Coke Formation

B102 Slurry Preheater temperature profile data taken after Run 164 MB indicated some coke formation in the areas of turns 33 and 35 on 5-6 June. The temperature data for this period and the MB immediately preceding follow:

Run	164MB	165	165	165	165	165
Date, June	4-5	5	5	5	5	5
Time, hr	2000	1800	2000	2100	2200	2300
Temperature , °F						
Turn 33 skin/fluid	854/790	856/784	852/780	858/751	864/697	889/777
Δt	64	72	72	107	67	112
Turn 35 skin/fluid	878/769	880/713	880/736	881/733	900/724	938/745
Δt	109	167	144	148	176	193
Inlet pressure, psig	2,396	-	2,410	2,410	-	-
Pressure drop, psi	19.5	-	-	24.0	-	-

At approximately 1900 hr on 5 June 1979, the Δt across turn 33 and turn 35 started increasing as did the pressure drop across the slurry preheater. Coking was confirmed when the coils were cleaned and hydroblasted.

The temperature profiles and pressure drop data for runs made during the quarter (shown in Table 14) indicate no significant coke formation in the coil.

Typical data at the end of each run are as follows:

Run	161	162	163	164
Date	12 April	1 May	30 May	4 June
Feed gas, scfh	9,730	10,210	9,730	2,680
Temperature, °F				
Turn 15 skin/fluid	572/514	627/554	600/	715/632
Δt	58	73	72	83
Turn 19 skin/fluid	625/561	672/594	687/563	760/707
Δt	64	78	124	53
Turn 23 skin/fluid	643/519	671/554	663/529	798/
Δt	124	117	134	42
Turn 27 skin/fluid	689/609	711/637	718/628	852/756
Δt	80	74	90	96
Inlet pressure, psig	2,155	2,150	1,925	2,375
Pressure drop, psi	50	35	125	15
Apparent solvent quality				
THF conversion				
% of MAF coal				
short	72.8	75.9	66.5	66.4
long	-	-	64.9	60.0

b. Preheater Temperature Profile

Runs 161 and 162 showed a fluid temperature decrease near turn 19, while Runs 163 and 164 showed a fluid temperature decrease around turn 33:

Run	161	162	163	164
Date, 1979	11 April	26 April	27 May	2 June
Fluid temperature at turn, °F				
19	581	578	620	677
23	537	532	634	720
31	714	702	800	815
33	715	702	765	783

2. Dissolver Bypass Mode

Run 164 was made with the dissolver bypassed at a coal feed rate of 256 lb/hr. The run consisted of two parts: (1) using a mixture of 15% LSRC and process solvent, and (2) using a mixture of 25% LSRC and process solvent. Operating conditions and SRC yield data for the 25% LSRC concentration are summarized in Table 7.

D. REACTION

1. Stability

Several dissolver operating parameters affect reaction stability, such as: temperature, solids accumulation, solvent quality, solvent composition, and coal composition. Nuclear density gauges monitor the solids concentrations at the bottom and at the middle of the dissolver. The solids have a tendency to concentrate in the bottom section of the dissolver. A "solids withdrawal line" periodically removes a small portion of the dissolver contents from a point 10 inches above the distributor plate. This system is shown in Figure 5. A 16-point temperature probe is used to monitor the temperature profile at various dissolver heights. Gas chromatography and elemental analyses are used to determine the solvent composition. The hydrogen-donor quality of the solvent and changes in coal reactivity are evaluated in a laboratory microautoclave.

a. Dissolver Solids Inventory and Withdrawal System

Table 14 presents the variations in slurry preheater outlet temperature and the temperature over the height of the dissolver for Runs 161, 162, and 163 material balance periods. The temperature variation at the preheater outlet and at the dissolver outlet were:

Run	161MB	162MB	163MB
Date, 1979	9-10 April	26 April	11-12 May
B102 Preheater outlet temp, °F	787-802	768-787	835-851
R101 temp, °F			
bottom	792-813	800-808	803-817
outlet	822-829	820-829	819-833

Daily average nuclear density gauge readings are given in Tables 2, 3, and 4. The amounts, compositions, and particle size distributions of the accumulated solids are given in Table 15. The nuclear density gauge readings were unreliable during April and May because of a faulty detector tube and a defective electronic circuit board.

Solids were continuously withdrawn from the dissolver during Runs 161, 162, and 163. On 20 April (Run 162), 109 lb of dissolver solids were blown down. These solids were reintroduced with the slurry feed on 21 April. On 30 May (Run 163), 386 lb of solids were blown down. On 22 June (Run 166) and on 27 June, the dissolver was again blown down. The solids were reintroduced.

The modified dissolver solids withdrawal system (see Figure 5) performed adequately during the quarter. The control valve XV4078 was operated at a low (2-3%) air load during April and May. The following settings on the control valve (at low air load) were added to obtain a withdrawal rate equivalent to 5 to 10% of the input feed slurry:

Air load, %	2-3
Valve open, sec	1.5-2.5
Valve closed, sec	50-59

The withdrawal rates were periodically checked by filling the calibration pot.

Date	Time	Air Load, %	Valve open, seconds	Valve closed, seconds	Withdrawal rate, lb/hr	Withdrawal rate, % of feed
8 May	2300	2.5	2	59	77	5.9
12 May	2300	3.0	2	59	89	7.0
16 May	2300	3.0	2.5	59	99	7.2
21 May	2300	2.5	1.5	59	88	6.8
28 May	2300	2.5	2.0	59	97	8.8

In June, control valve trim was changed to allow operation at a higher air load. The following settings were used:

Air load, %	65-70
Valve open, sec	4.5-6
Valve closed, sec	33

The withdrawal rates were periodically checked by filling the calibration pot.

Date	Time	Air Load, %	Valve open, seconds	Valve closed, seconds	Withdrawal rate, lb/hr	Withdrawal rate, % of feed
25 June	1145	70	5	33	94.8	7.5
25 June	1600	70	6	33	126.9	10.0
26 June	1100	65	4.5	33	115.3	10.0
26 June	1600	65	5	33	105.3	9.1

The ash percentage, cresol insolubles, SRC, and coal conversion were determined from R101 Dissolver solids withdrawal calibration pot effluent and V110 effluent streams.

(See Table 31). Coal conversions were comparable at the withdrawal point (near the dissolver bottom) and at the dissolver outlet (as estimated from V110 samples). The calibration pot samples contained more cresol insolubles and SRC than the V110 samples. The sulfur content of the SRC was less at the R101 outlet than at the R101 bottom as indicated below:

Date, 1979	6 May	28 May	25 June	26 June
R101 bottom, wt %	0.98	0.97	1.04	1.00
R101 outlet, wt %	0.90	0.85	0.89	0.90

The apparent hydrogen-donor quality of the recycle solvent during solids withdrawal was:

Run	161	161 MB	162	163A MB
Date, 1979	2 Apr	9-10 Apr	27 Apr	11-12 May
Microautoclave THF conversion, %				
short	71.7	71.9	72.9	67.9

Solids withdrawal had no apparent effects on solvent hydrogen-donor quality during Runs 161 and 162. The high preheater temperature (860°F) may have been responsible for the lower solvent hydrogen-donor quality due to dehydrogenation of the process solvent.

b. Solvent Quality

In order to correlate reaction behavior with changes in solvent composition, a 30-cc microautoclave unit was fabricated, capable of heating the contents (14 gm of a coal-and-solvent mixture) to the specified temperature (±5°F) in two minutes. The unit is shaken at a controlled rate, and is removed from the sand bath and quenched in water after each run.

The conditions generally used for microautoclave tests are:

Run	Temp, °F	Solvent-to-coal ratio	Reaction time, min
Short	750	8:1	10
Long	750	2:1	30

Figure 7 shows microautoclave conversions for short and long run conditions as a function of the tetralin concentration in 1-methylnaphthalene. Solvent hydrogen-donor qualities obtained during this quarter were:

Coal	Date, 1979	Run	Microautoclave THF Conversion, % short	long	H/C atomic ratio
Ky 9	3 April	161	70.5	64.9	1.22
Pyro Mine	9 April	161	71.9	68.9	1.22
	11 April	161	75.4	69.1	1.20
	16 April	162	73.1		
	23 April	162	75.8		
	27 April	162	72.9	71.0	1.22
	2 May	163	76.0		
	7 May	163	69.3		
	10 May	163	71.8	66.5	
	11-12 May	163	67.9	63.5	1.20
	17 May	163	70.0		
Ky 9	22 May	163	69.2		
Lafayette	25 May	163	68.2		
	27 May	163	67.2	64.9	1.20
	3 June	164	73.0	67.0	1.19
	4-5 June	164(a)	66.4	63.0	1.25
	14 June	165	73.2		
	25 June	166(b)	65.0		
	26 June	166	65.4		
	29 June	166	65.8		
	30 June	166	70.9	70.3	1.23

(a) V101B filtrate 25% LSRC-75% process solvent.
(b) V131A material.

2. Yields

Table 16 shows reaction section operating data for Runs 160, 161, 162, 163, and 164 material balance periods. Tables 6 and 7 show the calculated yields. The yield calculations are based upon two methods: process material balance and V110 short method. The following data show the apparent errors in elemental balances based upon each method:

Run	160MB		161MB		162MB	
Element	Error (a) by element, %		Error (a) by element, %		Error (a) by element, %	
	Process MB	V110 short method	Process MB	V110 short method	Process MB	V110 short method
Carbon	0.14	0.17	-0.05	-0.26	0.00	0.08
Hydrogen	0.61	0.90	1.74	1.62	0.96	1.37
Sulfur	6.00	5.56	-35.30	-34.49	-21.17	-21.84
Nitrogen	18.85	18.31	32.74	32.45	-32.59	-33.78
Ash	4.65	3.95	0.49	4.28	0.63	-0.61
Oxygen (b)	-15.37	-15.53	-3.07	-3.30	9.71	9.54

Run	163MB		164MB	
Element	Error (a) by element, %		Error (a) by element, %	
	Process MB	V110 short method	Process MB	V110 short method
Carbon	0.36	0.27	1.32	0.83
Hydrogen	0.96	0.95	1.35	-0.25
Sulfur	-7.15	-6.91	-53.84	-50.17
Nitrogen	-21.79	-22.09	0.99	1.05
Ash	-0.50	1.03	6.03	18.43
Oxygen (b)	-0.66	-0.73	-9.77	-8.46

(a) Based upon input. Positive error means the element was not completely accounted for in the output streams.
(b) By difference.

Tables 6, 7 and 8 also show the yields calculated from adjusted process flow rates which produced elementally balanced results.

a. Yields of SRC

Tables 2, 3 and 4 summarize the operating data and the SRC yield data (based on T102 Vacuum Column bottoms and V110 laboratory analyses by the forced ash balance method) for Runs 160 through 164. The SRC yields and hydrogen consumptions for Runs 160 through 164 were:

Performance Data Summary

Run	160MB		161MB		162MB		163MB		164MB	
Period, 1979	25-26 March		9-10 March		20 April		11-12 May		4-5 June	
Coal feed rate, MF lb/hr	488		498		493.5		498		241	
Slurry conc. % MF coal	38.0		38.5		38.0		38.2		35.3	
Feed gas rate, scfh	7,800		9,920		10,225		10,360		1,770	
Dissolver volume, %	75		75		75		75		0	
Solids withdrawal	no		yes		yes		yes		no	
Preheater temp, °F	780		780		780		850		685	
solvent in CSD feed, %	7.1		6.5		6.1		6.1		8.9	
solvent in CSD-SRC, %	8.5		3.2		11.2		5.5		7.5	
SRC yield (basis of coal)	MF	MAF	MF	MAF	MF	MAF	MF	MAF	MF	MAF
A. Solvent free basis, %										
by adjusted process method	55.8	62.4	57.2	65.5	52.7	60.9	50.0	57.4	57.2	62.7
by adjusted V110 short method	57.7	64.6	58.3	66.7	55.6	64.2	50.7	58.2	50.0	54.8
by avg of above two	56.8	63.5	57.8	66.1	54.2	62.5	50.4	57.8	53.7	58.8
SRC recovery in CSD unit[b]	79.2		78.9		77.2		79.2		78.6	
Overall SRC yield	45.0	50.3	45.6	52.2	41.8	48.3	39.9	45.3	42.2	46.2
B. Solvent contg basis, %										
by adjusted process method	60.1	67.2	61.2	70.1	56.1	64.8	53.2	61.1	62.7	68.9
SRC recovery in CSD unit[a]	80.4		76.25		81.6		78.7		77.4	
Overall SRC yield	48.3	54.0	46.7	53.5	45.8	52.9	41.9	48.1	48.5	53.3
Hydrogen consumption, %										
by adjusted process method	2.3	2.6	2.0	2.3	2.3	2.7	2.4	2.8	1.0	1.1
by adjusted V110 short method	2.2	2.5	2.0	2,5	2,3	2.7	2.4	2.8	1.3	1.6

(a) Calculated using recovered SRC flow rates.
(b) Light SRC basis.

For Runs 160 through 164, the estimated yields of benzene-insoluble, benzene-soluble, and pentane soluble SRC were:

Run	160MB		161MB	
SRC yield, % MF coal	Process MB[(a)]	V110 method[(a)]	Process MB[(a)]	V110 method[(a)]
Oil	13.8	15.4	13.4	14.0
Asphaltene	23.7	20.1	22.5	21.4
Preasphaltene	17.4	21.3	21.0	22.4
Total SRC	54.9	56.8	56.9	57.8

Run	162MB		163MB	
SRC yield, % MF coal	Process MB[(a)]	V110 method[(a)]	Process MB[(a)]	V110 method[(a)]
Oil	14.5	17.6	10.0	15.8
Asphaltene	29.6	27.2	23.6	21.0
Preasphaltene	6.9	9.0	15.7	13.3
Total SRC	51.0	53.8	49.3	50.1

Run	164MB	
SRC yield, % MF coal	Process MB[(a)]	V110 method[(a)]
Oil	2.7	1.0
Asphaltene	23.5	15.3
Preasphaltene	30.2	32.7
Total SRC	56.4	49.0

(a) Unadjusted yields.

The highest preasphaltene content in SRC occurred during SRT Run 164 (25% Light SRC addition to solvent).

b. Yields of Organic Distillates, Water, and Gases

The process solvent yield was sufficient to maintain a solvent balance during the second quarter.

Tables 5, 6, and 7 show the yields of distillate, hydrocarbon gases and water for Kentucky 9 coal during 160-164 material balance periods. Typical gas chromatographic analyses of the various product vent gases are given in Tables 17, 18, and 19. Analyses of the total flare gases are given in Table 20. Table 21 shows analyses of reaction products from the laboratory workup of the V110 Flash Tank composites for the material balance period. These, along with data from Tables 16 through 20, were used to calculate the short reaction section material balances.

The yields of liquid distillates, water, and gases were:

Run Yield,[(a)] % of MF coal	160MB	161MB	162MB	163MB	164MB
(Process MB data)					
Light organic liquid	1.5	1.0	1.2	1.5	1.6
Wash solvent	3.6	7.3	3.7	5.2	-9.8
Process solvent	17.5	6.4	15.6	13.3	14.8
Water	2.7	5.0	3.5	4.9	9.2
C_1-C_5 gases	3.8	3.7	5.6	6.6	6.0

(a) Unadjusted yields.

3. Heteroatom Removal

Oxygen, nitrogen, and sulfur removal can be estimated from elemental analyses of feed coal and SRC as follows:

$$\text{Heteroatom removal, \%} = 100\ (A-B)/A \qquad (1)$$

where:

A = heteroatom to carbon ratio in feed coal

B = heteroatom to carbon ratio in SRC

Estimated heteroatom removal for the runs made during the quarter were:

		Weight Ratio of Heteroatom to Carbon				Heteroatom Removal, %		
			SRC			Eq. (1)	SRC	
Run	Heteroatom	Feed Coal	V110	CSD Feed	KMV203	V110	CSD Feed	KM
161	Oxygen	0.11	0.061	0.077	0.053	44	30	52
	Nitrogen	0.024	0.019	0.019	0.019	21	21	21
	Sulfur	0.040	0.010	0.025	0.016	75	37	60
162	Oxygen	0.13	0.052	0.044	0.051	60	66	61
	Nitrogen	0.021	0.023	0.024	0.029	-9	-14	-38
	Sulfur	0.047	0.010	0.022	0.013	79	53	72
163	Oxygen	0.12	0.052	0.047	0.037	57	61	69
	Nitrogen	0.013	0.024	0.023	0.013	-84	-84	0
	Sulfur	0.047	0.011	0.023	0.009	76	51	81
164	Oxygen	0.13	0.067	0.058	0.054	48	48	58
	Nitrogen	0.013	0.018	0.016	0.016	-38	-23	-23
	Sulfur	0.040	0.012	0.017	0.012	70	57	70

Forms of sulfur occurring in the feed coal were:

	Sulfur forms, wt %			
Run	Pyritic	Sulfate	Sulfide	Organic
160	1.11	0.04	0.03	2.43
161	1.61	0.04	0.02	1.88
162	1.17	0.02	0.01	2.07
163A	1.61	<0.01	<0.01	1.75
164	1.11 (a)	0.14	0.02	1.67 (a)

(a) Corrected by plant Lab data.

Organic sulfur removal (OSR) can be calculated by the following equation based on the calorific value of coal and SRC:

$$\text{OSR, \%} = \left[(A/C - B/D) \div A/C\right]\ 100 \qquad (2)$$

where:

A = Organic sulfur in feed coal, wt %

B = Organic sulfur in SRC, wt %

C = Calorific value of coal, Btu/lb

D = Calorific value of SRC, Btu/lb

Values of OSR calculated by equation (2) follow:

	Calorific Value, Btu/lb			Organic Sulfur			Sulfur Removal, %	
Run	in coal	in V110	KMV203	coal	V110	KMV203	V110	KMV203
160	12,976	-	15,912	2.43	0.68	1.24	-	58
161	12,530	15,442	15,442	1.88	0.96	0.95	59	59
162	12,677	15,980	15,672	2.07	0.91	0.82	65	68
163	13,930	15,862	15,845	1.75	0.93	0.99	53	50
164	13,665	16,086	15,796	2.67		1.02	-	67

E. MINERAL RESIDUE SEPARATION

1. Filtration

During the second quarter, the United States Filter Corporation (USF) filter sluice header was replaced with a high pressure (2,000 psig) sluice header. The high pressure sluice header incorporates spray arms and nozzles that rotate toward the leaf center. The spray nozzle is automatically advanced one inch toward the leaf center for each revolution of the leaf. The leaf surfaces can be cleaned for three to eighteen minutes by adjusting the leaf rotation speed. Plates have been welded into the front and rear heads of the filter. Circulation of Dowtherm through these head cavities minimizes heat losses during filtration. The head plates reduced the filter volume from 435 gallons to 345 gallons.

Test runs were made to evaluate the mechanical performance of the sluice header and the new test leaves. For the runs, low pressure (100 psig) VeeJet nozzles (3/16-in. EOD) were installed.

After ten cycles (including two on precoat only and one on cleanup), the tests were discontinued due to high ash levels in the filtrate (caused by an off-center hub gasket). The defective gasket allowed filter feed to bypass the screens.

Inspection revealed that the leaves had remained flat. One side of each leaf was intact except where the outer screen (24 x 110 Dutch weave, calendered on outside) had separated from the inner layers. The other side of each leaf had an area two feet in diameter where the screen had become separated from the perforated drainage sheet. The screen had creased and was in danger of being torn by the cut-off blades. Spot welding (or silver-soldering) the screen to the perforated sheet at six-to-eight inch intervals could solve the creasing problem.

The basic concept of the new leaves to be made by USF is to diffusion-bond the outer screen, drain screen and perforated plate together as a "sandwich", then calendar the assembly to make it flat. These three "sandwich" components will be spot-welded on six-inch centers. Methods of sealing leaf periphery is under investigation. Possibilities include roll welding or continuous arc welding with roll plenishing.

For the seven runs on coal, the average V112 temperature was 562°F, the filter feed inlet temperature was 560°F and the filtrate leaving the filter was 559°F. Since the flow rate was high, the temperature drop between feed inlet and filtrate exit was not more than 3°F.

The USF filter cycle times were:

	Minutes
Sluice	12
Fill with precoat	4
Precoat	20
Remove excess precoat	2
Precoat drain	6
Fill with filter feed	3
Drain filter feed	6
Fill with wash solvent	4
Wash cake	2
Drain wash solvent	6
Cake blow	1
Depressure	3
Dry and break vacuum	5
Discharge	4
Repressure to 120 psig	3
Valve sequencing time	2
Total downtime	83

Due to the hub seal leak, ash dumps were smaller than normal and did not provide an adequate test of the ash cooler. Pressure in the ash cooler during ash discharge from the filter was traced to a blind in the line to K115. The pressure forced the discharge door to open.

2. Screen Evaluation

Pierced metal screens from National Standard Company were tested in the lab-size test filter to determine if they could retain filter feed solids. The screens tested had either trapezoidal-shaped holes or 0.118-in. wide slots. Three levels of rolling were available.

The screens with trapezoidal holes retained filter feed solids, but the filtration rate was slower than that for 24 x 110 Dutch weave screens, calendered on one side. The screens with slotted holes retained feed solids.

The filtration rate when using a precoat of Anthra-aid on 24 x 110 Dutch weave screens, calendered on one side, was equivalent to that using bare screens.

A stability test using Anthra-aid showed that 95 to 99% of the Anthra-aid was recovered after heating in process solvent or filtered reaction product for one hour at 500°F.

Results of 0.01 Ft^2 Test Filter

Screen	Temp, °F	Press, psig	Flow Thru, gm	Filtrate 32 min., gm	Cake, gm	Cake Thick, in.	Fil-trate, % CI	Flow Thru, % CI	Cake % CI	Cake % Ash
Run 162										
Conidure, trapezoidal holes, rolled smooth	530	110	9.2	48	23	1/2	0.08	0.5	64.7	45.3
24 x 110 calendered on one side	525	110	27	71	26	1/2	0.04	2.5	62.8	39.1
Run 163										
Conidure, slotted holes, rolled smooth	520	120	483	84	26	1/2	0.05	8.0	76.8	59.6
Conidure, trapezoidal holes, slightly rolled	520	110	No Flow				-	-	-	-
24 x 110 calendered on one side with precoat of 0.6 lb/ft^2 Anthra-aid No. 13 (a)	520	110	14.5	91	24	1 1/4	0.11	1.1	-	-
Conidure, slotted holes, highly rolled	525	110	22	66	23	5/8	0.20	7.5	63.6	41.1

(a) Large cake thickness due to hollow area in center of cake.

F. SOLVENT RECOVERY

1. T102 Vacuum Column

During an inspection on 19-20 June, evidence of severe corrosion in T102 Vacuum Column was observed. Ultrasonic thickness testing revealed a loss of up to 0.022-in. on tray 8 after four months' service. (Tray 8 is made of 316 SS, and was installed in February 1979). The 410 stainless steel cladding had several pits and furrows ranging from 0.042-in. to 0.078-in. deep. Repairs were made to the cladding, and specification solvent cuts were made during Run 166, but a much higher reflux rate and heat input than normally required were necessary.

On 26 June, T102 was set up as a flash still. Tray 8 process solvent drawoff was blocked in, packing reflux was eliminated, and all of the T102 drawoff was distilled overhead in tray 3. This mode of operation reduced the heat input requirement of T102.

Performance data for T102 are shown in Table 22. Tables 23 and 24 show the column product analyses and compositions. Figures 10 and 11 show the ASTM D86 and GC simulated boiling point curves for the process and wash solvents. A summary of the operating data for Runs 160 through 164 material balance periods is presented below:

Run	160CMB	161CMB	162AMB	163AMB	164AMB
T102 pressure, psia	0.4	0.6	0.6	0.6	1.1
T102 bottom temper^ture, °F	580	575	550	555	567
Overhead temperature, °F	192	194	192	193	202
Distillation SRC					
@ 500°F, 0.1 mm Hg, wt %	-	2.1	1.3	3.5	1.8
@ 600°F, 0.1 mm Hg, wt %	-	6.5	6.1	7.2	8.9
Softening point of SRC, °F	-	311	293	293	293
Fusion point of SRC, °F	-	329	307	303	312

2. T105 Fractionation Column

New 321 SS trays and 316 SS support rings were installed in T105, and the 304 SS cladding in the bottom half of the column was extended 4 feet upward from the column midpoint with a 321 SS extension. The new equipment was started up on 15 June 1979. The column operating conditions were set at the original parameters and specification solvent fractions were produced.

T105 developed a leak on nozzle 7X (tray 13) on 27 June 1979. This nozzle was not protected by the 304 SS cladding. Column T105 was shut down for repairs and T102 was set up for process and wash solvent separation.

3. T104 Light Solvent Recovery Column

A Dowtherm leak at the T104 reboiler heater coil was discovered on 21 May. T104 was shut down and the carbon steel heater coil was replaced with a 1-in. 316 stainless steel coil. The leak resulted from corrosion to a section of the coil that had been bent and twisted.

T104 was started up on 25 May after repairs were made. Operations have been satisfactory since startup. Tables 25 and 26 show the material balance compositions of the V105 decanter and T102 overhead stream which make up the feed to the T104 column. Typical column operating data obtained during the material balance periods are given in Table 27. Tables 28 and 29 show light organic product analyses and compositions. ASTM D86 and GC simulated distillation curves for the light organic product are shown in Figure 12. T104 bottoms were fed to T102 since T105 was out of service between 1 April and 15 June.

4. Solvent Inventory

The solvent inventory increased during the second quarter as shown:

Inventory, M lb	1 April	30 June	Change	Composition,[a] wt % IBP-350°F	350-450°F	450°F-EP
Light organic liquid						
in tanks	35.1	38.5				
shipped during qtr		37.1				
total	35.1	75.6	+40.5	21.5	66.5	12.0
Wash solvent						
in tanks	76.5	71.5				
in drums	-	-				
shipped during qtr	-	9.4				
total	76.5	80.9	+4.4	12.0	75.0	13.0
Process solvent						
in process	28.4	30.6				
in storage	25.2	25.9				
in drums	27.3	31.5				
shipped during qtr	-	2.6				
total	80.9	90.6	+9.7	0	0	100.0

(a) ASTM D86 analysis.

The wash and process solvent inventories during each run were:

Run	Date	Process solvent inventory, lb	Wash solvent in process solvent: ASTM D-86 vol, %	Wash solvent in process solvent: GC wt, %	Wash solvent inventory, lb	Process solvent in wash solvent: ASTM D-86 vol, %	Process solvent in wash solvent: GC wt, %
161	1 April	28,400			76,500		
	to						
	12 April	29,100	0		79,900	18.0	
162	12 April	29,100			79,900		
	to						
	1 May	28,700	0	6.2	75,300	21.1	29.4
163	1 May	28,700			75,300		
	to						
	30 May	24,500	8.0	7.5	63,600	20.4	26.6
164	2 June	30,600			58,200		
	*5 June	39,700	34.3	29.7	38,500	8.6	31.0
164	14 June	30,900			30,800		
	17 June	34,900			78,200		31.0
166	21 June	30,800			80,000		
	30 June	30,600	0	1.2	71,500	13.0	9.5

* During Run 164 cross-contamination occurred between V124B and process solvent system at a T102 piping junction.

5. Process Solvent Composition

Typical process solvent compositions during the period were as follows:

Coal	Kentucky 9				
Solvent source			V131B	(850°F B102)	
Run	160CMB	161AMB	162AMB	163AMB	164AMB
Date, 1979	25-26 March	9 April	26 April	11-12 May	4-5 June
Boiling Fractions, wt %					
IBP°F	(405)	(405)	(302)	(382)	(335)
IBP-450°F	3.4	4.1	7.2	6.3	31.0
450-550°F	25.0	30.7	34.8	39.7	35.3
550-650°F	29.8	29.1	26.3	27.2	16.8
650-EP°F	39.9	35.0	27.8	25.3	15.3
Residue	1.9	1.1	3.9	1.5	1.6
EP°F	(918)	(937)	(907)	(892)	(838)
Carbon, %	88.33	86.98	86.17	86.69	85.07
Hydrogen, %	8.63	8.89	8.71	8.70	8.89
H/C atomic ratio	1.164	1.22	1.20	1.196	1.245
Specific gravity	1.070	1.020	1.011	1.009	0.996
T102 btm solv, %	-	6.5	6.1	7.2	8.9
Microautoclave THF conversion, %					
short	74	72	75	68	66
long	72	69	72	64	60

In April, LSRC from the CSD unit was added to the process solvent at a rate of 10 to 11 lb/hr. In May, LSRC was added to the process solvent at an average rate of 16.3 lb/hr. The process solvent showed a decrease in the high boiling components (650°F-EP) and a consequent lowering in specific gravity during the quarter. Operating with the dissolver solids withdrawal system in use may have affected this trend in solvent composition.

G. SRC CRITICAL SOLVENT DEASHING (CSD)

Vacuum still bottoms having a high-ash content were transferred in the liquid phase to the CSD unit. The feed rate varied from 150 to 350 lb/hr. Four demonstration runs were made during the quarter: 161, 162, 163, and 164. Included in each run was at least one material balance.

The operating objectives of the CSD unit were partially met during the quarter: (1) low sulfur, low ash product; (2) reduced deashing solvent loss to the product; and (3) continuous operation. SRC recovery (based upon forced ash balance) ranged from 67 to 83%. The SRC contained an average of 0.92% sulfur and 0.16% ash.

Reaction section conditions and CSD recoveries are summarized below for the material balance periods:

Run	160	161	162	163	164
Preheater temperature, °F	780	780	780	850	885
Dissolver temperature, °F	825	825	825	825	-(a)
Dissolver pressure, psig	1,700	1,700	2,100	1,700	-(a)
Dissolver volume, %	75	75	75	75	-(a)
Solids withdrawal?	No	Yes	Yes	Yes	-(a)
SRC recovery, forced ash balance, %	82.3	75.9	80.6	78.8	77.5

(a) Dissolver bypass run.

The following conclusions can be drawn from these data:

- At constant dissolver temperature and pressure, solids withdrawal from the dissolver decreases SRC recovery in the CSD unit.
- Increased dissolver pressure increases the percentage of SRC recovered by the CSD unit.

1. Process Stability

The feed to the CSD unit continued from 8.0% ash to 16.6% ash during the material balance periods. On the average, 98% of the ash in the feed was recovered in the ash concentrate stream. Thus, 2% of the ash remained or 0.5% of the feed was not deashed.

Presently, there is no reliable means of calculating the feed rate to the CSD unit. The deashing solvent rate is determined by the feed rate. If the feed rate differs from the set point value, then the deashing solvent rate will be in error, and this affects operability. Plans are underway to install accurate feed rate measurement instruments.

Plugging of the letdown system continues to be a problem. Remedial studies are underway.

2. Feed Composition

The composition and properties of the feed during the material balance periods were:

Run	160	161	162	163A	164
Feed composition, wt%					
Oil	26.1	23.0	26.8	23.0	26.1
Asphaltene	32.1	27.7	39.4	33.0	34.3
Preasphaltene	22.6	25.8	8.8	20.8	22.6
Unreacted coal	6.5	7.4	7.6	6.6	10.3
Ash	12.8	16.1	17.4	16.6	6.7
Feed properties					
Melting point, °F	329	320	300	298	302
Distillate, wt %					
600°F, 0.1 mm Hg	14.7	6.5	6.1	7.2	8.9
Sulfur, wt %	1.64	1.74	1.60	1.66	1.34

The SRC recovery in the CSD process increases with increasing asphaltene-to-preasphaltene ratio in the feed. Higher ratios seem to occur at higher dissolver pressures, as shown below:

Run	160	161	162
Dissolver pressure, psig	1,700	1,700	2,100
Asphaltene/preasphaltene ratio in feed	1.4	1.0	3.2
SRC recovery, %	82	76	84

The compositions of the CSD feed and the V110 SRC are shown below:

Run	160		161		162	
	V110 SRC	KM[b] Feed SRC	V110 SRC	KM[b] Feed SRC	V110 SRC	KM Feed SRC
Composition, wt %						
Oil	27.7	32.3	24.2	30.0	33.9	35.7
Asphaltene	36.1	39.8	37.0	36.2	50.0	52.5
Preasphaltene[a]	36.2	27.9	38.8	33.8	16.1	11.8

(a) Cresol soluble.
(b) From feed pumps to CSD unit.

Run	163		164	
	V110 SRC	KM[b] Feed SRC	V110 SRC	KM[b] Feed SRC
Composition, wt%				
Oil	33.3	29.9	24.8	31.4
Asphaltene	41.8	43.0	40.2	41.3
Preasphaltene	24.9	27.1	35.0	27.3

(a) Cresol soluble.
(b) From feed pumps to CSD unit, solvent containing basis.

3. SRC Recovery

Normalized yield data for the CSD unit were:

Run	160		161	
Feed rates, lb/hr	% of MF Coal	% of Feed	% of MF Coal	% of Feed
SRC	49.1	62.8	41.4	51.0
Oil	13.5	17.3	8.8	10.9
Asphaltene	24.9	31.8	26.0	32.1
Preasphaltene	9.3	12.0	6.3	7.8
Unreacted coal	1.2	1.6	0	0.1
Ash	0	0	0	0
Deashing solvent	0.1	0.2	0.1	0.2
Ash Concentrate	27.6	35.3	34.9	43.0
Oil	1.3	1.6	2.1	2.5
Asphaltene	1.8	2.3	1.8	2.2
Preasphaltene	6.7	8.5	8.5	10.5
Unreacted coal	6.2	7.9	8.4	10.3
Ash	9.8	12.5	13.0	16.0
Deashing solvent	1.8	2.4	1.1	1.4

Run	162		163	
Feed rates, lb/hr	% of MF Coal	% of Feed	% of MF Coal	% of Feed
SRC	42.0	54.8	39.3	51.8
Oil	13.7	17.9	12.1	15.9
Asphaltene	24.7	32.2	20.6	27.2
Preasphaltene	3.4	4.4	6.4	8.4
Unreacted coal	0.1	0.1	0.1	0.1
Ash	0	0	0.2	0.2
Deashing solvent	0.1	0.2	0	0.1
Ash Concentrate	33.4	43.5	31.8	41.9
Oil	2.6	3.3	2.3	3.0
Asphaltene	2.5	3.3	1.6	2.1
Preasphaltene	4.8	6.3	4.3	5.6
Unreacted coal	6.4	8.4	8.7	11.4
Ash	12.8	16.7	12.2	16.1
Deashing solvent	4.2	5.5	2.8	3.7

Run	164	
Feed rates, lb/hr	% of MF Coal	% of Feed
SRC	44.2	32.8
Oil	8.9	6.6
Asphaltene	21.1	15.7
Preasphaltene	13.9	10.3
Unreacted coal	0.1	0.1
Ash	0.0	0.0
Deashing solvent	0.1	0.1
Ash Concentrate	52.3	38.9
Oil	2.8	2.1
Asphaltene	2.3	1.7
Preasphaltene	8.8	6.5
Unreacted coal	25.1	18.6
Ash	9.0	6.7
Deashing solvent	4.3	3.2

SRC component balances for each run were:

Run	160				
	KM Feed	KM - Products: Ash conc	KM - Products: SRC + LSRC	KM - Products: Total	Total, % of Feed
Component, lb/hr					
Deashing solvent	0	6.70	0.65	7.35	-
Oil	74.03	4.67	56.74	61.41	82.9
Asphaltene	91.05	6.44	95.21	101.65	111.6
Preasphaltene	63.82	24.16	33.92	58.08	91.0
Ash	36.31	35.55	0.04	35.59	98.0
Unreacted coal	18.44	22.49	4.48	26.97	146.3
Total	283.65	100.01	191.04	291.05	102.6

Run	161				
	KM Feed	KM - Products			Total, % of Feed
		Ash conc	SRC + LSRC	Total	
Component, lb/hr					
Deashing solvent	0	4.56	0.69	5.25	-
Oil	76.28	8.42	49.38	57.80	75.8
Asphaltene	91.87	7.45	118.30	125.75	136.9
Preasphaltene	85.57	34.92	25.78	60.70	70.9
Ash	53.40	53.01	0.00	53.01	99.3
Unreacted coal	24.54	34.23	0.17	34.40	140.2
Total	331.65	142.59	194.32	336.91	99.5

Run	162				
	KM Feed	KM - Products			Total, % of Feed
		Ash conc	SRC + LSRC	Total	
Component, lb/hr					
Deashing solvent	0	16.09	0.48	16.57	-
Oil	78.67	9.82	66.29	76.11	96.7
Asphaltene	115.65	9.60	102.26	111.86	96.7
Preasphaltene	25.83	18.53	13.05	31.58	122.3
Ash	51.07	49.11	0.10	49.21	96.4
Unreacted coal	22.31	24.55	0.22	24.77	111.0
Total	293.53	127.70	182.40	310.10	105.6

Run	163				
	KM Feed	KM - Products			Total, % of Feed
		Ash conc	SRC + LSRC	Total	
Component, lb/hr					
Deashing solvent	-	11.60	0.73	12.33	-
Oil	71.59	9.38	68.15	77.53	108.3
Asphaltene	102.72	6.41	97.29	103.70	101.0
Preasphaltene	64.74	17.45	26.10	43.55	67.3
Ash	51.67	49.97	0.67	50.64	98.0
Unreacted coal	20.54	35.49	0.35	35.84	174.5
Total	311.27	130.30	183.29	323.60	104.0

Run	164				
	KM Feed	KM - Products			Total % of Feed
		Ash conc	SRC + LSRC	Total	
Component, lb/hr					
Deashing solvent	0	10.19	0.25	10.44	-
Oil	82.43	6.53	70.09	76.62	93.0
Asphaltene	108.32	5.41	99.23	104.64	96.6
Preasphaltene	71.37	20.61	33.58	54.19	95.9
Ash	21.16	21.17	0.06	21.23	100.3
Unreacted coal	32.53	58.89	0.25	59.14	181.8
Total	315.81	122.80	203.46	326.26	103.3

4. Ash Separation

a. Ash Concentrate Processing

Ash concentrate from the underflow of the first stage of the CSD unit is discharged continuously from the ash processing systems. The percentage of the feed reporting to the ash concentrate discharge for each material balance run was:

Run	160	161	162	163
Ash concentrate, % of feed	35.3	43.0	43.5	41.9
Ash in ash concentrate, %	35.6	37.2	38.4	38.4

The reduction in the amount of ash concentrate relative to the feed during Run 160 was due primarily to the ash content in the feed. For Runs 161, 162, and 163, the ash in the feed averaged 16.7%, but for Run 160, the ash in the feed was only 12.8%.

The preasphaltene (PA) and unreacted coal (UC) balances for the material balance are presented below:

Run	160		161		162		163		164	
Component, lb/hr	PA	UC	PA	UC	PA	UC	PA	UC	PA	UC
Feed	63.82	18.44	85.57	24.54	25.83	22.31	64.74	20.54	71.37	32.53
Ash conc.	24.16	22.49	34.92	34.23	18.53	24.55	17.45	35.49	20.61	58.89
SRC	33.92	4.44	25.78	0.17	12.99	0.22	26.10	0.32	32.68	0.20
LSRC	0	.04	0	0	0.06	0	0	0.03	0.90	0.05
Output/input x 100	91.00	146.26	70.94	140.18	122.26	111.03	67.27	174.49	75.93	181.80

Except for Run 162, the percent unreacted coal increased while the percent preasphaltene decreased. Figure 14 illustrates the relationship between CSD unit first stage temperatures and percent UC recovery. Figure 15 illustrates the relationship between unreacted coal and preasphaltene recovery.

b. SRC Recovery

The SRC recoveries for the material balance periods were:

Run	160	161	162	163	164
SRC recovery, %					
by normalized material balance[(a)]	82.1	76.2	80.8	78.4	77.5
by forced ash balance	82.3	75.9	80.6	78.8	77.5

(a) Calculated using flow rates obtained by difference between feed ash and ash concentrate streams. Included correction for formation of undissolved coal.

The recoveries for the individual SRC components were:

Run	160			161		
	KM(b) feed	Ash conc	SRC(a) Recovery	KM(b) feed	Ash conc	SRC(a) Recovery, %
Component, lb/hr						
Deashing solvent	0	6.70			4.56	
Oil	68.58	4.67	93.2	76.28	8.42	88.96
Asphaltene	87.52	6.44	92.64	91.87	7.45	91.89
Preasphaltene	63.82	24.16	62.14	85.57	34.92	59.19
Ash	36.31	35.55		53.40	53.01	
Unreacted coal	18.41	22.49		24.54	34.23	
Total	274.64	100.00	82.11	331.65	142.60	76.16

Run	162			163		
	KM(b) feed	KM Ash conc	SRC(a) Recovery, %	KM(b) feed	KM Ash conc	SRC(a) Recovery, %
Component, lb/hr						
Deashing solvent		16.09			11.60	
Oil	71.73	9.82	86.31	62.25	9.38	84.94
Asphaltene	111.82	9.60	91.42	96.36	6.41	93.35
Preasphaltene	25.80	18.53	28.18	64.74	17.45	73.05
Ash	51.07	49.11		51.66	49.97	
Unreacted coal	22.31	24.55		20.53	35.49	
Total	282.73	127.70	80.80	295.54	130.30	78.42

Run	164		
	KM(b) feed	KM Ash conc	SRC(a) Recovery, %
Component, lb/hr			
Deashing solvent		10.19	
Oil	82.43	6.53	92.1
Asphaltene	109.32	5.41	95.0
Preasphaltene	71.37	20.61	71.1
Ash	21.16	21.17	
Unreacted coal	32.53	58.89	
Total	315.81	122.80	77.5

(a) Calculated using flow rates obtained by difference between feed ash and ash concentrate streams. Included correction for formation of unreacted coal.
(b) Exclusive of LSRC recycled.

The overall SRC recovery is calculated by subtracting the oil and asphaltene rates in the ash concentrate, as well as the incremental unreacted coal in the ash concentrate (compared to that of the feed) from the component feed rates. This corrects for any loss of SRC due to formation of cresol-insoluble material by repolymerization in the CSD unit.

Recoveries of oil and asphaltene ranged from 84-94%. The recovery of preasphaltene ranged from 28-73%. For Runs 160, 161, and 163, the preasphaltene in the feed averaged 23.4%, and the preasphaltene recovery averaged 64.8%. But for Run 162, the preasphaltene was only 8.8% and recovery was 28.2%.

The SRC elemental analyses for the material balance periods were as follows:

Run	160	161	162	163	164
Element, wt %					
Carbon	86.63	86.49	86.22	87.99	87.20
Hydrogen	6.18	5.86	6.29	6.29	5.60
Nitrogen	1.91	1.64	2.07	1.18	1.40
Sulfur	1.25	1.34	0.91	0.85	1.10
Ash	0.02	0.01	0.06	0.40	0.00
Oxygen	4.01	4.66	4.45	3.29	4.70

Component balances for the CSD unit show that the amount of cresol insoluble reaction product increases during processing in the unit, and that the amount of preasphaltene decreases. As shown in Figure 14, when the temperature in the first stage of the CSD unit increases, the per cent cresol insoluble coal in ash (calculated in the same manner as the per cent feed component) also increases.

Feed component deviations are also due to:

- Composition changes attributable to the CSD unit itself.
- Imprecise elemental analyses.

5. Light SRC (LSRC) Separation

The LSRC, a mixture of distillate process solvent and SRC, can be obtained from the third stage of the CSD unit. The LSRC can be used to replace process solvent that remains in the SRC which is fed to the CSD unit.

During the second quarter, LSRC feed to the process contained an average of 30% solvent. The LSRC compositions for Runs 160 through 164 remained essentially constant. Elemental analyses of the LSRC from each run were:

Run	160	161	162	163	164
Element, wt %					
Carbon	85.43	86.56	85.92	86.03	87.03
Hydrogen	7.05	6.76	6.85	7.12	6.40
Nitrogen	1.55	1.70	1.85	1.16	1.00
Sulfur	1.00	0.83	0.74	0.79	0.92
Ash	0	0	0	0.09	0.05
Oxygen	4.97	4.15	4.64	4.81	4.60

6. Deashing Solvent Recovery

The reasons for most of the deashing solvent losses were determined. Deashing solvent losses to products averaged 3.44% of the CSD feed, while total losses were 7.1% of the feed. The following table illustrates this:

Run	160		161		162	
Stream	lb/hr	% of CSD feed	lb/hr	% of CSD feed	lb/hr	% of CSD feed
Ash concentrate	6.70	2.36	4.56	1.37	16.09	5.48
SRC	0.53	0.19	0.51	0.15	0.48	0.16
LSRC	0.12	0.04	0.18	0.05	0	0
Total	7.35	2.59	5.25	1.58	16.57	5.64

Run	163		164	
Stream	lb/hr	% of CSD feed	lb/hr	% of CSD feed
Ash concentrate	11.60	3.73	10.19	3.23
SRC	0.19	0.06	0.24	0.08
LSRC	0.54	0.17	0.01	0
Total	12.33	3.96	10.44	3.31

Solvent was also lost to the atmosphere, as shown on the table below:

Run	160	161	162	163	164
Deashing solvent losses to atmosphere, lb/hr	27.45	26.75	27.93	11.77	26.36
% of CSD Feed	9.67	8.05	9.51	3.78	8.35

The solvent losses from the CSD unit occur mainly in the ash concentrate and to the atmosphere. The primary losses seem to occur from the CSD first stage. Techniques to recover the deashing solvent from the first stage are under study. Possibilities include direct contact with superheated steam, indirect heating with steam and sealing of vessels.

The deashing solvent recovery system was operated during the second quarter to remove contaminants from the deashing solvent.

H. PRODUCT ANALYSES AND PROPERTIES

The SRC composition was determined by conventional solvent extraction (extraction with benzene in the presence of Celite to separate the oil-asphaltene mixture from the benzene-insoluble preasphaltenes). After benzene was removed by distillation, the residue (oil-asphaltene mixture) was extracted with pentane to separate the oil from the pentane-insoluble asphaltenes.

The solvent refined coal analyses (including the solvent fractionation results) are shown in Table 11. Data for the solvent fractionation of SRC are:

Run	160MB			161MB			162MB		
Date, 1979	25-26 March			9-10 April			26 April		
Sample location	V110,	CSD,	CSD,	V110,	CSD,	CSD,	V110,	CSD,	CSD,
Material	lab-filt. SRC	SRC feed	deashed SRC	lab-filt. SRC	SRC feed	deashed SRC	lab-filt. SRC	SRC feed	deashed SRC
Composition, wt %[a]									
Oil	27.7	25.8	21.5	24.2	23.6	25.2	33.9	30.0	24.3
Asphaltenes	36.0	43.6	57.0	37.0	39.6	53.8	50.0	57.2	66.6
Preasphaltenes	36.3	30.6	21.5	38.8	36.8	21.0	16.1	12.8	9.1

Run	163MB			164MB		
Date, 1979	11-12 May			4-5 June		
Sample location	V110,	CSD,	CSD,	V110,	CSD,	CSD,
Material	lab-filt. SRC	SRC feed	deashed SRC	lab-filt. SRC	SRC feed	deashed SRC
Composition, wt %[a]						
Oil	33.3	22.7	26.9	24.8	24.7	13.9
Asphaltenes	41.8	47.4	56.0	40.2	45.3	51.9
Preasphaltenes	24.9	29.9	17.1	35.0	30.0	34.2

(a) Cresol soluble and solvent-free basis.

The preasphaltene content of the SRC from the CSD unit is lower than the preasphaltene content of the reaction section (V110) SRC. It appears that the SRC from the CSD unit had the highest preasphaltene content during the SRT addition run (Run 164).

Viscosities of SRC from the CSD unit for several MB runs are shown below:

Coal type	Kentucky 9			
Run	160MB	161MB	162MB	163MB
Date, 1979	25-26 March	9-10 April	26 April	11-12 May
Solids withdrawal	no	yes	yes	yes
Dissolver volume	75%	75%	75%	75%
Dissolver pressure, psig	1,700	1,700	2,100	1,700
Preheater temp, ^{o}F	780	780	780	860
Viscosity at 500^{o}F, cp				
at 0.84 shear rate, sec^{-1}	5,500	3,700	4,300	3,200
1.7 shear rate, sec^{-1}	4,600	3,450	3,600	3,000
3.4 shear rate, sec^{-1}	4,150	3,150	3,225	2,825
Viscosity at 550^{o}F, cp				
at 0.84 shear rate, sec^{-1}	1,400	600	800	500
1.7 shear rate, sec^{-1}	1,000	450	600	400
3.4 shear rate, sec^{-1}	825	375	450	350

The SRC samples from the CSD unit were heated to 600 °F at 0.1 mm Hg to remove the solvent prior to viscosity determination.

I. PRODUCT SOLIDIFICATION

Liquid SRC from T102 is fed to two vibrating water-cooled trays of the Rexnord Product Cooler. The SRC solidifies into brittle sheets which shatter into small fragments upon vibration. The fragmented SRC is conveyed to storage. A portion of the liquid SRC from T102 was processed through the CSD unit where it was deashed and collected in drums. The amount of T102 bottoms processed in the CSD unit during the second quarter was 154.8 tons, which was 48.8% of the total T102 bottoms product.

J. EFFLUENT TREATMENT

Construction of the return activated sludge system was essentially complete by January 1979. Caustic waste was introduced to the pretreatment tanks on 23 January, after initial checkout of the unit with city water. The bioreactors (aeration basins) were heated to 60° F with live steam and the first innoculation with biological cultures began on 29 January. The bioculture came from the plant sanitary system and from a biological waste treatment system at a nearby coke-oven by-products plant. Activated carbon was also added to aid in the biological treatment of the waste water.

The effluent treatment system has been able to process all of the waste streams. The unit has maintained discharges within the legal limits imposed by the Alabama Water Improvement Commission (AWIC) and the EPA. A process flow diagram, a copy of the AWIC permit, and monthly trend charts of the major permit parameters are presented in Appendix C.

The only significant equipment failure was plugging of the gradient bed filter that occurred in May. This was caused by suspended solids that escaped from the final clarifier. The emergency holding basin was used to hold the clarifier outfall while the filter gradient was being replaced.

The use of activated carbon was discontinued early in June, and a small amount of feed (1-2 gpm from the equalization basin) was added to the second stage bio-reactor. The settling of sludge in the clarifier improved. Currently, the clarifier effluent is within permit specifications for suspended solids. These actions should have corrected the plugging problem. Reductions of BOD have been consistently above 99% since startup.

V. MECHANICAL PERFORMANCE

A. AGITATORS

After several shear pins on V101A Slurry Blend Tank agitator failed, the unit was inspected and a bent blade was found. The blade was straightened and the coupling was rebored to tighten the wobbling mixer shaft.

B. COMPRESSORS

No major mechanical problems were attributed to the plant compressors.

C. DRYERS

The mixer was removed from the new D102 Ash Cooler to repair a leak at a weld attaching the discharge nozzle to the vessel wall. The vessel fabricator made repairs and the vessel was recoded with an ASME "R" designation.

D. FIRED HEATERS

On 6 June, B102 Slurry Preheater plugged. After several unsuccessful attempts to unplug the unit, the heater coil was cut in fourteen places for hydroblasting. Pinhole leaks were also found at two thermowells located in the upper section of the heater. Samples of the heater coil and thermowells were sent to Air Products and Chemicals, Inc. for metallurgical analysis.

Because of numerous B102 Slurry Preheater burner failures, a safety system annunciator has been ordered to help determine the cause.

All other plant heaters operated for the period without problems.

E. HEAT EXCHANGERS

E102 Dissolver Product Cooler for V103 Flash Tank leaked at a tube plug after a blowout of the plug gasket. The plug was welded into the tube sheet.

F. FILTERS

Modifications of the United States Filter Corporation (USF) filter were completed and the filter was assembled and pressure-tested. The filter door, leaking from a warped flange, was sent to a machine shop where its gasket surface was re-machined. On 14 June, the filter was started. Because of high ash in the filtrate, the filter was shut down on 17 June for inspection. A gasket between a screen and a screen spacer was defective. The screen cloth was also partly detached from the support screens. All maintenance work on the filter was stopped until USF could supply improved screens.

G. PUMPS

The Lawrence slurry pump operated without problems for the filter test period. A bearing on P103B Slurry Feed Pump failed, and the pump drive was found to be badly worn. The faulty bearing was replaced and new components have been ordered to replace the worn parts. Blown check valve gaskets and packing leaks continue to plague P180A and B CSD Feed Pumps.

H. VALVES

The tip of the plug on XV4078 Solids Withdrawal Valve was found to be broken. A new solids withdrawal valve (with modified plug) was installed and performed as designed. The original valve was a Group 36 Annin; the replacement was a Group 94 Annin angle valve.

LV415 A and B High Pressure Letdown Valves continued to operate without problems. Two attempts to test a silicon carbide plug in the LV415A valve failed when the plug fractured.

The first stage letdown system at the CSD unit continued to plug.

I. DISSOLVER (REACTOR) AND COLUMNS

A new gasket was installed on the bottom head of the R101 Dissolver during the bypass run. When the B102 Slurry Preheater plugged, the lines from B102 to R101 plugged also. Hydroblasting was required to clear the lines. The solids withdrawal system was inspected and returned to service.

The gasket on the lower head of the R101 Dissolver began leaking on 4 May (after an extended plant outage of the B102 Slurry Preheater). The bolts had been tightened to 9,000 ft-lb torque when the head was last bolted. It required 2,000 ft-lb of torque to loosen the bolts.

Repairs to the T105 Fractionation Column (replacing the tray 8 and 9 support rings and downcomers with 316 SS material) were completed on 15 June. The area from tray 10 to the bottom of tray 17 was lined with 11 gauge, 321 SS sheet. Holes, 3/4-in. in diameter on 4-1/2-in. centers, were drilled in each of 14 sections such that the liner could be plug-welded to the column wall. Upon installation of a section of the liner, root passes were made and all but one of the plug weld holes were welded. The unwelded hole was used to pressure-test the root passes for leaks. After installation of the liner, the welds were again pressure-checked and the test hole was closed. All carbon steel nozzles located in the area of the new lining were replaced with nozzles lined with 316 SS tubing. Corrosion probe and sampling nozzles were installed at trays 1, 9 and 15. Twenty new trays of 321 SS were installed in the column, and the column was pressure-checked using nitrogen at 20 psig. After the column was heated up to temperature on solvent, leaks developed at the full penetration welds of the new nozzles in the carbon steel section of the tower. (Welders had reported problems obtaining a good metal bond to the tower wall, possibly a result of hydrogen penetration). Preheating to 400-500°F for one hour allowed entrapped hydrogen gas to excape but, after preheating, welders still experienced difficulty bonding new material to the column shell.

T102 Vacuum Column was inspected on 19 June. The area below tray 8 contained five areas of corrosion characterized by long, narrow, deep grooves in the 410 SS cladding. Also, several small holes were noted in tray 8 support ring. The corroded areas were covered with strips of 316 SS plate and welded to the shell. Materials for a full repair are being expedited for late July.

A Dowtherm leak in the coil of T104 Light Solvent Recovery Column developed on 21 May. A new coil was fabricated and the column was returned to service on 25 May.

J. SPECIAL EQUIPMENT

Two new microautoclave drives were fabricated for use in the lab. These units use a smaller and lighter power head for ease of handling.

K. CRITICAL SOLVENT DEASHING UNIT

On 8 May, the unit was down to repair an electrical short circuit which appeared to have resulted from an overload and the presence of moisture. The unit was again shut down on 18 May to clean the lines and equipment.

Plugging of lines continued to be a problem. The Projects Group is in the process of modifying the unit to eliminate some of the problems, and to allow more access room for maintenance.

VI. PROJECTS

A. ACTIVE

1. Project 4142 - New V204 Flush Solvent Tank

This project provides for a new V204 Flush Solvent Tank rated at 600°F and 200 psig to provide flush solvent at 550-600°F to critical piping systems in the plant. This project is scheduled to be completed in conjunction with the hydrotreater installation (Project 4143).

2. Project 4143 - Hydrotreater Installation

This project provides for the installation of a hydrogenation unit at the Wilsonville pilot plant. It will permit exploration of various modes of short residence time operation while maintaining process solvent quality at low hydrogen consumption. It will also yield experimental data on the production of liquid fuels from SRC-I using conventional hydroprocessing catalysts. Engineering design is in progress. The target date for construction to start is mid-October 1979. Project completion is targeted for 1 July 1980.

3. Project 4144 - Critical Solvent Deashing Modifications

This project provides for the following:

- recovery of deashing solvent in a high-pressure, high-temperature recycle system,
- a new first stage to provide increased capacity for future process conditions, and
- expanded plant operating area to accommodate new equipment and relocated existing equipment.

The engineering design is scheduled to be completed by 31 July. Construction is scheduled to begin in mid-August with a target completion date of 15 November.

4. Project 4145 - USF Filter Modifications

This project provides for the addition of tanks, pumps, and piping systems to provide the filter with a high-pressure sluice capability in the precoat and non-precoat modes of operation. Engineering design work is complete. Construction is scheduled to begin 9 July with a target completion date of 31 August.

B. COMPLETED

1. Project 4122 - New Ash Cooler

This project covers the installation of a new ash cooler, which is designed to improve the cooling of the dry ash discharge from the filter and also to improve dust and vapor containment. This project was completed in May.

2. Project 4127 - Lawrence Slurry Pumps

This project covers the installation of a Lawrence Slurry Pump, which is designed to handle abrasive slurries at the high temperatures and high heads required for the mineral residue separation section of the plant. The pump is built with a replaceable metal liner which, when worn, will leave the casing intact for containment of process fluid. This project was completed in May.

VII. CONCLUSIONS

The following were observed during the second quarter of 1979:

The hydrogen-donor quality of the process solvent decreased markedly after a change in the Kentucky No. 9 coal on 20 May from the Pyro mine to the Lafayette mine. No other operating parameters changed significantly. Before the switch in coals, process solvent hydrogen-donor quality had been in the high-sixty to mid-seventy per cent range. After the switch, the solvent hydrogen-donor quality gradually decreased to the mid-sixty per cent range. Efforts to raise solvent hydrogen-donor quality by increasing the dissolver pressure met with only partial success; and the high solvent qualities obtained during Run 162 (when feeding Pyro mine coal) could not be reproduced using the Lafayette coal. As shown in Table 12, there appear to be no major differences in coal analyses except for the ash content and the chemical form of the existent sulfur.

From the limited analytical data available, one cannot explain the decrease in solvent hydrogen-donor quality. Prior data indicate that solvent hydrogen-donor quality tends to increase with increasing dissolver pressure. This tendency is best illustrated in Runs 159 and 160 (Ref. 1) and Runs 161 and 162 (in this report). Runs 159, 160 and 161 were made at the same dissolver pressure and recycle gas rate. While solvent hydrogen-donor quality varied during these three runs, the variations can be attributed to variations in solvent boiling range. Solvent from Run 159 MB had more light boiling, lower hydrogen-donor quality components that that from Runs 160 MB or 161 MB. Solvent from Run 160 MB had the least boiling components and the highest quality. The reasons for the variations in solvent boiling range are not clear from the present data. The apparent effect of solvent boiling range on solvent hydrogen-donor quality was evident in Runs 159, 160, and 161. However, in Run 162, the solvent hydrogen-donor quality (microautoclave short test) was clearly superior to that for the previous three runs. There are strong indications that the major factor influencing the improvement in solvent hydrogen-donor quality was the higher dissolver pressure (2,100 psig versus 1,700 psig) of Run 162.

No conclusions are drawn at this time concerning the effect of recycling LSRC on solvent hydrogen-donor quality, SRC yields, or CSD recovery. Further investigations of LSRC effects are scheduled for the third quarter of 1979.

VIII. FUTURE PLANS

During the third quarter of 1979, the effects of reaction conditions on the performance of the Critical Solvent De-ashing (CSD) unit will be studied.

Observations of the product recovery capability of the CSD unit will be made at dissolver conditions ranging from 1,700 to 2,400 psig pressure and 825 to 850°F. Tests will be made with and without withdrawal of solids from the dissolver bottom and at various concentrations of process solvent in the CSD unit feed.

A dissolver bypass run will be completed to evaluate the CSD unit performance at short residence time conditions while blending about 25% third-stage CSD unit product into the process solvent.

Evaluation of the USF filter with new screens (using pre-coat) will begin in September. Evaluation of the filter modifications will continue into the fourth quarter. The CSD unit will be down for six weeks (except for a two-week off-the-line run on H-Coal®) during the evaluation of the USF filter. Modifications of the CSD system will be completed during this period.

REFERENCE

1. Quarterly Technical Progress Report (FE-2270-48) for the period January-March 1979, prepared for Southern Company Services, Inc., Project No. 43480 (prepared by Catalytic, Inc.).

APPENDIX A
OPERATING LOG

April, 1979

1. Run 161 was in progress with withdrawal of 5-10% solids from the bottom of R101 Dissolver. T105 was out of service, undergoing repairs. The CSD unit lost only 0.3 hr of operating time.

2. Operations were generally good. A series of solids withdrawal rate checks was begun at R101.

3. The CSD unit operated for only five hours due to problems with the second stage level instrument.

4. T102 bottoms transfer was started at 0420 hr. Processing was continuous. Average rate was 277 lb/hr.

5. The CSD unit had no operational delays. The solids withdrawal system operated smoothly.

6. Letdown system plugging disrupted CSD operation for approximately four hours.

7. A 24-hr material balance period "A" was started at 1200 hr.

8. A second 24-hr material balance period "B" was begun when the "A" period ended.

9. Several power surges occurred during a heavy rainstorm, but no operating time was lost. Run 161C material balance period started at 1200 hr.

10. No operational problems were experienced. Material balance period "D" started at 1200 hr, but was ended at 2030 hr because of problems with the CSD unit second stage level control. Coal feed to the SRC unit was not interrupted. T102 bottoms was diverted to K125.

11. With conditions again stable, 24-hr material balance "E" was started at 0001 hr.

12. A change to Run 162 was made by raising R101 outlet pressure from 1,700 psig to 2,100 psig. A series of momentary power failures was experienced on the second shift. All equipment was quickly restarted. Transfer to the CSD unit was stopped at 1010 hr because of plugging in the letdown system.

13. A power dip at 0825 hr tripped out several pieces of equipment. Each was restarted immediately. The CSD unit was operational at 2030 hr.

14. The CSD letdown system plugged. A leak in a jacketed line allowed SRC to contaminate the T66 heat transfer medium.

15-18. Operations were generally good.

19. The CSD unit was restarted at 1515 hr. B102 Slurry Preheater had flame failure five times during the second shift. The problem was due to poor combustion.

20. The plant waste water treatment system has been producing specification effluent despite excessive rainfall. Flame failure and a thermowell leak on B102 forced an emergency shutdown at 1425 hr. The dissolver solids amounted to 109 lb. The CSD unit went on standby.

21. Coal feed was resumed at 0505 hr. The blowdown solids were reintroduced. Transfer to the CSD unit was started at 1053 hr.

22. The letdown system plugged in the CSD unit, forcing a shutdown at 0600 hr. Feed was resumed at 0855 hr.

23. CSD feed was suspended from 1630 hr until 2300 hr due to plugging problems.

24. SRC unit problems were minimal. CSD unit feed was intermittent because of plugging.

25. Plugging continued to be a problem in the CSD unit during the first two shifts.

26. A 24-hr material balance was started at 0001 hr.

27. A second material balance was started as the "A" period ended, but it was stopped at 0330 hr due to a feed line failure to the CSD unit. Feed to the CSD unit was resumed at 1155 hr.

28. The vacuum column has operated quite smoothly throughout the month. Letdown system plugging in the CSD unit has been a continuing problem.

29. Two tube sheet plugs on E102 have been leaking, but the leaks have not worsened.

30. The SRC and CSD area problems were unchanged.

May, 1979

1. Run 162 was ended at 1830 hr. Operating conditions for Run 163 were changed to a higher B102 outlet temp-

erature with part of the feed gas diverted around the heater to control R101 outlet at 825°F. R101 outlet pressure was reduced by 400 psig. The changes were made to improve the CSD SRC recovery.

2. R101 temperature control was sensitive.

3. B102 Slurry Preheater flame control failed several times. Coal feed was stopped at 0725 hr. Sixty-two pounds of solids were collected on blowdown.

4. Coal feed was resumed at 2030 hr. A portion of the downtime was caused by an R101 bottom head flange leak.

5. The blowdown solids were reintroduced with the coal feed. T102 and T104 columns operated without trouble. Feed to the CSD unit was started at 0317 hr, and was continuous.

6. Transfer from T102 to the CSD unit was continuous. SRC unit operations were steady.

7. Temperature control of R101 was erratic. The CSD unit was on-line throughout the day.

8. Temperature control of R101 continued erratic. Indications from the density meters were also erratic. The CSD unit was forced down by an electrical short circuit.

9. CSD unit operations were resumed at 0516 hr.

10. A B102 high pressure outlet sample obtained at 1755 hr indicated 87.6% conversion.

11. A 24-hr material balance data period was started at 1200 hr.

12. The SRC and CSD units operated smoothly during the material balance period despite several momentary power dips.

13. A leak occurred at a union in the V110 vent line. A stainless steel line replacement was made.

14-16. The first stage CSD temperature was reduced by small increments to determine the effects on SRC recovery. No improvement above 82% was noted.

17. The method of dissolver/heater temperature control was altered to use the bypass feed gas rather than the heater outlet temperature as the variable to maintain 825°F at the dissolver outlet. The change was an im-

provement. The CSD first stage plugged and required hydroblasting.

18. Coal feed was suspended for 1.7 hours to permit work on B102 fuel control valve.

19. Problems were experienced from slurry made with wet coal. (Rainwater had seeped into a tote bin).

20. A changeover from Pyro to Lafayette mine coal was made at 0930 hr. Repairs to T105 continued. The CSD system was pressure-checked.

21. Dowtherm was found in the recycle solvent. The source was found to be a leak in T104 heater coil. Feed to the CSD unit was started at 1730 hr.

22. T104 was taken out of service to repair the leaking coil. CSD unit operations were continuous.

23-24. Operations were generally good. Stepwise adjustments in the first CSD stage were begun to further check the effect upon SRC recovery.

25. T104 was returned to service at 1400 hr.

26. A solids withdrawal sampling error required discontinuing coal feed for three hours to repressurize the front end.

27. A material balance period was started at 0001 hr, but it was terminated at 1200 hr when both feed pumps to the CSD unit failed.

28. Transfer to the CSD unit was resumed at 0335 hr. The letdown system plugged several times.

29. Operations were smooth in all areas.

30. Run 163 was terminated at 1900 hr in order to prepare the plant for an SRT dissolver bypass run. Blowdown solids were 386 lb (more than expected with the solids withdrawal system in operation).

June, 1979

1. Preparatory work for the next run was underway.

2. Run 164, a short residence time (SRT) run, was started at 0940 hr. Light SRC was added to the slurry makeup solvent in the amount of 15% by weight. The CSD unit was operated concurrently.

3. An increase to 25% LSRC in the slurry makeup solvent was made at 0600 hr. Pressure control problems in the CSD area made it necessary to stop coal feed at 1635 hr.

4. The run was resumed at 0600 hr. A 24-hr material balance period was started at 2100 hr.

5. The material balance had been underway for only 1.25 hours when a high differential pressure developed across B102 Slurry Preheater, forcing a shutdown.

6-13. Both the SRC and CSD units were down. B102 coil was hydroblasted; five worn thermowell tips were re-welded. Decoking was completed on 13 June. Valve repacking and necessary maintenance were completed in the CSD area.

14. Coal feed was begun at 0300 hr for start of Run 165, designed to rehydrogenate the process solvent and to supply feed to the USF vertical-leaf filter.

15-16. Two cycles were run on the filter with precoat only; then seven cycles with dissolved coal feed and a final solvent wash followed.

17. The filter was shut down for inspection. Solids in the filtrate were unacceptably high. Run 165 was terminated at 1835 hr because of a low fuel oil supply resulting from a truckers' strike.

18-20. The plant was down. B102 fuel oil valve was overhauled. Repairs necessitated by corrosion were made to T102 Vacuum Column.

21. Run 166 was started at 2130 hr. The CSD unit was made ready for operation.

22. A 2.5 hour power outage occurred at 0500 hr. R101 was blown down. Several motors were damaged in the CSD area when the power supply single-phased.

23. Coal feed was resumed at 1600 hr. One hour and 10 minutes feed interruption was required to correct a problem with the dissolver blowdown valve. The solids withdrawal system was put in service.

24. V144 blowdown material was introduced with slurry feed. B102 was down from 0830 to 0910 hr for maintenance work on the fuel oil valve. Coal feed was off again at 2150 hr when a power dip shut down B102.

25. Coal feed was resumed at 0130 hr. The solids withdrawal system operated smoothly. The three distillation columns also performed well. Feed to the CSD unit was somewhat erratic because of problems with the P180 transfer pumps.

26. T102 operating mode was altered to make it perform as a flash column with combined solvent removal from tray 3.

27. A leak occurred in the tray 13 area (at nozzle 7X) of T105 at 0930 hr. A packing leak in a solids withdrawal valve made it necessary to go off coal at 1215 hr. T102 was returned to the normal operating mode because of the leak in T105.

28. Coal feed was resumed at 0525 hr. Solids withdrawal was stopped as a move to improve the hydrogen-donor quality of the process solvent. Routine addition of 40 lb sodium carbonate per tote bin in coal slurry makeup was started at 1120 hr as a system corrosion inhibitor.

29. The CSD unit was on-line with no major problems. T105 was pressure-tested and found tight.

30. All systems (SRC, CSD, and waste treatment) were running smoothly as the quarter ended.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"A" PROGRAM: PRECOAT, SLUICE WITH FILTER FEED, USING SLUICE ARMS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
A-2	Pressure filter.	180	Open: PV673. Step: when PSH672C trips.
A-11	Fill filter through bottom.	260	Divert: XV654 to V141, XV658 to F125. Open: XV669, XV6035, XV6029, XV6053. DPCV6036, FV6026 on FIC6026. Step: when LSH 661 trips.
A-13	Set valves for precoating. Switch to side feed.	2	Open: XV686B, XV671. Close: XV6029. Step: when XV6029 and XV6027 limit switches indicate valves are closed.
A-14	Check valving.	2	Close: XV669, DPC6036. Step: when XV669 limit switch indicates valve is closed.
A-15	Precoat.	1,200	Step: when timer K-3 is out.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"A" PROGRAM: PRECOAT, SLUICE WITH FILTER FEED, USING SLUICE ARMS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
A-16	Remove excess precoat solvent.	60	Open: DPCV687. Close: XV686B. Step: when LSL620 trips.
A-17	Drop shell pressure.	10	Close: DPCV687. Open: DPCV686A. XV675. Step: when PSL672B trips.
A-18	Precoat drain.	470	Divert: XV658 to V141. Open: FV600 on flow control, PV673 on flow control. Close: XV671. Step: when LSL656 trips.
A-19	Fill with filter feed.	230	Divert: XV655 to F125, XV654 to V112. Open: XV669, XV6029, DPCV6036 on DPIC6036. Close: PV673, FV600, XV675, XV6035. Step: when LSH661 trips.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"A" PROGRAM: PRECOAT, SLUICE WITH FILTER FEED, USING SLUICE ARMS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
A-20	Start filtration at low flow rate.	10	Open: DPCV687 on ΔP control. FV6026 on low flow. Close: XV669, DPCV686A, DPCV6036. Step: when timer T-1 is out.
A-21	Step when DP reaches 50 psig.	120	Step: when DPSHH650 trips.
A-22	Filter to V120.		Open: FV6026 to high flow, XV6035. Step: when LSL640B trips.
A-27	Check valving.	2	Divert: XV655 to V112. Open: XV675. Close: XV6029. Step: when XV654 limit switch indicates valve is diverted to V112.
A-28	Drop shell pressure.	10	Close: FV6026, XV6035. Step: when PSL672B trips.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"A" PROGRAM: PRECOAT, SLUICE WITH FILTER FEED, USING SLUICE ARMS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
A-29	Check valving.	2	Step: when XV655 limit switch indicates valve is diverted to V112.
A-30	Drain filter feed to V112.	470	Open: FV600 on flow control, PV673 on flow control. Step: when LSL656 trips.
A-35	Position valves for wash fill. Check valving.	2	Divert: XV681 to V178. Close: FV600, PV673. Open: XV6029, XV669, DPCV6036 on DPIC-6036. FV6026 on FIC-6026. Step: when XV681 limit switch indicates valve is diverted to V178.
A-36	Fill with wash solvent.	280	Close: PV673, XV675. Open: XV6027. Step: when LSH661 (or LSH656) trips.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"A" PROGRAM: PRECOAT, SLUICE WITH FILTER FEED, USING SLUICE ARMS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
A-37	Cake wash. Check valving.	2	Open: XV6035. Close: XV669, DPCV6036. Step: when XV669 limit switch indicates valve is closed.
A-38	Cake wash.	300	Step: when specified amount of wash fed as set on differential level switch LSL9044.
A-40	Close valves.	10	Open: XV675. Close: FV6026, XV6029, XV6027, XV6035. Step: when XV6027 and XV6029 are closed.
A-41	Drop shell pressure.	10	Step: when PSL672B trips.
A-43	Drain.	520	Open: FV600 on FIC600, PV673 on flow control. Step: when LSL656 trips.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"A" PROGRAM: PRECOAT, SLUICE WITH FILTER FEED, USING SLUICE ARMS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
A-44	Check valving.	2	Divert: XV681 to XV654. Close: FV600. Step: when XV681 limit switch indicates valve is diverted to XV654.
A-45	Cake blow.	60	Open: PV673 on flow control. Step: when timer T-2 is out.
A-46	Open filtrate line to vent.	2	Open: XV6037. Close: DPCV687, XV675, XV6053, PV673. Step: when XV6037 limit switch indicates valve is open.
A-47	Depressurize.	120	Open: XV674, FV684 on DPIC687, DPCV6036 on DPIC6036. Close: PV673. Step: when PSL672 trips.
A-49	Dry cake in "C" program	364	Open: XV690, DPCV6036. Close: XV674, FV684. Step: when "C" program is on step C-8.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"A" PROGRAM: PRECOAT, SLUICE WITH FILTER FEED, USING SLUICE ARMS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
A-51	Prepare for discharge.	10	Open: XV665 A and B. Turn conveyor motor on. Close: XV690, XV6036, XV6037. Step: when XV665 limit switch indicates valve is open.
A-52	Discharge by rotating leaves and conveyor.	180	Turn on leaf rotator (low speed). Step: when timer T-5 is out.
A-53	Close bottom valve.	10	Close: XV655 A and B. Turn off leaf motor. Step: when XV665 limit switch indicates valve is closed.
A-54	Check that leaves are in position.	0-60	Turn off conveyor motor. Step: when leaf position switch indicates bottom position.
A-55	Pressure to 120 psig.	180	Open: PV673 on flow control. Step: when PSH672C trips.

Note: When XV665 A opens, vibrator turns on. When operating in manual do not leave vibrator on for more than ten minutes. Also XV665B will not open unless the ash cooler door is closed.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"A" PROGRAM: PRECOAT, SLUICE WITH FILTER FEED, USING SLUICE ARMS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
A-56	Sluice from V112 in B program.	1,080	Open: FV6026 on flow control, XV6035, XV659. Step: when B program is at B7.
A-57	Blow heel.	10	Open: XV675, PV673 flow control. Close: FV6026, XV6035. Step: when timer T-1 times out.
A-58	Wait for leaf to position.	0-60	Close: XV675, XV659, PV673. Step: when leaf position switch indicates bottom position. Advance "B" program to B1.
	END OF CYCLE.		Return to step A-1 to start another cycle or to A-0 if program hold is used.
	Programmer off.		XV658 to V141, XV654 to V112, XV655 to V112, XV681 to XV654, XV604 to V140, XV542 to V111, XV801G open, XV6053 closed. Other valves are normally closed.
	Downtime: Precoat	5,870	
			V112 is refilled manually each cycle. Precoat is transferred from V140 to V141 manually each cycle.

"B" PROGRAM: SLUICING STEPS

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
B-1	Hold until started by A program.		"A" program steps "B" program on step A-56.
B-5	Sluice leaves from V112.	1,080	Open: XV6028, XV655, XV6038. Step: when end of sluice limit switch trips.
B-6	Flush high & low level probes.		Step: when timer K-4 times out.
B-7	Step "A" program.		Advance "A" program to A-57. Step: when step A-57 is reached. Return to B-1.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"C" PROGRAM

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
C-1	Check vent valve position	1	Step: if XV801G is open.
C-2	Hold for "A" program.	1	Step: when "A" program is on step A-49.
C-3	Continue to depressure to K115 and start vacuum.	10	Step: when timer K-6 times out.
C-4	Dry.	300	Step: when timer K-5 is out.
C-5	Break vacuum.	60	Open: SV801C. Close: XV801H. Step: when PSH 835 indicates 0 psig.
C-6	Reset valves.	2	Open: XV801G. Close: XV801C. Step: when XV801G limit switch indicates valve is open.
C-7	Blow horn.	10	Step: when timer K-6 times out.

APPENDIX B: SUMMARY OF USF FILTER CYCLE

"C" PROGRAM

STEP	DESCRIPTION	EXECUTION, SECONDS	OCCURRENCE OR MANUAL ACTION
C-8	Return to "A" program. Hold until end of cake discharge.	2	"C" program steps "A". Step: when "A" program is on step A-52. Return to Cl.

END OF CYCLE.

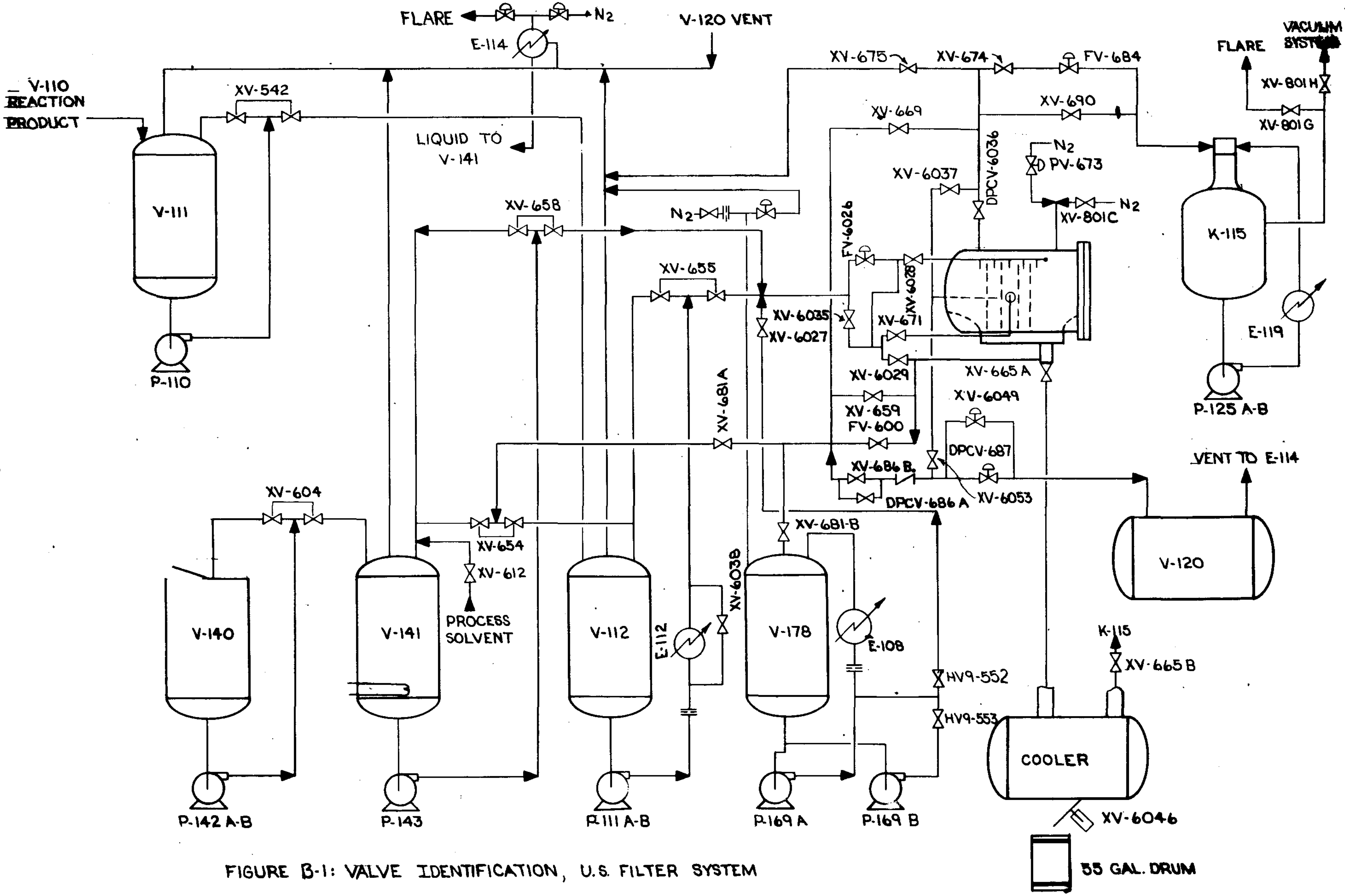

FIGURE B-1: VALVE IDENTIFICATION, U.S. FILTER SYSTEM

APPENDIX C

STATE OF ALABAMA
WATER IMPROVEMENT COMMISSION

PERMIT FOR DISCHARGE
Issued To:

Cayalytic, Inc.
Wilsonville, AL

Plans, specifications and other information for the design, construction, and operation of waste treatment facilities having been approved by the staff of the office of the Alabama Water Improvement Commission, Montgomery, Alabama, in accordance with Title 22, §§ 22-22-1 et seq., Code of Alabama (1975); and having determined that the project was constructed in accordance with the approved plans and specifications, a permit is hereby issued for the discharge of treated wastes from the facility described as follows:

Process Wastes: Discharge 001

In-plant collection of wastes in the liquid waste sump and the caustic sump. Caustic wastes are pumped through an oil separator rated at 20 gpm, then to two 10,000 gallon pretreatment tanks then to a 55,000 equalization/storage tank. Caustic sump wastes then join with liquid waste sump wastes for biological treatment. Aeration Tank #1 has a volume of 38,500 gallons, and discharges to a secondary settling tank with a surface area of 64 square feet. Wastes then flow through Aeration Tank #2, which has a volume of 36,000 gallons, then to a secondary clarifier 10 feet in diameter. Clarifier overflow is filtered in an automatic backwash, dual-media filter with an area of approximately 21 square feet. A 50,000 gal. emergency holding basin is used to collect stormwater and spills in the plant. Wastewaters are pumped to the equalization/storage tank or to the biological treatment system. Waste biological sludge is treated in a 1,500 gallon aerobic digester then dewatered in covered sand bed filters with an area of 100 square feet.

Sanitary Wastes: Discharge 002

Treatment is provided in a 15,000 gallon per day package plant.

The purpose of said treatment facilities is to provide treatment of process and sanitary waste from a solvent-refined coal pilot plant. The effluent from the above described facilities is to be discharged into a tributary of Yellow Leaf Creek.

This permit for discharge as described above is hereby issued subject to the following conditions:

1. The approval of the Water Improvement Commission;

2. The rules and regulations of the said Water Improvement Commission;

3. The provisions of Title 22, §§ 22-22-1 et seq., Code of Alabama (1975), and amendments now or hereafter adopted;

4. The wastes discharged under this permit shall not contain materials likely to be: toxic or otherwise injurious to fish, aquatic life, or wildlife; detrimental to the health and welfare of the public; or restrictive to use of the stream for agriculture, livestock watering, navigation or other beneficial purposes;

5. The effluent shall not violate applicable water quality standards now or hereafter adopted;

6. The characteristics of the treated waste shall not exceed the following limits:

Discharge 001: Process Wastes

Parameter	Daily Average	Daily Maximum
Flow	15,000 GPD	---
Biochemical Oxygen Demand, 5-day	30 mg/1	60 mg/1
Total Suspended Solids	30 mg/1	60 mg/1
Oil and Grease	10 mg/1	15 mg/1
Phenolics	0.5 mg/1	1.0 mg/1
Temperature	95°F	100°F
Settleable Solids	---	1.0 ml/1
pH	6.0 - 9.0	

Discharge 002: Sanitary Wastes

Parameter	Daily Average	Daily Maximum
Flow	---	15,000 GPD
Biochemical Oxygen Demand, 5-day	30 mg/1	60 mg/1
Total Suspended Solids	30 mg/1	60 mg/1
Fecal Coliform	200/100 ml	400/100 ml
pH	6.0 - 9.0	

7. The treated wastes shall be monitored in a manner approved by the Commission staff.

Signed: Ira L. Myers, M.D., Chairman
Water Improvement Commission

James W. Warr
Director
Water Improvement Commission

Issued this 11th day of December, 1978,

this permit supersedes all Water Improvement Commission permits previously issued to Catalytic, Inc.

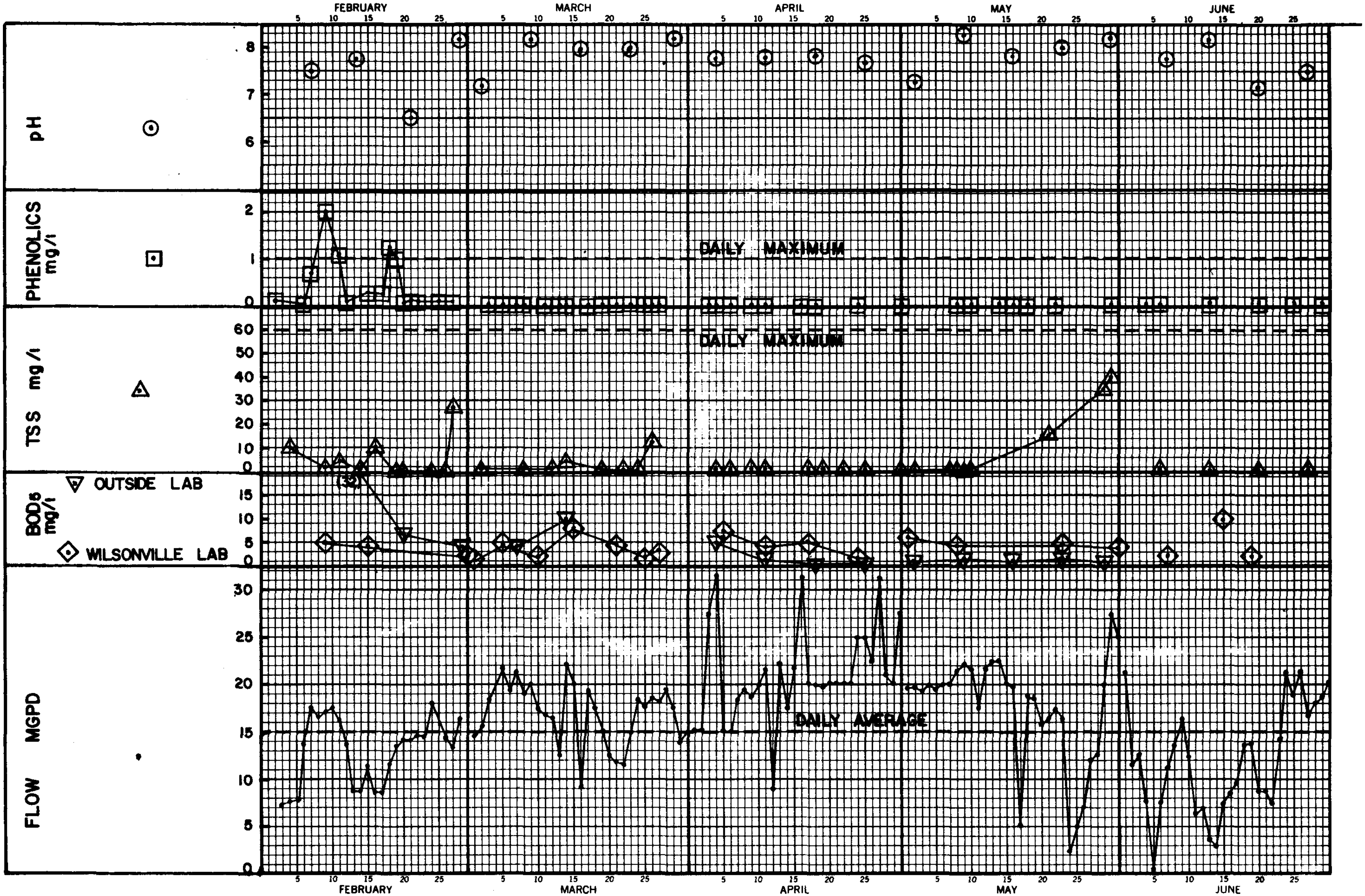

FIGURE C-1 EFFLUENT TREND CHART (1979)

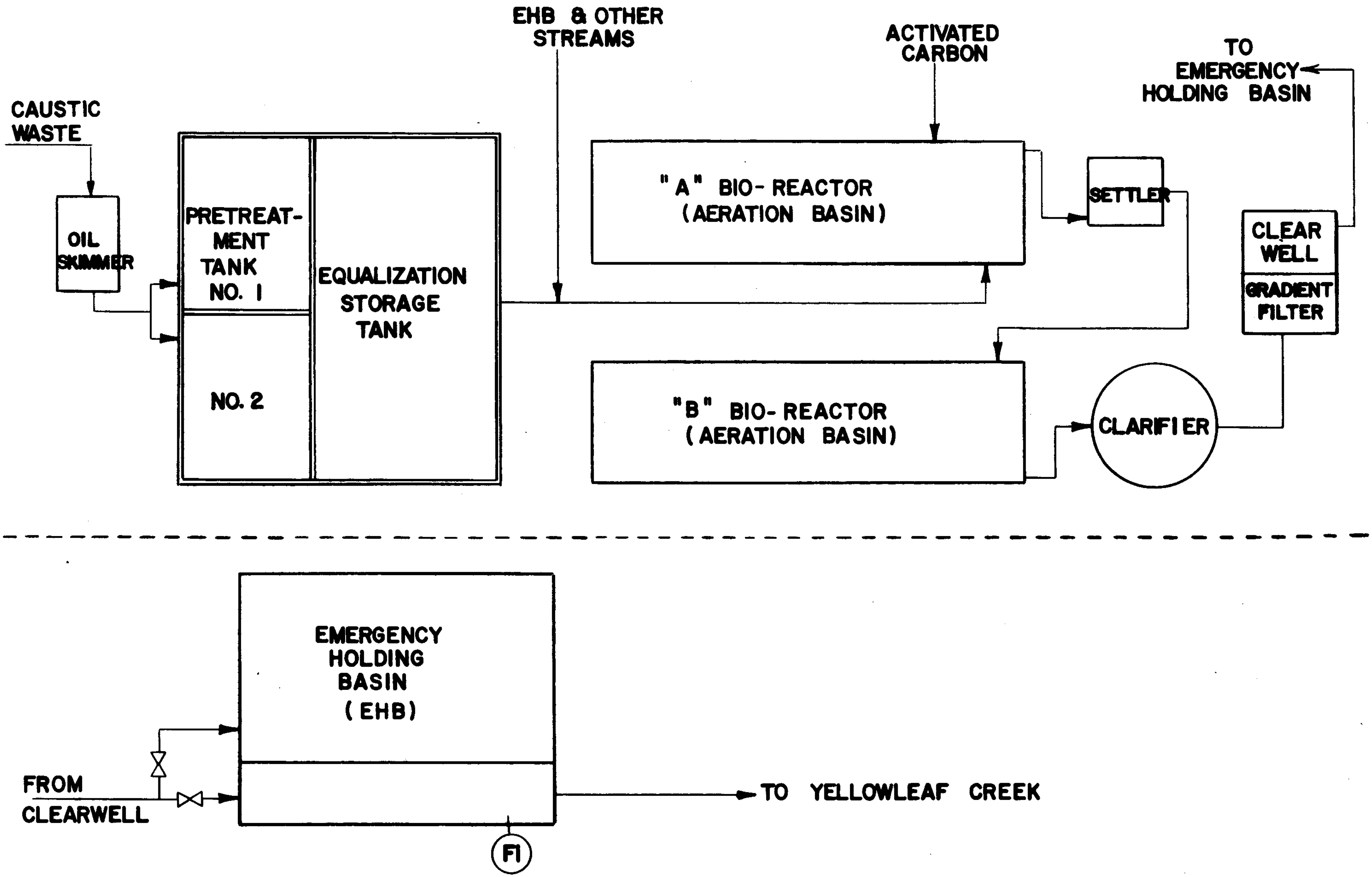

FIGURE C-2 EFFLUENT TREATMENT SYSTEM

Table 1
SRC Pilot Plant Operating Hours and Filter Cycles

Run	w/solv & H_2 hr (a)	Reaction section with coal slurry and hydrogen, hr (c): 5% (b)	10% (b)	20% (b)	25% (b)	27% (b)	33% (b)	38.5% (b)	40% (b)	Filtration section, cycles	Vacuum Flash section, hr
161 (e)	265							265			265
162	473							461			474
163	670							655			664
164	95						71				74
165	91							88		10	92
166 (f)	195							160			165
Report period	1,789						71	1,629		10	1,734
Prior 1979	1,654							1,433			1,466
Total 1979	3,443						71	3,062		10	3,200
Total 1978	7,207	0	0	0	0	0	0	6,697	0	1,102	7,002
Total 1977	5,559	0	39	40	324	713	992	2,574	0	2,319	5,625
Total 1976	6,329	0	111	184	1,367	0	69	4,098	0	2,893	6,610
Total 1975	4,883	0	48	637	2,013	0	1,041	0	300	1,575	4,892
Total 1974	4,675	23	73	69	3,193 (d)	0	407	0	0	1,208	4,874
Overall total to date	32,096	23	271	930	6,897	713	2,580	16,431	300	9,107	32,203

(a) On-stream hours with solvent and hydrogen through B102 Slurry Preheater and R101 Dissolver.
(b) Coal slurry concentration, MF basis.
(c) On-stream hours with coal slurry and hydrogen through B102 Slurry Preheater and R101 Dissolver.
(d) Includes 165 hours on 5-20% concentration during early runs.
(e) April portion of run.
(f) June portion of run.

Table 2
Operating Data Summary for April 1979

Date April 1979	Coal Feed MF lb/hr	Coal Feed hr	Slurry conc MF coal, %	Feed Gas: H_2 %	Feed Gas: to B102 scfh	Feed Gas: total scfh	V131B[a] % conv	B102 Preheater: inlet press, psig	B102 Preheater: ΔP btm, psi	B102 Preheater: ΔP mid, psi	B102 Preheater: ΔP top, psi	B102 Preheater: outlet temp, °F	R101 Dissolver: Temperature btm °F	R101 Dissolver: Temperature outlet °F	R101 Dissolver: Density btm %	R101 Dissolver: Density mid %	R101 Dissolver: Density top %
Run 161* Kentucky 9 (Pyro) Coal																	
1	515	24	40.1	85	9,830	9,830		1,764	19	11	9	801	814	826	9	15	-
2	492	24	39.1	84	9,740	9,740	71.7	1,767	20	11	9	798	813	826	9	16	-
3	491	24	38.5	84	9,870	9,870	72.3	1,770	20	10	10	798	812	828	12	18	-
4	508	24	39.0	85	10,000	10,000	72.2	1.769	22	8	10	800	813	825	10	16	-
5	500	24	38.3	85	10,040	10,040	71.4	1,783	24	6	11	793	811	825	12	18	-
6	494	24	37.4	85	10,040	10,040	71.4	1,783	20	10	12	793	812	825	11	16	-
7	495	24	37.9	84	9,870	9,870		1,783	20	12	12	791	812	824	11	18	-
8	472	24	40.1	85	10,100	10,100		1,777	20	-	10	792	811	825	12	18	-
9	497	24	38.4	84	9,850	9,850		1,775	17	19	10	792	809	823	11	17	-
10	499	24	38.4	84	9,870	9,870	72.9	1,783	15	12	10	790	809	824	12	18	-
11	515	24	38.4	84	9,730	9,730	72.9	1,777	19	11	10	789	808	824	12	17	-
12	515	1	38.4	84	9,730	9,730	72.9	1,775	23	7	11	790	808	823	11	16	-
Run 162 Kentucky 9 (Pyro) Coal																	
12	489	23	38.9	85	10,570	10,570	72.9	2,111	20	7	8	783	805	825	18	24	-
13	508	24	38.5	84	10,120	10,120		2,154	14	13	9	782	804	824	21	28	-
14	507	24	38.2	84	9,730	9,730		2,150	13	15	9	779	804	824	20	27	-
15	501	24	38.0	85	9,840	9,840		2,150	10	18	9	779	805	825	20	26	-
16	517	24	38.5	85	10,000	10,000	73.1	2,150	16	14	9	777	804	825	20	26	-
17	505	24	38.2	85	10,000	10,000	74.4	2,150	14	13	9	776	804	825	20	26	-
18	508	24	38.2	85	9,870	9,870	73.0	2,150	9	16	8	778	805	825	19	25	-
19	511	24	37.9	85	9,920	9,920	73.5	2,150	11	15	9	777	803	824	19	25	-
20	479	16.7	38.2	85	9,880	9,880	75.0	2,150	13	14	9	776	803	822	21	23	-
21	492	18	37.1	85	9,670	9,670		2,140	12	15	8	782	805	823	18	23	-
22	507	24	38.4	85	9,980	9,980		2,148	14	12	9	775	804	825	20	22	-
23	499	24	38.2	85	9,980	9,980	75.8	2,150	17	7	8	776	804	825	19	22	-
24	499	24	38.0	85	9,900	9,900	72.0	2,150	-	-	8	775	805	825	19	24	-
25	482	24	38.0	85	10,030	10,030	76.6	2,150	-	-	8	778	804	824	19	27	-
26	494	24	38.0	85	9,930	9,930	74.5	2,150	17	13	8	776	805	825	19	24	-
27	490	24	37.5	85	10,290	10,290	72.9	2,152	13	14	8	776	805	825	18	24	-
28	494	24	37.1	85	10,260	10,260		2,157	14	15	8	774	805	825	19	24	-
29	472	24	38.3	86	10,460	10,460		2,157	20	-	9	772	804	824	20	25	-
30	491	24	38.0	85	10,210	10,210	75.9	2,157	17	12	8	773	805	825	19	25	-

* Continuation of Run begun during preceding quarter (Ref. 1).

Table 2 (continued)
Operating Data for April 1979

Date	Coal	Performance			H_2	T102 Vacuum Column			T104(e)	T102 Vacuum Column (e) (f)		
			SRC			Temperature				Tray 8	Tray 3	
April	conv	yield(b)	yield(c)	sulfur(d)	con- sumed	btm	top	press top	lt org +350°F	-450°F	-350°F	+450°F
1979	% MAF	% MAF coal	% MAF coal	%	% MAF	°F	°F	psia	wt %	wt %	wt %	wt %
					Run 161* Kentucky 9 (Pyro) Coal							
1	91.3		77.5	0.95	1.3	577	192	0.7	6.1	ND	ND	2.6
2	94.2	65.4	50.8	0.99	1.4	576	193	0.8		ND	ND	3.9
3	94.8		58.0	0.87	1.5	582	193	0.8	ND	ND	ND	2.4
4	94.5	68.2	45.5	0.93	1.4	579	193	0.8	5.0	ND	ND	4.0
5	94.3		58.8	0.97	1.5	577	192	0.8		7.1	ND	3.7
6	94.7	61.9	50.4	0.95	1.5	580	193	0.7	0	19.1	2.1	6.4
7	93.3	69.0	55.1	0.94	1.4	583	193	0.7	0	10.1	2.0	5.9
8	92.2		64.5	0.85	1.7	582	192	0.7		ND	ND	0
9	93.6	65.2(g)	63.1	0.89	1.5	577	193	0.6				
10	93.8		60.6	0.89	1.4	570	192	0.5				
11	92.4	76.0			1.6	568	194	0.5				
12	92.5					570	193	0.5		3.3	0.9	
					Run 162 Kentucky 9 (Pyro) Coal							
12	92.5		72.9	-	1.8	575	192	0.5				
13	93.3		73.2	-	1.7	574	193	0.5		6.4	0.8	21.5
14	95.5	71.1	40.3	0.82	1.6	572	193	0.5		6.2	4.9	20.1
15	93.2		74.9	0.84	1.7	565	192	0.5		5.9	0.4	22.9
16	93.5		64.8	-	1.7	566	193	0.5		6.1	0.3	20.7
17	93.1	71.5	75.8	0.90	1.7	568	193	0.5		5.8	0.7	20.2
18	93.0		75.6	0.96	1.7	567	192	0.5		4.6	0.7	22.2
19	92.9	72.0	72.0	1.00	1.7	567	192	0.5				
20	92.9		69.2	0.89	1.8	563	192	0.5	4.3	6.1	0.7	20.1
21	-		-	-	1.8	570	193	0.5	30.2			
22	93.7	59.1	63.1	0.85	1.7	568	192	0.5	29.9	6.4	0.2	18.5
23	94.2		59.5	0.62	1.7	568	192	0.5	32.0	2.5	0.6	19.6
24	93.8		75.6	0.86	1.8	567	192	0.5	7.9	ND	ND	6.8
25	94.0	68.4	60.9	0.94	1.8	560	193	0.5	23.8	3.2	0.73	28.5
26	93.9		65.4	0.86	1.7	551	192	0.6		8.7	1.01	13.3
27	94.1	59.7	68.2	0.81	1.8	554	192	0.6		7.7	0.40	14.3
28	93.9		63.0		1.8	561	192	0.6	8.9	6.7	0.90	14.5
29	93.9	64.2	77.6	0.90	1.8	563	192	0.6	20.9	7.3	1.00	15.0
30	95.8			0.82	1.5	559	191	0.6	6.0	6.8	1.40	14.6

* Continuation of run begun during preceding quarter (Ref. 1).

Table 2 (continued)
Operating Data Summary for April 1979
Critical Solvent Deashing Unit
(Two-Stage)

Date, April 1979	Feed Rate T102 btms lb/hr	Feed Time, hr	Run No.	Feed from T102 btms: Ash, %	UC, %	Solv, %	Sulf, %	Melting Point, °F	Ash Concentrate: Ash, %	UC, %	(h) SRC, %	(h) Solv, %	DAS, %	SRC: Ash, %	Sulf, %	(h) Solv, %	DAS, %	Melting Point, °F	(i) Recovery %(j)	%(k)
1	253.2	23.7	161	11.9	9.1	10.0	1.60	392	25.5	33.4	33.4	3.2	4.5	<0.01	0.84	8.6	-	293	67.5	63.1
2	289.7	24.0	161	14.0	8.9	9.3	1.60	357	31.7	32.9	29.4	2.6	3.4	0.28	0.93	9.1	-	265	72.4	68.6
3	242.0	5.0	161	15.2	6.6	9.2	1.67	350	32.3	31.6	24.3	4.5	7.3	0.21	0.92	5.7	-	270	67.7	67.7
4	277.0	19.7	161	15.4	8.3	9.3	1.50	360	32.0	30.2	30.7	4.5	2.6	0.02	0.92	6.4	-	232	68.1	68.9
5	304.3	24.0	161	16.0	7.4	7.3	1.60	377	36.5	34.8	23.2	3.7	1.8	0.16	0.92	5.3	-	266	73.3	76.8
6	279.8	20.3	161	15.8	7.5	10.5	1.67	367	35.4	23.5	31.2	7.9	2.0	0.04	0.94	5.7	-	265	72.2	74.0
7	304.1	12.0	161	14.7	8.0	9.3	1.61	367	35.4	21.5	32.1	6.7	4.3	0.12	0.91	6.7	-	265	75.6	68.1
7-8	307.0	24.0	AMB	15.5	8.1	5.2	-	-	34.9	39.9	-	-	1.4	-	-	-	-	-	72.8	73.7
8-9	313.6	23.1	BMB	15.5	8.5	-	-	-	35.5	39.8	-	-	3.8	-	-	-	-	-	74.1	70.8
9-10	338.0	24.0	CMB	16.1	7.4	6.5	1.74	320	38.4	46.4	11.9	6.76	3.32	0.01	1.35	3.2	0.27	336	75.9	77.4
10	470.0	8.3	DMB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	305.7	24.0	EMB	15.5	8.5	5.43	1.81	392	38.3	37.5	15.33	5.56	3.31	0.02	1.00	8.73	0.3	320	78.3	80.5
12	279.1	10.1	162	15.6	8.0	5.4	-	-	39.4	28.6	-	-	2.1	-	-	-	-	-	79.0	75.4
13	330.9	3.5	162	16.2	8.3	5.3	-	-	-	-	-	-	-	-	-	-	-	-	83.6	74.6
14	278.7	16.8	162	16.8	8.7	5.3	-	315	43.9	23.6	-	6.4	1.7	-	-	-	-	-	82.9	81.9
15																				
16									Down due to feed line breakage											
17																				
18																				
19	186.3	5.8	162	16.2	7.8	7.1	1.64	-	-	-	-	-	-	0.03	0.87	-	-	302	-	58.5
20	221.3	14.5	162	16.5	10.5	7.2	1.62	322	42.0	15.9	3.4	19.3	19.4	0.14	0.91	5.9	-	270	83.2	90.7
21	241.1	14.2	162	16.2	12.8	4.7	1.50	331	40.1	-	36.6	5.0	2.3	0.07	0.82	5.0	-	315	83.9	79.7
22	276.6	20.7	162	16.6	9.1	3.0	1.67	324	42.5	24.2	26.4	4.6	2.3	0.06	0.75	4.9	-	306	82.0	78.0
23	304.8	21.7	162	16.4	9.4	5.6	1.64	316	41.7	25.2	27.3	4.3	1.5	0.13	0.85	-	-	308	81.8	85.2
24	310.1	20.9	162	16.6	10.2	5.4	1.72	310	42.8	33.2	22.8	-	1.2	-	0.85	5.9	-	285	83.6	82.1
25	293.5	21.3	162	16.3	10.1	-	-	-	43.3	25.8	17.2	8.4	5.3	-	-	-	-	-	84.7	85.3
26	294.7	24.0	162AMB	15.6	8.0	6.1	1.64	300	43.9	22.0	2.8	18.7	12.6	0.06	0.91	11.2	0.3	276	84.4	82.8
27	259.5	12.7	162	16.5	7.3	9.0	-	324	45.6	25.4	16.7	2.7	9.6	0.26	0.83	6.7	-	266	84.0	-
28	147.8	6.1	162	16.6	8.4	10.5	1.56	311	43.1	22.9	26.4	3.6	4.0	0.23	0.87	5.2	-	277	82.0	83.5
29	198.1	5.0	162	16.6	8.0	9.5	-	-	45.9	24.1	17.8	4.4	7.8	-	-	-	-	-	84.7	81.7
30	234.5	18.5	162	17.7	8.3	9.8	1.84	322	45.7	26.3	19.9	5.3	2.8	-	-	-	-	-	82.8	-

Footnotes appear at the conclusion of Table 4.

Table 3
Operating Data Summary for May, 1979

Date, May 1979	Coal Feed MF lb/hr	Coal Feed hr	Slurry conc MF coal, %	Feed Gas: H_2 %	Feed Gas: to B102 scfh	Feed Gas: total scfh	V131B(a) % conv	B102 Preheater: inlet press, psig	B102 Preheater: ΔP btm, psi	B102 Preheater: ΔP mid, psi	B102 Preheater: ΔP top, psi	B102 Preheater: outlet temp, °F	R101 Dissolver Temperature: btm °F	R101 Dissolver Temperature: outlet °F	R101 Dissolver Density(1): btm %	R101 Dissolver Density(1): mid %	R101 Dissolver Density(1): top %
Run 162 Kentucky 9 (Pyro) Coal - continued																	
1	481	19.5	38.0	85			73.4	2,156	14	12	8	774	813	825			
Run 163 Kentucky 9 (Pyro and Lafayette) Coal																	
1	495	4.5	38.2	85				1,712	18	7	6	837	813	825			
2	480	24	37.9	84	6,000	9,680	76.0	1,706	15	6	1	849	809	826			
3	471	8.5	37.5	87	5,570	9,690	73.7	1,703	15	5	1	844	804	821			
4	495	2.5	38.7	-	-	-	-	1,750	13	-	3	852	797	802			
5	495	24	38.7	84	5,790	9,410		1,742	18	5	2	849	810	825			
6	514	24	39.7	85	5,650	9,610		1,735	15	9	2	848	813	826			
7	520	24	40.5	84	5,630	9,730	69.3	1,737	17	6	2	848	811	827			
8	517	24	39.4	84	5,170	9,580	72.0	1,737	16	4	2	847	812	826			
9	520	24	38.2	85	4,780	9,200	73.1	1,717	13	4	2	849	810	825			
10	510	24	38.3	85	4,720	9,020	71.8	1,726	13	5	2	849	812	827			
11	506	24	37.9	85	4,570	9,190	70.4	1,734	12	5	3	849	811	827			
12	489	24	38.4	85	4,620	9,200		1,734	12	6	3	848	810	825			
13	490	24	38.7	85	4,610	9,180		1,740	13	7	3	849	810	825			
14	496	24	38.9	85	4,570	9,270	68.8	1,746	14	6	3	846	812	828			
15	500	24	38.3	85	4,640	9,330	71.3	1,750	15	7	3	842	807	823			
16	519	24	38.0	86	4,660	9,440	69.0	1,750	14	7	4	842	808	823			
17	496	24	37.5	84	4,380	9,270	70.0	1,750	15	7	3	840	808	825			
18	496	22.3	37.5	85	3,990	9,220	71.5	1,750	13	9	3	846	808	825			
19	526	24	39.1	86	5,000	9,740		1,758	9	13	4	845	806	820			
20	523	24	37.2	85	4,400	9,810		1,751	12	13	4	849	808	825			
21	487	24	37.8	84	4,210	9,320		1,776	13	14	4	848	807	824			
22	554	24	38.4	84	4,190	9,600	69.3	1,752	15	14	4	848	807	826			
23	519	24	39.1	85	4,280	9,730	69.8	1,779	16	15	4	849	807	824			
24	512	24	39.0	85	4,280	9,470	68.8	1,800	18	13	4	850	807	823			
25	483	24	38.3	85	4,290	9,330	68.2	1,800	20	13	4	849	807	822			
26	448	21.2	39.0	84	4,230	9,380		1,800	16	17	5	848	807	823			
27	519	24	39.4	85	4,290	9,420		1,800	16	18	5	849	807	824			
28	445	24	40.2	84	4,440	9,760		1,800	16	18	5	848	807	823			
29	512	24	39.5	85	4,240	9,470	63.8	1,807	18	18	3	849	808	825			
30	513	20	39.6	85	4,250	9,730	66.5	1,816	15	22	7	849	809	826			
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Table 3 - (continued)
Operating Data Summary for May 1979

Date May 1979	Performance: Coal conv % MAF	Performance: SRC yield(b) % MAF coal	Performance: SRC yield(c) % MAF coal	Performance: SRC sulfur(d) %	H_2 consumed % MAF	T102 Vacuum Column Temperature btm °F	T102 Vacuum Column Temperature top °F	T102 Vacuum Column press top psia	T104(e) lt org +350°F wt %	T102 Vacuum Column(e)(f) Tray 8 -450°F wt %	T102 Vacuum Column(e)(f) Tray 3 -350°F wt %	T102 Vacuum Column(e)(f) Tray 3 +450°F wt %
					Run 162 Kentucky 9 (Pyro) Coal - continued							
1	94.6			0.83		555	193	0.6	5.0	6.8	1.3	24.4
					Run 163 Kentucky 9 (Pyro and Lafayette) Coal							
1						555	191	0.6				
2	92.9	67.9	55.5	0.79	1.8	558	192	0.6	7.4	10.1	1.5	12.9
3	94.4		45.9	0.83	2.0	558	193	0.6	35.2	7.8	1.6	13.9
4						555	198					
5	92.8		73.4		1.5	556	191	0.6	53.4	11.8		
6	92.2	75.7	60.3		1.3	555	193	0.6	12.0	7.2	1.0	23.1
7	92.9		77.7		1.7	556	193	0.6	11.1	7.0	1.1	16.6
8	92.8		76.9		1.6	558	192	0.6	3.7	7.3	1.5	15.5
9	92.6	73.6	69.1	0.90	1.5	559	191	0.6		6.7	1.4	17.3
10	92.0		79.1	0.76	1.4	560	192	0.6		ND	ND	0.0
11	93.0		72.6		1.6	557	193	0.6	0	6.7	7.6	24.9
12	92.9	69.1	67.8		1.6	556	192	0.6		7.8	1.3	17.2
13	93.2		61.5		1.6	558	192	0.6	1.9	7.2	1.8	17.6
14	92.8		67.9	0.78	1.6	559	192	0.6	6.2	6.6	1.4	17.3
15	92.9	67.0	73.4	0.84	1.6	561	193	0.6		6.5	1.3	19.9
16	92.4		71.8	0.85	1.4	561	196	0.6	4.0	6.0	1.6	18.8
17	92.4		75.7	0.80	1.4	560	195	0.6	10.3	10.4	1.4	14.9
18	92.6	64.5	72.6	0.81	1.4	559	195	0.6	17.8	6.8	1.1	16.3
19					1.2	561	196	0.6	29.5	6.4	1.7	24.9
20	92.8		69.2	0.79	1.5	562	194	0.6	4.7	7.1	1.1	16.8
21	93.7	67.4	75.8	0.82	1.7	558	194	0.6		2.9	1.5	18.6
22	93.0		68.4	0.91	1.3	560	194	0.6		8.1	0.4	19.0
23	93.4	62.2	71.6	0.88	1.6	561	197	0.6		9.3	1.5	35.0
24	92.9		81.1	0.89	1.6	559	195	0.6		4.8	0.6	22.6
25	93.2	71.0	73.4	0.83	1.5	559	195	0.6		7.8	0.6	24.8
26	93.3			0.89	1.3	555	194	0.6				
27	93.5	76.3	81.7	0.89	1.2	555	195	0.6				
28	93.4		68.7	0.92	1.4	555	195	0.6	36.6	5.3	0.7	24.5
29	93.2		72.9		1.4	553	195	0.6	30.0	3.0	0.5	28.6
30	93.4	73.2		0.85	1.5	552	195	0.6	15.5	6.1	0.6	18.1

Table 3 (continued)
Operating Data Summary for May 1979
Critical Solvent Deashing Unit (Two-stage)

Date, May 1979	Feed Rate T102 btms lb/hr	Feed Time, hr	Run No.	Feed from T102 btms: Ash, %	UC, %	Solv, %	Sulf, %	Melting Point, °F	Ash Concentrate: Ash, %	UC, %	(h) SRC, %	(h) Solv, %	DAS, %	SRC: Ash, %	Sulf, %	(h) Solv, %	DAS, %	Melting Point, °F	(i) Recovery %(j)	%(k)
1	125.5	7.9	163	16.5	10.2	5.7	1.70	318	41.6	28.5	21.0	4.4	4.5	0.17	0.86	7.5	-	313	82.3	86.6
2	286.2	23.8	163	16.5	14.1	8.1	1.72	311	38.8	33.9	19.0	5.9	2.4	0.37	0.93	9.3	-	284	82.8	83.5
3				16.4	8.3	10.5	1.85	311	42.8	26.2	25.6	4.3	1.1	0.18	0.95	7.7	-	297	81.9	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	221.0	20.9	163	17.6	8.4	6.5	-	329	38.4	27.6	21.3	2.9	9.8	0.24	0.87	4.8	-	274	73.2	76.4
6	261.0	24.0	163	16.7	12.3	9.3	1.71	306	39.1	30.9	15.9	4.5	9.6	0.21	0.88	11.2	-	279	80.7	77.9
7	291.6	24.0	163	16.7	10.1	9.3	1.58	327	40.9	21.1	25.9	3.5	8.6	0.25		9.0	-	289	80.8	80.5
8				16.2	10.3	9.2	1.85	307	39.3	25.7	23.4	3.2	8.4	0.24	0.86	7.5	-	305	79.9	-
9	186.2	17.9	163	17.4	6.6	10.0	1.60	311	38.7	26.3	29.2	3.0	2.8	<0.01	0.82	4.9	-	284	72.4	64.8
10	268.5	24.0	163	16.5	6.3	6.5	1.83	309	43.5	27.2	15.2	11.7	2.4	<0.01	0.87	8.0	-	284	80.4	69.6
11	331.2	12.0	163	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11-12	316.0	24.0	AMB	16.6	6.6	7.2	1.66	298	42.0	29.9	15.0	4.2	8.9	0.46	0.85	5.5	0.12	277	78.7	79.6
12	311.2	12.0	163	16.3	8.0	8.4	1.50	365	42.0	31.2	18.0	2.9	5.9	0.87	0.66	7.8	-	320	80.8	82.1
13	292.5	24.0	163	16.0	7.7	10.6	1.70	304	40.5	32.6	16.8	1.8	8.3	0.08	0.84	7.6	-	275	79.3	77.7
14	278.7	24.0	163	16.0	9.6	6.9		320	40.1	37.0	-	-	2.9	0.13	0.82	3.2	-	284	80.8	79.8
15	238.1	22.9	163	16.0	8.1	10.2	1.62	305	41.1	35.7	9.4	3.3	10.5	-	-	-	-	-	80.5	76.4
16	284.6	24.0	163	16.0	7.8	6.4	-	-	41.0	33.1	5.6	5.9	14.4	-	-	-	-	-	80.0	83.5
17	290.5	18.2	163	15.5	8.2	6.2	-	-	40.7	36.5	7.8	5.7	9.3	-	-	-	-	-	81.1	71.9
18																				
19									Down due to plugging											
20																				
20				10.7	8.0	2.8	2.12	324	34.4	37.3	21.2	0.6	6.5	0.36	1.13	6.1	-	288	68.3	-
21	165.2	6.5	163	11.5	9.0	6.5	-	343	25.0	33.6	12.0	28.2	1.2	-	-	-	-	-	67.9	68.1
22	298.0	24.0	163	10.9	9.2	7.5	1.60	319	26.4	34.3	11.5	19.6	8.2	0.16	0.88	6.3	-	292	73.5	71.7
23	312.3	24.0	163	10.9	8.1	7.7	1.63	320	27.8	40.7	17.3	5.3	8.9	0.05	0.86	2.1	-	294	75.0	73.2
24	283.3	19.3	163	10.7	7.7	16.7	-	-	30.1	41.8	9.1	11.7	7.3	-	1.01	5.5	-	286	79.0	73.1
25	299.8	22.9	163	10.6	8.4	9.8	1.37	310	30.0	39.5	11.6	6.7	12.2	0.06	0.84	6.9	-	292	79.8	74.1
26	316.9	12.1	163	11.5	7.5	-	1.48	318	30.7	40.2	11.2	9.3	8.6	-	-	-	-	-	77.2	74.3
27	272.8	12.0	BMB	11.3	6.9	10.3	1.47	307	29.5	39.7	15.5	9.4	5.9	0.08	-	7.4	0	288	75.6	70.4
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	282.8	23.2	163	10.7	8.5	-	-	-	28.0	51.6	7.9	6.6	5.9	-	-	-	-	-	76.5	73.3
30	296.5	14.7	163	10.6	9.1	8.0	1.54	326	28.9	42.0	14.6	7.5	7.0	0.45	0.88	6.5	-	297	78.9	71.3
31																				

Footnotes appear at the conclusion of Table 4.

Table 4
Operating Data Summary for June 1979

Date June 1979	Coal Feed MF lb/hr	Coal Feed hr	Slurry conc MF coal, %	Feed Gas: H_2 %	Feed Gas: to B102 scfh	Feed Gas: total scfh	V131B[a] % conv	B102 Preheater: inlet press, psig	B102 Preheater: Δp btm, psi	B102 Preheater: Δp mid, psi	B102 Preheater: Δp top, psi	B102 Preheater: outlet temp, °F	R101 Dissolver: Temp. btm °F	R101 Dissolver: Temp. outlet °F	R101 Dissolver: Density btm %	R101 Dissolver: Density mid %	R101 Dissolver: Density top %
Run 164 Kentucky 9 (Lafayette) Coal																	
2	256	13.3	32.7	90	3,610	3,610	72.9	2,380	-	17[m]	-	(n) 855		By-Passed			
3	249	17.6	33.7	88	3,270	3,270		2,385	-		-	856	-	-	-	-	-
4	220	17.0	35.6	88	2,680	2,680		2,387	-	20[m]	-	859	-	-	-	-	-
5	241	23.4	35.2	85	1,770	1,770		2,396	-		-	859	-	-	-	-	-
Run 165 Kentucky 9 (Lafayette) Coal																	
14	412	20.0	37.1	86	9,560	9,560		2,173	10	13	6	781	797	816	35	24	-
15	484	24	37.8	85	10,200	10,200	61.5	2,196	14	13	7	761	792	823	38	28	-
16	438	24	38.3	84	10,030	10,030		2,190	11	14	6	757	799	823	41	31	-
17	451	19.6	38.4	85	10,110	10,110	66.3	2,190	8	14	5	759	800	824	44	31	-
Run 166 Kentucky 9 (Lafayette) Coal																	
21	441	1.5	37.7														
22	319	6.0	34.5	84				2,150	9	12	3	774	800	828	24	20	-
23	284	5.8	33.4	88				2,125	7	2	-	831	802	822	31	21	-
24	474	22.2	36.5	85	10,220	10,220		2,178	10	10	5	778	799	823	22	20	-
25	487	21.5	38.4	87	10,630	10,630	65.0	2,197	-	-	6	775	802	823	29	20	-
26	475	24	41.0	85	10,440	10,440	65.2	2,201	23	10	5	772	800	824	29	21	-
27	539	13.3	41.3	85	10,570	10,570		2,200	26	10	6	774	801	825	25	20	-
28	505	17.6	38.4	85	10,320	10,320		2,207	11	13	3	780	801	821	27	20	-
29	501	24	40.3	85	10,430	10,430	66.4	2,224	21	11	8	762	797	825	35	26	-
30	536	24	39.0	85	10,390	10,390	70.9	2,231	24	11	8	765	797	822	39	27	-

Table 4 -(continued)
Operating Data Summary for June 1979

Date June 1979	Coal conv % MAF	Performance: yield(b) % MAF coal	SRC yield(c) % MAF coal	SRC sulfur(d) %	H_2 consumed % MAF	T102 Vacuum Column Temperature btm °F	T102 Vacuum Column Temperature top °F	T102 Vacuum Column press top psia	T104(e) lt org +350°F wt %	T102 Vacuum Column(e)(f) Tray 8 -450°F wt %	T102 Vacuum Column(e)(f) wash solvent Tray 3 -350°F wt %	T102 Vacuum Column(e)(f) wash solvent Tray 3 +450°F wt %
Run 164 Kentucky 9 (Lafayette) Coal												
2	91.2	-			2.0	560	195	1.5				
3	90.6			0.86	2.7	564	196	1.0	31.7	19.6	3.5	9.2
4	90.1	71.9	78.2	0.86	2.8	566	201	0.9	81.7	24.4	1.9	5.2
5	-				2.4	566	201	1.1				
Run 165 Kentucky 9 (Lafayette) Coal										T105 Frac Column(e) btm -450°F wt %	T105 Frac Column(e) wash solvent -350°F wt %	T105 Frac Column(e) wash solvent +450°F wt %
14					2.3	566	202	0.9	87.9	6.8		
15	94.2		81.8	0.79	1.6	567	196	0.5	88.1	8.3	3.7	8.1
16	94.7	63.8	65.0	0.72	1.9	573	186	0.5	77.0	2.8	6.7	15.0
17	94.6		70.0	0.78	1.6	585	188	0.5	85.2	8.7	3.7	23.8
Run 166 Kentucky 9 (Lafayette) Coal												
22	93.8					550	183	0.4		ND	ND	30.8
23						495	182	3.9				
24	94.5		76.4	0.70	1.7	565	194	0.7	18.7	7.0	5.4	1.7
25	92.3		71.0	0.89	1.6	572	194	0.5	15.0	3.2	6.3	6.2
26	94.6	62.3			1.8	578	199	0.6	15.0	2.4	2.0	7.6
27	94.2		70.0	0.90	1.5	573	222	0.7	32.8	1.3	4.1	15.5
28	93.4				1.7	569	205	0.6	0	-	-	-
29	94.3	74.5	76.2	0.92	2.0	569	199	0.5	31.3	1.0	3.4	41.9
30	92.8		64.4	0.95	1.8	576	204	0.5	40.7		1.4	52.9

Table 4 (continued)
Operating Data Summary for June 1979
Critical Solvent Deashing Unit (Two - Stage)

Date June 1979	Feed rate T102 btms lb/hr	Feed time, hr	Run No.	Feed from T102 btms: Ash, %	UC, %	Solv, %	Sulfur, %	Melting point, °F	Ash Concentrate: Ash, %	UC, %	SRC,[h] %	Solv,[h] %	DAS, %	SRC: Ash, %	Sulfur, %	Solv,[h] %	DAS, %	Melting Point, °F	Recovery[i] %(j)	%(k)
2	233.1	11.6	164																	
3	174.5	13.4	164	8.0	9.5	9.7	0.94	289	19.6	48.5	18.5	7.5	5.9	0.10	-	6.3		293	71.7	67.1
4	313.3	12.2	164	8.5	7.2	9.6	1.43	295	20.6	48.1	19.5	7.4	4.4	0.22	1.10	-		295	69.7	-
4-5	305.5	24.0	AMB	6.7	10.3	8.9	1.34	301	18.8	52.3	15.2	5.4	8.3	-	1.09	7.5	0.23	302	77.5	73.4
								Down due to lack of feed												
24	231.8	14.8	166	8.3	5.5	7.6	2.17	330	22.2	40.1	26.7	4.8	6.2	<0.01	0.77	8.7		263	72.6	71.2
25	240.1	24.0	166	10.1	8.4	6.2	1.60	356	25.5	30.6	28.8	6.9	8.2	<0.01	0.93	7.2		277	74.1	70.8
26	346.9	11.5	166	12.1	8.4	7.8	-	341	32.8	34.4	22.1	4.7	6.0	-	-	-		297	79.4	68.4
27	214.4	10.7	166	11.5	8.4	7.3	1.49	300	27.0	39.3	24.7	4.0	5.0	0.25	0.81	6.7		307	71.7	66.3
28	334.5	15.9	166	9.9	7.0	9.0	1.39	-	29.7	35.0	28.0	3.7	3.6	0.10	0.91	10.9		278	80.2	81.5
29	348.4	15.3	166	11.1	6.3	6.4	1.57	295	35.7	29.9	22.9	4.8	6.7	0.11	0.80	8.1		301	83.4	88.0
30	320.3	18.4	166	11.2	6.4	4.9	1.59	317	35.0	31.9	20.0	2.6	10.5	0.27	0.90	4.9		284	82.5	85.5

(a) THF short method.
(b) Cresol-soluble material.
(c) V110 lab analysis and forced ash balance method.
(d) From laboratory workup of V110 Flash Tank sample, distilled at 600°F, 0.1 mm Hg.
(e) GC.
(f) Separation normally made in T105 Frac. Col. (not presently operable).
(g) MB ABC (1200, 7 April - 1200, 10 April)
(h) 600°F, 0.1 mm Hg.
(i) % of cresol-soluble feed from T102.
(j) By forced ash balance.
(k) By normalized material balance.
(l) Nuclear density gauges were not operating properly during this period.
(m) Total ΔP.
(n) Average at next thermocouple downstream for Run 164 was 882°F.

Table 5
Conditions and Results Summary
Kentucky 9 Coal

Date, 1979	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160 MB	161 MB	162 MB	163 MB	164 MB
Coal					
Volatile matter, (Dry basis, %)	30.1	28.1	29.6	28.3	27.6
H/C atomic ratio	0.85	0.79	0.79	0.82	0.80
Microautoclave conversion, %					
short	-	-	-	-	-
long	78.4	81.8	80.0	77.6	75.1
Process Solvent					
IBP, °F	405	405	401	383	335
EP, °F	937	937	909	892	838
% minus 450°F/% plus 650°F	3.7/41.2	4.0/35.0	8.1/26.8	6.3/25.7	31.6/15.5
Specific gravity	1.070	1.020	1.010	1.009	0.996
H/C atomic ratio	1.16	1.22	1.20	1.19	1.24
Microautoclave conversion, %					
short run	73.6	71.9	74.7	67.9	66.4
long run	-	68.9	71.8	63.5	60.0
Operating conditions					
Feed					
Coal feed rate, MF lb/hr	488	498	494	498	241
Concentration, % MF coal	38.2	38.5	38.4	38.7	35.3
Feed gas, Mscf/ton MF coal to B102	40.2	39.8	41.3	18.5	14.7
Hydrogen purity, Mol %	81.2	81.7	84.1	81.3	84.6
Reaction					
Coal space rate, MF $lb/hr\text{-}ft^3$					
Cumulative(a)	29.2	29.8	29.6	29.8	61.8
Dissolver(b)	35.9	36.6	36.3	36.6	-
Temperature, °F					
Preheater outlet	784	796	776	848	859-885
Dissolver					
Bottom	809	808	805	811	-
Middle	824	822	822	824	-
Outlet	825	825	825	827	-
Pressure, psig	1,700	1,700	2,100	1,700	-
Hydrogen pressure, psia					
Preheater inlet	1,417	1,468	1,821	1,423	2,040
Preheater outlet	1,302	1,305	1,669	1,247	-
Dissolver outlet	1,066	1,037	1,412	967	-
Results					
Conversion, % MAF coal					
Preheater	-	-	-	-	-
Dissolver	94.2	93.4	94.0	93.3	90.9
Hydrogen consumption(c)					
% MF coal	2.55	2.38	2.55	2.62	1.32
Sulfur, % of SRC product	0.84	0.89	0.94	0.82	1.06
Yields, % MF coal(c)					
SRC (d)	54.92	56.92	50.95	49.41	56.33
Organic liquid	22.55	14.62	20.48	19.99	6.63

Table 5 (continued)
Conditions and Results Summary
Kentucky 9 Coal

Date, 1979	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160 MB	161 MB	162 MB	163 MB	164 MB
Results (continued)					
Gases					
C_1-C_5	3.82	3.65	5.58	6.63	6.00
CO-CO_2	0.31	0.50	0.16	0.46	2.17
H_2S	2.73	2.69	2.73	2.28	3.57
NH_3	0.33	0.21	0.62	0.43	0.28
Water	2.74	4.96	3.53	4.91	9.24
Unreacted coal	5.23	5.78	5.22	5.81	8.33
Ash	9.91	13.04	13.27	12.73	8.77
Dissolver solids conc, lb/ft^3	-	-	-	28.4	-

(a) Using 1.6 ft^3 as preheater volume, plus 1.5 ft^3 for full-dissolver transfer line (2.3 ft^3 for dissolver bypass line) plus dissolver volume.
(b) Using 9.197 ft^3 as half-dissolver volume.
(c) Based upon unadjusted yields, process method.
(d) Solvent-free basis (distilled to 600°F at 0.1 mm Hg).

Table 6
Conditions and Results Summary
Adjusted Yields
Kentucky 9 Coal

Date, 1979	25-26 March			
Run	160 MB			
Material Balance Method	Process Method		V110 Short Method	
Basis	Unadjusted	Elementally balanced	Unadjusted	Elementally balanced
Yields, % MF coal				
Gases				
H_2S	2.7	3.0	2.7	3.0
CO_2	0.1	0.1	0.1	0.1
CO	0.3	0.3	0.3	0.3
C_1	1.4	1.4	1.4	1.4
C_2	1.1	1.1	1.1	1.1
C_3	0.9	1.0	0.9	1.0
C_{4-5}	0.5	0.5	0.5	0.5
NH_3	0.3	0.3	0.3	0.3
Water	2.7	1.3	2.7	1.2
Distillates				
C_5-350°F	1.5	1.5	1.5	1.5
350-450°F	3.6	3.6	3.6	3.5
450-950°F	17.5	16.6	15.5	14.7
SRC (d)				
Oil	13.8	14.1	15.4	15.7
Asphaltene	23.7	24.1	20.1	20.4
Benzene insoluble (a)	17.4	17.7	21.3	21.6
Ash	9.9	10.4	9.9	10.4
Unreacted coal	5.2	5.5	5.3	5.5
Hydrogen consumption, % MF coal	2.6	2.3	2.6	2.2
Organic liquid yield, (b)				
Distribution, % of total liquid product (c)				
IBP-350°F	6.6	6.9	7.2	7.5
350-450°F	16.1	16.6	17.3	17.9
450-550°F	40.6	41.1	42.3	43.0
550-650°F	22.1	21.7	21.4	21.0
650-EP°F	14.6	13.7	11.9	10.7

Table 6 (continued)
Conditions and Results Summary
Adjusted Yields
Kentucky 9 Coal

Date, 1979	9-10 April			
Run	161 MB			
Material Balance Method	Process Method		V110 Short Method	
Basis	Unadjusted	Elementally balanced	Unadjusted	Elementally balanced
Yields, % MF coal				
Gases				
H_2S	2.7	1.3	2.7	1.3
CO_2	0.3	0.1	0.3	0.1
CO	0.2	0.1	0.2	0.1
C_1	1.5	1.4	1.5	1.4
C_2	1.0	1.0	1.0	1.0
C_3	0.8	0.8	0.8	0.8
C_4	0.3	0.3	0.3	0.3
NH_3	0.2	0.2	0.2	0.2
Water	5.0	6.2	5.0	6.2
Distillates				
C_5-350°F	1.0	1.0	1.0	0.9
350-450°F	7.3	7.3	7.3	7.3
450-950°F	6.4	6.0	6.2	5.0
SRC				
Oil	13.4	13.5	14.0	14.1
Asphaltene	22.5	22.7	21.4	21.6
Benzene insoluble[a]	21.0	21.1	22.4	22.6
Ash	13.0	13.1	12.4	13.0
Unreacted coal	5.8	5.8	5.7	5.9
Hydrogen consumption, % MF coal	2.4	2.0	2.4	2.0
Organic liquid yield,[b]				
Distribution, % of total liquid product[c]				
IBP-350°F	5.6	5.8	5.7	6.1
350-450°F	46.4	47.3	47.0	50.3
450-550°F	66.8	67.8	67.4	70.2
550-650°F	13.6	13.6	13.4	12.2
650-EP°F	-32.4	-34.5	-33.5	-38.8

Table 6 (continued)
Conditions and Results Summary
Adjusted Yields
Kentucky 9 Coal

Date, 1979	26-27 April			
Run	162 MB			
Material Balance Method	Process Method		V110 Short Method	
Basis	Unadjusted	Elementally balanced	Unadjusted	Elementally balanced
Yields, % MF coal				
Gases				
H_2S	2.7	1.8	2.7	1.8
CO_2	0.1	0.1	0.1	0.1
CO	0.1	0.1	0.1	0.1
C_1	1.7	1.8	1.7	1.8
C_2	1.3	1.4	1.3	1.4
C_3	1.2	1.3	1.2	1.3
C_{4-5}	1.4	1.6	1.4	1.6
NH_3	0.6	0.6	0.6	0.6
Water	3.5	4.1	3.5	4.1
Distillates				
C_5-350°F	1.2	1.2	1.2	1.2
350-450°F	3.7	3.4	3.5	3.2
450-950°F	15.6	13.6	12.7	10.9
SRC				
Oil	14.5	15.1	17.6	18.2
Asphaltene	29.6	30.6	27.2	28.1
Benzene insoluble[a]	6.9	7.0	9.0	9.3
Ash	13.3	13.4	13.5	13.4
Unreacted coal	5.2	5.3	5.2	5.2
Hydrogen consumption, % MF coal	2.6	2.3	2.6	2.3
Organic liquid yield,[b]				
Distribution, % of total liquid product[c]				
IBP-350°F	6.0	6.6	7.0	7.7
350-450°F	17.4	18.0	19.5	20.2
450-550°F	43.2	42.9	45.1	45.0
550-650°F	17.2	16.4	15.2	14.1
650-EP°F	16.2	16.1	13.2	13.0

Table 6 (continued)
Conditions and Results Summary
Adjusted Yields
Kentucky 9 Coal

Date, 1979	11-12 May			
Run	163 MB			
Material Balance Method	Process Method		V110 Short Method	
Basis	Unadjusted	Elementally balanced	Unadjusted	Elementally balanced
Yields, % MF coal				
Gases				
H_2S	2.3	2.0	2.3	2.0
CO_2	0.3	0.2	0.3	0.2
CO	0.2	0.2	0.2	0.2
C_1	2.0	2.0	2.0	2.0
C_2	1.5	1.6	1.5	1.6
C_3	1.3	1.4	1.3	1.4
C_{4-5}	1.7	1.8	1.7	1.8
NH_3	0.4	0.4	0.4	0.4
Water	4.9	4.2	4.9	4.2
Distillates				
C_5-350°F	1.5	1.5	1.5	1.5
350-450°F	5.2	5.3	5.2	5.2
450-950°F	13.3	13.4	12.9	12.7
SRC				
Oil	10.0	10.2	15.8	16.1
Asphaltene	23.6	23.9	21.0	21.3
Benzene insoluble(a)	15.7	15.9	13.3	13.4
Ash	12.7	12.7	12.4	12.6
Unreacted coal	5.8	5.8	5.8	5.9
Hydrogen consumption, % MF coal	2.6	2.4	2.6	2.4
Organic liquid yield, (b)				
Distribution, % of total liquid product(c)				
IBP-350°F	7.6	7.5	7.7	7.8
350-450°F	26.1	26.0	26.5	26.8
450-550°F	50.8	51.4	51.1	52.0
550-650°F	-9.8	-9.3	-10.5	-10.7
650-EP°F	25.3	24.4	25.2	24.1

Table 6 (continued)
Conditions and Results Summary
Adjusted Yields
Kentucky 9 Coal

Date, 1979	4-5 June			
Run	164 MB			
Material Balance Method	Process Method		V110 Short Method	
Basis	Unadjusted	Elementally balanced	Unadjusted	Elementally balanced
Yields, % MF coal				
Gases				
H_2S	3.6	1.4	3.6	1.4
CO_2	1.9	0.7	1.9	0.7
CO	0.3	0.2	0.3	0.2
C_1	2.7	2.7	2.7	2.7
C_2	2.0	2.0	2.0	2.1
C_3	1.2	1.1	1.2	1.2
C_{4-5}	0.1	0.1	0.1	0.1
NH_3	0.3	0.2	0.3	0.3
Water	9.2	7.9	9.2	8.2
Distillates				
C_5-350°F	1.6	1.7	1.7	1.7
350-450°F	-9.8	-9.6	-8.3	-8.5
450-950°F	14.8	17.1	22.8	23.0
SRC				
Oil	2.7	2.6	1.0	1.0
Asphaltene	23.5	23.8	15.3	15.6
Benzene insoluble[(a)]	30.2	30.8	32.7	33.4
Ash	8.8	9.3	7.4	9.1
Unreacted coal	8.3	8.9	7.4	9.1
Hydrogen consumption, % MF coal	1.3	1.0	1.3	1.3
Organic liquid yield,[(b)]				
Distribution, % of total liquid product[(c)]				
IBP-350°F	24.4	18.7	10.5	10.6
350-450°F	-148.2	-105.0	-51.2	-52.5
450-550°F	7.7	14.4	22.3	22.1
550-650°F	35.4	31.2	27.1	27.3
650-EP°F	180.7	140.7	91.9	92.5

(a) Benzene insoluble, cresol soluble.
(b) Liquid fractions by GC determination.
(c) A negative value indicates that the amount of that fraction decreased because part of that fraction was consumed in the process.
(d) Solvent-free basis (distilled to 600°F and 0.1 mm Hg.

Table 7
Conditions and Results Summary
Dissolver Bypass Run
Kentucky 9 Coal

Run	164 MB
Date, 1979	2-5 June
Time Period	0940, 2 June - 2222, 5 June
Solvent	
Microautoclave conversion, %	V131B
short run	66.4
long run	60.0
Feed	
Coal rate, MF lb/hr	241
Concentration, % MF	35.3
Gas rate, Mscf/ton MF coal to preheater inlet	14.7
Hydrogen purity, mol %	84.6
Reactor Conditions	
Coal space rate,(a) MF lb/hr-ft^3	61.8
Preheater Temperature, °F	
Turn 15 skin/fluid	707/715
Turn 23 skin/fluid	790/735
Turn 31 skin/fluid	840/819
Turn 37 skin/fluid	861/-
Outlet fluid	858
Inlet pressure, psig	2,396
Pressure drop, psi	
total	19.5
Results	
Conversion, % MAF coal	90.9
Hydrogen consumed,(b) % MAF coal	1.44
SRC yield, % MAF coal	
V110 drumout basis(c)	71.9
Forced ash balance basis(d)	78.2
Sulfur in SRC, %	1.06

(a) Using 1.6 ft^3 as preheater reaction volume plus 2.3 ft^3 for transfer line.
(b) Based upon on-line hydrogen analyzers and gas flow rates.
(c) Based upon laboratory distillation of filtered V110 sample @ 600°F, 0.1 mm Hg absolute; using V110 drumout basis.
(d) SRC yield, % MAF coal

$$= 100 \times \frac{(\%\text{ ash in MF coal}) \times (\%\text{ SRC in V110})}{(\%\text{ ash in V110}) \times (100 - \%\text{ ash in MF coal})}$$

Table 8
Conditions and Results Summary
CSD Yield Data
Kentucky 9 Coal

Run	160 MB		161 MB		162 MB		163 MB		164 MB	
Feed Rate, lb/hr	284		332		294		311		316	
Yields	% MF Coal (a)	% of Feed	% MF Coal (a)	% of Feed	% MF Coal (a)	% of Feed	% MF Coal (a)	% of Feed	% MF Coal (a)	% of Feed
SRC										
oil	13.5	17.3	8.8	10.9	13.7	17.9	12.1	15.9	8.9	6.6
asphaltene	24.9	31.8	26.1	32.1	24.7	32.2	20.6	27.2	21.1	15.1
preasphaltene	9.3	12.0	6.3	7.8	3.4	4.4	6.4	8.4	13.9	10.3
unreacted coal	1.2	1.6	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ash	0	0	0	0	0	0	0.2	0.2	0	0
deashing solvent	0.1	0.2	0.1	0.2	0.1	0.2	0	0.1	0.1	0.1
Ash concentrate										
oil	1.3	1.6	2.1	2.5	2.6	3.3	2.3	3.0	2.8	2.1
asphaltene	1.8	2.3	1.8	2.2	2.5	3.3	1.6	2.1	2.3	1.7
preasphaltene	6.7	8.5	8.6	10.5	4.8	6.3	4.3	5.6	8.8	6.5
unreacted coal	6.2	7.9	8.4	10.3	6.4	8.4	8.7	11.4	25.1	18.6
ash	9.8	12.5	13.0	16.0	12.8	16.7	12.2	16.1	9.0	6.7
deashing solvent	1.8	2.4	1.1	1.4	4.2	5.5	2.8	3.7	4.3	3.2
SRC Recovery (b)	80.4		76.3		81.6		78.7		77.4	
Distillate										
in SRC, wt %	-		3.2		11.2		5.5		7.5	
in Light SRC, wt %	34.5		33.5		28		25.4		14.5	
Deashing Solvent Loss, % of KM feed										
total	12.3		9.7		15.1		7.8		11.6	
to products	2.6		1.6		5.6		4.0		3.3	

(a) Based upon adjusted coal feed and KM feed (from T102) rates which produced elementally balanced material balances.
(b) Based upon net SRC in feed and SRC product stream.
(c) @ 600°F and 0.1 mm Hg.

Table 9
Coal Feed Summary
Kentucky 9 Coal

Run	Coal	Feed Slurry Conc, MF lb/hr	Feed Slurry Conc, % MF Coal	Coal Feed, Pounds As-is	Coal Feed, Pounds MF	Coal Feed, Pounds MAF	Weighted Average, wt % Moist	Weighted Average, wt % Ash	Weighted Average, wt % Sulf
161[a]	Ky 9	498	38.6	133,565	131,980	118,224	1.2	11.1	3.2
162	Ky 9	487	38.1	225,861	224,498	195,073	0.6	13.1	3.2
163	Ky 9	502	38.4	330,559	328,671	291,775	0.6	11.2	3.2
164	Ky 9	246	34.4	17,689	17,507	15,986	1.0	8.7	3.0
165	Ky 9	453	38.2	39,935	39,703	36,218	0.6	8.8	3.1
166[b]	Ky 9	488	39.0	79,036	78,107	71,345	1.2	8.7	2.3
Averages		483	38.3				0.8	11.2	3.0
Totals				826,645	820,466	728,621			

(a) April portion of run.
(b) June portion of run.

Table 10
SRC Production Summary

Run	Coal	MCIF, lb/hr		MCIF yield, % MAF coal	Analysis, wt %				MP	SRC, Pounds					
										MF		MAF		MCIF	
		K125	KM		Solv	CI	Ash	S	°F	K125	KM	K125	KM	K125	KM
161[a]	Ky 9	99	205	68.0	8.1	23.1	15.1	1.6	370	33,882	70,707	28,844	59,952	26,164	54,218
162	Ky 9	178	94	64.2	6.4	25.3	16.7	1.7	320	109,331	58,423	91,158	48,668	82,022	43,234
163	Ky 9	147	154	67.4	8.2	22.9	14.8	1.7	319	124,809	130,460	106,712	110,862	95,976	100,934
164	Ky 9	37	187	63.4[c]	9.4	17.1	7.6	1.2	284	3,225	16,095	2,965	14,884	2,668	13,357
165	Ky 9	260	0	62.8	5.3	17.7	9.3	1.1	335	27,653	0	25,090	0	22,758	0
166[b]	Ky 9	130	162	65.4	6.9	16.1	10.7	1.7	326	25,336	31,453	22,620	28,097	20,803	25,835
Averages		160	157	66.1	8.3	22.6	14.5	1.6	328						
Totals										324,236	307,138	277,389	262,463	250,391	237,578

(a) April portion of run.
(b) June portion of run.
(c) With LSRC input removed.

Table 11
Solvent Refined Coal Analyses
Kentucky 9 Coal

Date, 1979	9-10 April			26-27 April		
Run	161 MB			162 MB		
Sample	CSD-Feed	CSD-SRC	V110[a]	CSD-Feed	CSD-SRC	V110[a]
Proximate Analysis, wt %						
Volatile Matter	21.40	42.18	37.99	39.77	43.99	41.43
Fixed Carbon	62.78	57.35	59.26	42.91	55.71	58.25
Moisture	<0.01	0.21	<0.01	<0.01	<0.01	<0.01
Ash	15.82	0.26	2.75	17.32	0.30	0.32
Ultimate Analysis, wt %						
Carbon	70.59	86.48	86.46	70.84	86.21	85.98
Hydrogen	4.72	5.86	5.75	5.30	6.28	6.01
Nitrogen	1.38	1.65	1.65	1.73	2.08	2.05
Sulfur	1.74	1.35	0.89	1.60	0.91	0.94
Chlorine	0.30	0.05	0.17	0.36	0.04	0.09
Ash	15.82	0.26	2.75	17.32	0.30	0.32
Oxygen, by difference	5.45	4.35	2.33	2.85	4.18	4.61
Heating Value, Btu/lb	13,263	15,442	15,792	13,160	15,672	15,980
Sulfur Forms, wt %						
Pyritic	0.34	<0.01	0.01	0.06	<0.01	<0.01
Sulfate	0.02	<0.01	0.03	0.03	<0.01	<0.01
Sulfide	0.75	0.03	ND	0.50	0.02	0.01
Organic	0.63	1.31	0.85	1.02	0.89	0.93
Melting Point, °F	320	336	365	300	276	140
Distillate						
at 500°F, wt %	2.1	2.3	-	1.3	2.1	-
vacuum, mm Hg	1.0	1.0	-	0.03	0.02	-
at 600°F, wt %	6.5	3.2	-	6.1	11.2	-
vacuum, mm Hg	0.1	0.5	-	0.1	0.05	-
Solvent Fractionation Analysis, wt %						
Oil[b]	23.0	21.4	24.2	26.8	32.7	33.9
Asphaltenes[c]	27.7	63.2	37.0	39.4	58.9	50.1
Benzene insoluble[d]	26.1	15.0	36.0	8.7	8.0	16.1
Cresol insoluble	7.4	0.1	0	7.6	0.1	-
Ash	15.8	0.3	2.8	17.3	0.3	-

Table 11 (continued)
Solvent Refined Coal Analyses
Kentucky 9 Coal

Date, 1979	11-12 May			4-5 June		
Run	163 MB			164 MB		
Sample	CSD-Feed	CSD-SRC	V110(a)	CSD-Feed	CSD-SRC	V110(a)
Proximate Analysis, wt %						
Volatile Matter	32.30	44.90	37.31	32.59	30.65	33.92
Fixed Carbon	51.36	54.35	62.19	60.84	69.21	65.71
Moisture	<0.01	0.06	0.04	<0.01	<0.01	<0.01
Ash	16.34	0.69	0.46	6.57	0.14	0.37
Ultimate Analysis, wt %						
Carbon	72.86	87.99	86.59	80.68	87.16	85.78
Hydrogen	5.14	6.29	6.07	5.28	5.58	5.58
Nitrogen	1.69	1.18	1.72	1.33	1.43	1.55
Sulfur	1.69	0.85	0.82	1.34	1.09	1.06
Chlorine	0.29	0.06	0.18	0.14	0.06	0.11
Ash	16.34	0.69	0.46	6.57	0.14	0.37
Oxygen, by difference	1.99	3.40	4.16	4.66	4.54	5.55
Heating Value, Btu/lb	13,174	15,845	15,862	14,774	15,796	16,086
Sulfur Forms, wt %						
Pyritic	0.13	<0.01	<0.01	0.03	<0.01	<0.01
Sulfate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfide	0.20	0.02	<0.01	0.15	0.02	<0.01
Organic	1.36	0.83	0.82	1.16	1.07	1.06
Melting Point, °F	298	278	347	303	356	338
Distillate						
at 500°F, wt %	3.5	1.6	-	1.8	2.6	-
vacuum, mm Hg	0.04	0.05	-	0.05	0.05	-
at 600°F, wt %	7.2	5.5	-	8.9	7.5	-
vacuum, mm Hg	0.025	0.05	-	0.05	0.025	-
Solvent Fractionation Analysis, wt %						
Oil(b)	23.0	30.7	33.3	26.1	20.3	24.8
Asphaltenes(c)	33.2	52.4	41.8	34.3	47.9	40.2
Benzene insoluble(d)	20.9	16.0	24.9	22.7	31.5	35.0
Cresol insoluble	6.6	0.2	-	10.3	0.2	-
Ash	16.3	0.7	-	6.6	0.1	-

(a) Laboratory filtered and vacuum distilled.
(b) Pentane soluble.
(c) Benzene soluble, pentane insoluble.
(d) Cresol soluble.

Table 12
Feed Coal Analyses

Coal	Kentucky 9	Kentucky 9	Kentucky 9	Kentucky 9	Kentucky 9
Date	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160 MB	161 MB	162 MB	163 MB	164 MB
Proximate Analysis, wt %					
Moisture	1.02	0.84	0.24	0.84	0.92
Ash	10.51	12.60	13.44	12.90	8.77
Volatile Matter	29.74	27.83	29.56	28.11	27.33
Fixed Carbon	58.73	58.73	56.76	58.15	62.98
Ultimate Analysis, wt %					
Carbon	71.65	70.16	68.70	69.60	72.66
Hydrogen	5.10	4.67	4.54	4.80	4.91
Nitrogen	1.46	1.67	1.45	0.88	0.95
Chlorine	0.20	0.45	0.28	0.28	0.26
Sulfur	3.61	2.86	3.27	3.30	2.88
Ash	10.51	12.60	13.4	12.9	8.77
Oxygen (by difference)	7.47	7.59	8.36	8.24	9.57
Dry Heating Value, Btu/lb	12,976	12,530	12,677	13,930	13,665
Sulfur Forms, wt %					
Pyritic	1.11	1.30	1.17	1.58	1.11
Sulfate	0.04	0.03	0.02	<0.01	0.14
Sulfide	0.03	0.02	0.01	<0.01	0.02
Organic	2.43	1.51	2.07	1.72	1.61
Mineral Analysis, wt %					
Phos. pentoxide, P_2O_5	0.16	0.14	0.14	0.15	0.08
Silica, SiO_2	55.90	54.42	50.66	54.13	53.54
Ferric Oxide, Fe_2O_3	13.26	17.65	18.75	18.18	18.06
Alumina, Al_2O_3	20.93	19.79	20.57	19.03	21.43
Titania, TiO_2	1.56	1.12	1.05	1.03	0.90
Lime, CaO	1.97	1.86	1.57	1.62	0.92
Magnesia, MgO	0.98	1.21	1.08	1.23	0.80
Sulfur Trioxide, SO_3	1.59	0.47	0.52	0.99	0.57
Potassium Oxide, K_2O	2.37	2.66	4.89	3.01	2.80
Sodium Oxide, Na_2O	0.37	0.51	0.49	0.35	0.46
Undetermined	0.91	0.17	0.28	0.28	0.44

Table 13
Slurry Preheater Operating Data
Kentucky 9 Coal
Fluid: Slurry/H_2

Date, 1979	9-10 April	26-27 April	11-12 May	4-5 June
Run/Test	161 MB	162 MB	163 MB	164 MB
Feed gas rate, scfh	9,860	10,100	4,600	2,150
Temperature, °F [(a)]				
Feed inlet TR 344-7	130	133	126	149
Turn 7 skin/fluid TR 344-6/5	421/385	420/398	511/446	542/437
Turn 7 skin/fluid Δt	36	22	65	105
Turn 15 skin/fluid TR 401-1/2	579/512	584/530	695/609	713/640
Turn 15 skin/fluid Δt	67	54	86	73
Turn 19 skin/fluid TR 401-3/4	626/564	639/572	723/672	770/716
Turn 19 skin/fluid Δt	62	67	51	54
Turn 23 skin/fluid TR 401-5/6	648/521	655/532	757/709	806/751
Turn 23 skin/fluid Δt	127	123	48	55
Turn 27 skin/fluid TR 401-7/8	702/620	695/615	807/666	862/767
Turn 27 skin/fluid Δt	82	80	141	98
Turn 31 skin/fluid TR 401-9/10	730/710	723/703	807/767	856/839
Turn 31 skin/fluid Δt	20	20	40	17
Turn 33 skin/fluid TR 401-11/12	758/712	745/702	838/771	854/790
Turn 33 skin/fluid Δt	46	43	67	64
Turn 35 skin/fluid TR 401-13/14	806/711	786/703	870/791	878/769
Turn 35 skin/fluid Δt	95	83	79	109
Turn 37 skin/fluid TR 401-15/16	807/747	790/736	866/829	877/-
Turn 37 skin/fluid Δt	60	54	37	-

Table 13 (continued)
Slurry Preheater Operating Data
Kentucky 9 Coal
Fluid: Slurry/H_2

Date, 1979	9-10 April	26-27 April	11-12 May	4-5 June
Run/Test	161 MB	162 MB	163 MB	164 MB
Feed gas rate, scfh	9,860	10,100	4,600	2,150
B102 outlet				
TR 401-17[b] (TE 344-12)	796	-	-	-
TR 401-18 (TE 329)	797	776	848	859
TR 401-19 (TE 368)	796	779	872	891
Stack TR 308	1,000	958	985	939
Pressure, psig				
Inlet	1,782	2,150	1,735	2,396
Outlet (by difference)	1,725	2,108	1,700	2,368
Pressure drop ΔP, psi				
Inlet to turn 23, DPT 368	11.7	16.6	11.4	5.7
Turn 23 to turn 31, DPT 370	9.5	11.0	5.4	2.4
Turn 31 to coil outlet, DPT 371	10.2	8.4	2.7	2.1
Total, Σ (368 + 370 + 371)	31.4	36.0	19.5	10.2
Fuel oil, gph				
FR 307	14.1	12.6	11.7	8.4

(a) See Figure 4 for location of thermocouples.
(b) Used as outlet temperature.

Table 14
Dissolver Temperature Profile
Kentucky 9 Coal

Date, 1979	9-10 April			26 April			11-12 May		
Run	161 MB			162 MB			163 MB		
Dissolver Volume in use, %	75			75			75		
Temperature, °F	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
TR 401-17 (Preheater Outlet)	787	796	802	768	776	787	835	849	851
TR 401-21 (Feed Inlet)	767	776	777	753	759	762	759	767	768
TR 401-22 (Dissolver Bottom)	792	808	813	800	805	808	803	811	817
TR 401-23	799	811	814	805	809	812	809	814	820
TR 401-24	799	812	817	806	809	813	809	815	821
TR 401-25	801	813	817	809	813	816	812	817	824
TR 401-26	804	814	817	811	813	816	812	817	824
TR 401-27	809	816	819	812	815	819	814	820	826
TR 401-28	810	818	821	812	817	821	815	822	828
TR 401-29	818	820	822	815	819	823	817	823	829
TR 401-30[a]	820	822	827	817	822	825	817	824	832
TR 401-31	821	823	827	819	822	826	820	825	832
TR 401-32	822	824	829	820	823	827	821	826	833
TR 401-33	822	825	829	820	824	828	818	826	833
TR 401-34[b]	822	825	829	820	825	829	819	827	833

(a) Slurry temperature near 50% outlet.
(b) Slurry temperature near 75% outlet.

Table 15
Reaction Solids Analyses
(V144 Emergency Blowdown Tank)

Coal	Kentucky 9
Date, 1979	30 May
Blowdown Solids	V144/AWS
Quantity, lb	386
Proximate Analysis, wt %	
Moisture	0.71
Ash	54.98
Volatile Matter	8.44
Fixed carbon, by difference	35.87
Ultimate Analysis, wt %	
Carbon	34.81
Hydrogen	1.79
Nitrogen	0.51
Sulfur	8.95
Chlorine	1.08
Ash	52.86
Oxygen (by difference)	-
Sulfur Forms, wt %	
Pyritic	0.77
Sulfate	0.21
Sulfide	5.71
Organic	2.26
Mineral Analysis of Ash, wt %	
Phos. Pentoxide, P_2O_5	0.08
Silica, SiO_2	35.07
Ferric oxide, Fe_2O_3	44.31
Alumina, Al_2O_3	13.20
Titania, TiO_2	1.18
Lime, CaO	2.13
Magnesia, MgO	0.65
Sulfur Trioxide, SO_3	0.77
Potassium Oxide, K_2O	1.16
Sodium Oxide, Na_2O	0.28
Undetermined	1.17
Carbon dioxide, wt %	0.06
Wet Screen Analysis, wt %	
retained on mesh	
50	6.2
100	5.9
200	12.3
270	12.3
325	22.0
-325	41.3
Solids density, gm/cc	1.515

Table 16
Reaction Section Operating Data
Kentucky 9 Coal

Date, 1979	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160 MB	161 MB	162 MB	163 MB	164 MB
Dissolver volume in use, %	75	75	75	75	(c)
Flow rates, lb/hr					
MF coal to B102	488	498	494	498	241
Solvent to B102	788	794	793	788	442
Light solvent from V105	139	157	204	209	74
Water from V105	19	25	19	27	24
Gas flow rates, scfh					
Feed gas					
to B102	9,801	9,920	10,225	4,595	1,769
bypassing B102	-	-	-	4,580	-
Makeup hydrogen	3,008	2,992	3,317	3,456	1,228
Recycle gas from V104	11,490	11,072	11,862	9,345	6,265
HP purge gas	508	695	708	841	356
LP vent gas from V105	410	299	570	484	433
Degas vent(a)	80	91	124	167	112
Gas removed by caustic scrubber	138	143	118	129	131
Temperature, °F					
B102 outlet	784	796	776(d)	848(d)	859(d)
R101 bottom	809	808	805	811	-
R101 middle(b)	824	822	822	824	-
R101 top(b)	825	825	825	827	-
V103 HP flash	610	610	633	630	643
V104 HP vent	75	73	76	78	80
V110 LP flash	552	541	572	566	563
Pressure, psig					
B102 inlet	1,730	1,782	2,150	1,735	2,396
B102 outlet	1,703	1,725	2,108	1,700	2,368
V110 outlet gas	112	120	120	100	139
V105 outlet gas	7	7	7	7	7
Hydrogen purity, vol %					
Feed gas to B102	81.2	81.7	84.1	81.3	84.6
Recycle gas from V104	75.9	77.2	80.1	76.4	73.7
Recycle gas from V106	77.4	78.6	80.8	77.3	75.1
LP vent gas from V105	38.3	39.6	42.6	37.8	42.7
Degas vent	68.7	61.6	64.4	66.0	65.3

(a) Includes compressor vents, plus on-line GC sample streams.
(b) Liquid.
(c) Dissolver bypassed.
(d) Thermocouple outlet (pt. 17) bad, used pt. 18 instead.

Table 17
High Pressure Vent Separator Gas Analyses (V104)
Kentucky 9 Coal

Date, 1979		25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run		160	161	162	163	164
Component	Mol wt	Mole %	Mole %	Mole %	Mole %	Mole %
H_2	2.02	75.9	77.2	80.1	76.4	72.7
N_2	28.02	0.3	0.2	0.2	0.2	0.3
CO	28.00	0.7	0.6	0.5	0.7	0.7
CO_2	44.00	0	0.1	0	0.1	0.6
H_2S	34.08	1.1	1.1	1.0	1.2	1.4
CH_4	16.03	16.4	15.7	13.7	15.6	17.9
C_2H_2	26.02	0	0	0	0	0
C_2H_4	28.03	0	0	0	0	0
C_2H_6	30.05	3.9	3.7	3.2	4.1	4.5
C_3H_6	42.05	0	0	0	0	0
C_3H_8	44.06	1.4	1.2	1.1	1.4	1.6
iC_4H_{10}	58.08	0.1	0	0	0	0.1
nC_4H_{10}	58.08	0.2	0.2	0.2	0.3	0.2
iC_5H_{12}	72.15	0	0	0	0	0
nC_5H_{12}	72.15	0	0	0	0	0
C_6H_{14}	86.18	0	0	0	0	0

Table 18
Decanter Vent Gas Analyses (V105)
Kentucky 9 Coal

Date, 1979		25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run		160	161	162	163	164
Component	Mol wt	Mole %	Mole %	Mole %	Mole %	Mole %
H_2	2.02	38.3	39.6	42.6	37.8	42.7
N_2	28.02	28.9	21.5	19.3	23.4	29.1
CO	28.00	0.3	0.2	0.2	0.1	0.2
CO_2	44.00	0.2	0.2	0.5	0.2	0.3
H_2S	34.08	4.0	7.4	4.8	2.3	1.4
CH_4	16.03	12.8	13.5	12.7	12.4	15.2
C_2H_2	26.02	0	0	0	0	0
C_2H_4	28.03	0	0	0	0	0
C_2H_6	30.05	7.7	8.4	7.6	8.5	7.8
C_3H_6	42.05	0	0	0	0	0
C_3H_8	44.06	5.3	6.8	6.3	6.9	3.2
iC_4H_{10}	58.08	0.4	0.5	0.5	0.6	0
nC_4H_{10}	58.08	1.3	0.4	2.8	2.7	0.1
iC_5H_{12}	72.15	0.4	0.4	0.6	0.6	0
nC_5H_{12}	72.15	0.4	1.1	1.3	1.5	0
C_6H_{14}	86.18	0	0	0.5	2.6	0

Table 19
Degas Vent Gas Analyses (V132)
Kentucky 9 Coal

Date, 1979		25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run		160	161	162	163	164
Component	Mol wt	Mole %	Mole %	Mole %	Mole %	Mole %
H_2	2.02	68.7	61.6	64.4	66.0	65.3
N_2	28.02	19.4	18.7	16.0	12.6	34.4
CO	28.00	0.2	0.4	0.5	0.5	0
CO_2	44.00	0.8	0	0	0	0
H_2S	34.08	0.3	0	0	0	0
CH_4	16.03	8.0	14.0	13.8	14.8	0.2
C_2H_2	26.02	0	0	0	0	0
C_2H_4	28.03	0	0.1	0.2	0.2	0
C_2H_6	30.05	2.1	4.0	3.9	4.4	0.1
C_3H_6	42.05	0	0	0	0	0
C_3H_8	44.06	0.5	1.1	1.0	1.3	0
iC_4H_{10}	58.08	0	0	0	0	0
nC_4H_{10}	58.08	0	0.1	0.2	0.2	0
iC_5H_{12}	72.15	0	0	0	0	0
nC_5H_{12}	72.15	0	0	0	0	0
C_6H_{14}	86.18	0	0	0	0	0

Table 20
Flare Gas Analyses (K110)
Kentucky 9 Coal

Date, 1979		25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run		160	161	162	163	164
Component	Mol wt	Mole %	Mole %	Mole %	Mole %	Mole %
H_2	2.02	39.8	43.1	37.2	41.3	17.6
N_2	28.02	47.6	44.2	50.0	44.1	72.1
CO	28.00	0	0.2	0.3	0.2	0.1
CO_2	44.00	0	0	0	0	0.2
H_2S	34.08	0	0	0	0	0.1
CH_4	16.03	7.7	7.8	6.7	8.3	5.1
C_2H_2	26.02	0	0	0	0	0
C_2H_4	28.03	0	0	0	0	0
C_2H_6	30.05	2.8	2.8	2.8	3.2	2.3
C_3H_6	42.05	0	0	0	0	0
C_3H_8	44.06	1.5	1.4	1.8	1.9	1.5
iC_4H_{10}	58.08	0.5	0.4	0.1	0.1	0.2
nC_4H_{10}	58.08	0	0	0.7	0.6	0.6
iC_5H_{12}	72.15	0.1	0.1	0.1	0.1	0.1
nC_5H_{12}	72.15	0	0	0.2	0.2	0.1
C_6H_{14}	86.18	0	0	0.1	0	0

Table 21
Low Pressure Flash (V110) Product Analyses
Kentucky 9 Coal

Date, 1979	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160 MB	161 MB	162 MB	163 MB	164 MB
Composition, wt %					
Cresol Insoluble (CI)	6.7	7.8	8.4	8.8	6.8
Ash	4.4	5.2	5.9	6.0	3.2
SRC[a]	25.8	26.5	27.2	25.7	39.2
Distillate[b]	67.5	65.7	64.4	65.5	54.0
Distillate Composition, wt %					
IBP-350°F	0	0.1	0	0	0.8
350-450°F	3.4	5.6	6.0	5.8	16.0
450-550°F	22.9	30.7	32.1	35.9	32.4
550-650°F	29.5	29.5	29.0	25.6	21.4
650°F-EP	44.2	34.1	32.9	32.7	29.4
Distillate, lab					
Ultimate Analysis, wt %					
Carbon	86.54	87.50	86.52	85.78	86.68
Hydrogen	8.97	8.93	8.87	8.95	8.63
Nitrogen	0.68	0.85	0.96	0.84	1.25
Sulfur	0.08	0.44	0.38	0.40	0.38
Ash	<0.01	<0.01	<0.01	<0.01	<0.01
Oxygen (by difference)	3.73	2.28	3.26	4.03	3.06
SRC, lab					
Solvent Fractionation and Ultimate Analysis[c]					
Cresol Insoluble, lab					
Ultimate Analysis, wt %					
Carbon	25.88	24.79	21.90	23.56	41.27
Hydrogen	1.17	1.30	1.20	1.36	2.01
Nitrogen	0.26	0.25	0.42	0.35	0.40
Sulfur	4.59	5.00	5.02	4.73	4.17
Ash	63.90	66.60	70.50	68.90	46.70
Oxygen (by difference)	4.20	2.06	0.96	1.10	5.45

(a) Distillation conditions: 316°C @ 0.1 mm Hg.
(b) Distillate = 100 - (CI + SRC).
(c) See Table 11.

Table 22
Vacuum Column Operating Data
T102
Kentucky 9 Coal

Date, 1979	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160B-C MB	161C MB	162A MB	163A MB	164A MB
Operating Conditions					
Pressure, psia	0.4	0.5	0.6	0.6	1.1
Flow rates, lb/hr					
Feed					
from V110	1,110	1,087	1,043	1,032	558
from T104 bottom	152	284	298	258	100
Overhead Light Solvent					
feed to T104	27	137	115	66	53
Tray 1 reflux	1,646	1,768	1,646	1,590	1,179
Wash Solvent (Tray 3)					
to V178	36	13	28	14	-95
Process Solvent (Tray 8)					
to V131B	821	817	825	828	384
Bottoms (SRC)					
to K125/CSD	378	404	377	382	316
to B103	12,676	10,133	13,198	12,945	18,092
Temperature, °F					
Tray 1 (ovhd)	191	192	192	192	201
Tray 8	301	295	293	301	284
Packing reflux	294	318	313	317	311
B103 outlet	580	580	565	560	565
Bottom	580	575	560	560	566
Product Pump Power, amps	30	33	26	30	30
Compositions,(a) wt %					
Tray 3					
IBP-350°F	3.1	1.1	1.6	1.4	1.9
350-450°F	55.3	75.1	87.5	81.8	93.0
450°F, EP	41.7	23.8	10.9	16.8	5.1
Tray 8					
IBP-350°F	0	0	0	0	0.3
350-450°F	4.1	4.6	6.9	6.8	24.1
450°F, EP	95.9	95.4	93.1	93.2	75.6

(a) Fisher 4800 gas chromatography.

Table 23
Recovered Solvent Analyses
Kentucky 9 Coal

Date, 1979	25-16 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160B-C MB	161C MB	162A MB	163A MB	164A MB
Recycle Solvent from T102 (Tray 8)					
Boiling Fractions, wt %					
(IBP, °F)	(337)	(405)	(375)	(386)	(350)
IBP-350 °F	0	0	0	0	0.3
350-450 °F	4.1	4.6	6.9	6.8	24.1
450-550 °F	25.0	35.8	37.2	41.2	34.3
550-650 °F	29.5	28.4	26.0	23.9	19.2
650°F, EP	41.4	31.2	29.9	28.1	22.1
(EP, °F)	(937)	(904)	(937)	(937)	(890)
Specific Gravity	1.023	1.017	1.010	1.010	1.030
Ultimate Analysis, wt %					
Carbon	88.95	86.94	87.15	86.54	86.05
Hydrogen	8.94	8.91	8.83	9.12	8.78
Nitrogen	0.66	1.37	0.67	0.77	0.56
Chlorine	-	-	-	-	-
Sulfur	0.36	0.44	0.39	0.40	0.41
Ash	<0.01	<0.01	<0.01	<0.01	<0.01
Oxygen (by difference)	1.09	2.34	2.96	3.17	4.20
Wash Solvent from T102 (Tray 3)					
Boiling Fractions, wt %					
(IBP, °F)	(277.4)	(340)	(337)	(338)	(330)
IBP-350 °F	3.1	1.1	1.6	1.4	1.9
350-450 °F	55.3	75.1	87.5	81.8	93.0
450-550 °F	40.3	23.8	10.9	16.8	5.1
550-650 °F	1.3	-	0	0	0
650°F, EP	0	-	0	0	0
(EP, °F)	(568.4)	(506)	(485)	(492)	(466)
Specific Gravity	0.968	0.957	0.955	0.955	0.946
Ultimate Analysis, wt %					
Carbon	85.02	84.71	84.04	84.61	84.97
Hydrogen	9.93	9.68	10.25	9.92	10.22
Nitrogen	0.49	0.60	0.83	1.08	1.43
Chlorine	-	-			-
Sulfur	0.24	0.29	0.33	0.31	0.31
Ash	<0.01	<0.01	<0.01	<0.01	<0.01
Oxygen (by difference)	4.32	4.72	4.55	4.08	3.07

Table 24
Recovered Solvent Compositions (wt %)
Kentucky 9 Coal

Date, 1979	25-26 March		9-10 April		26-27 April		11-12 May		4-5 June	
Run	160B-C MB		161C MB		162A MB		163A MB		164A MB	
	Tray 3	Tray 8	Tray 3	Tray 8	Tray 3	Tray 8	Tray 3	Tray 8	Tray 3	Tray 8
Component or boiling range, °F(a)										
100-155	-	-	-	-	-	-	-	-	-	-
hexane	-	-	-	-	-	-	-	-	-	-
157-175	-	-	-	-	-	-	-	-	-	-
cyclohexane	-	-	-	-	-	-	-	-	-	-
177-230	-	-	-	-	-	-	-	-	-	-
toluene	0.2	-	-	-	-	-	-	-	-	-
232-280	2.8	-	-	-	-	-	-	-	-	-
xylene (p-,m-)	-	-	-	-	-	-	-	-	0.2	-
o-xylene	-	-	-	-	-	-	-	-	-	-
282-349	-	-	1.1	-	1.6	-	1.4	-	0.7	0.3
indane	11.3	0.2	5.0	-	7.2	0.3	6.3	0.1	11.1	4.6
351-359	-	-	-	-	-	2.6	-	-	-	-
phenol	1.3	-	4.3	-	5.9	-	6.3	-	9.6	4.6
360-383	4.3	-	21.1	-	30.3	-	25.6	2.3	30.6	1.2
c-decalin	-	-	-	-	-	-	-	-	-	-
385-395	5.7	1.2	8.1	0.1	11.9	-	8.5	-	11.7	6.5
cresol	-	-	-	-	-	-	-	-	-	-
396-404	-	-	-	-	-	-	-	-	-	-
tetralin	12.8	-	15.3	1.3	10.8	0.4	14.6	0.5	12.6	0.9
406-423	10.3	-	-	-	-	-	-	0.8	3.3	6.2
naphthalene	3.9	0.9	-	0.8	12.3	0.8	12.0	3.1	8.2	1.5
425-459	5.7	1.8	21.3	2.5	9.1	2.8	8.5	-	5.8	3.3
quinoline	7.7	1.3	9.1	1.3	7.7	2.6	8.5	1.9	3.4	3.8
461-465	2.3	-	-	1.0	-	-	1.0	-	-	1.2
2-methylnaphthalene	12.4	4.8	1.8	4.2	2.4	7.4	4.9	9.0	1.5	9.5
1-methylnaphthalene	-	-	-	-	-	-	-	-	-	-
473-491	2.7	1.0	10.4	4.8	0.4	1.4	1.8	2.4	0.2	1.4
biphenyl	4.2	3.4	1.3	6.6	0.4	9.4	0.1	7.4	0.1	4.9
diphenyl-ether	-	-	-	-	-	-	-	-	-	-
497-531	8.9	7.5	1.0	10.6	-	9.5	0.4	11.2	-	8.2
acenaphthene	1.3	3.5	0.2	3.8	-	3.7	0.1	4.0	-	2.8
532-548	-	-	-	1.7	-	-	-	3.2	-	-
dibenzofuran	0.7	3.5	-	1.8	-	3.2	-	2.3	-	2.6
549-568	-	1.8	-	3.4	-	3.3	-	1.3	-	2.3
fluorene	1.1	1.3	-	8.7	-	5.9	-	8.1	-	4.5
569-629	0.4	19.9	-	10.6	-	11.7	-	10.0	-	8.3
dibenzothiophene	-	-	-	-	-	-	-	-	-	-
phenanthrene	-	6.6	-	5.8	-	5.0	-	4.5	-	4.1

Table 24 (continued)
Recovered Solvent Compositions (wt %)
Kentucky 9 Coal

Date, 1979	25-26 March		9-10 April		26-27 April		11-12 May		4-5 June	
Run	160B-C MB		161C MB		162A MB		163A MB		164A MB	
	Tray 3	Tray 8	Tray 3	Tray 8	Tray 3	Tray 8	Tray 3	Tray 8	Tray 3	Tray 8
Component or boiling range, °F(a)										
644-675	-	1.5	-	3.1	-	2.5	-	2.9	-	2.2
1-methylphenanthrene	-	2.5	-	3.6	-	4.1	-	4.8	-	4.5
677-684	-	-	-	1.3	-	-	-	-	-	-
9-methylanthracene	-	4.9	-	1.5	-	1.6	-	0.7	-	1.3
686-721	-	4.6	-	4.4	-	2.7	-	3.8	-	1.7
fluoranthene	-	1.4	-	2.4	-	1.1	-	2.0	-	1.8
722-739	-	1.5	-	-	-	-	-	-	-	-
pyrene	-	3.2	-	1.7	-	2.2	-	1.4	-	1.5
741-837	-	12.2	-	7.0	-	8.7	-	7.1	-	3.0
chrysene	-	0.2	-	0.6	-	1.0	-	0.2	-	0.9
unknown > chrysene	-	9.3	-	5.4	-	6.1	-	7.3	-	0.4

(a) By Fisher 4800 gas chromatograph.

Table 25
Organic Liquid Analyses
Kentucky 9 Coal

Date, 1979	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160B-C MB	161C MB	162A MB	163A MB	164A MB
Organic Liquid from V105					
Boiling fractions, wt %					
(IBP, °F)	(148)	(176)	(156)	(156)	(156)
IBP-200°F	1.8	0.7	1.4	1.9	1.6
200-350°F	2.6	2.4	1.6	1.7	7.1
350-450°F	16.0	18.3	19.9	17.3	43.0
450°F-EP	79.6	78.6	77.1	79.1	48.3
(EP, °F)	(740)	(755)	(676)	(722)	(969)
Specific Gravity	0.935	0.943	0.951	0.929	0.933
Ultimate Analysis, wt %					
Carbon	87.19	86.48	85.58	86.95	85.18
Hydrogen	9.83	9.76	10.52	10.16	10.20
Nitrogen	0.71	0.90	0.81	1.09	1.41
Sulfur	0.22	0.39	0.37	0.05	0.29
Ash	<0.01	<0.01	<0.01	<0.01	<0.01
Oxygen (by difference)	2.04	2.47	3.35	2.33	2.92
Organic liquid from T102 ovhd					
Boiling fractions, wt %					
(IBP, °F)	(253)	(231)	(231)	(231)	(222)
IBP-200°F	0.1	0.2	0	0	0
200-350°F	5.7	13.5	7.8	13.0	14.4
350-450°F	82.2	80.3	87.0	82.4	82.5
450°F, EP	12.0	6.0	5.2	4.6	3.1
(EP, °F)	(503)	(473)	(466)	(466)	(466)
Specific Gravity	0.937	0.914	0.929	0.929	-

Table 26
Organic Liquid Compositions, (wt %)
Kentucky 9 Coal

Date, 1979	25-26 March		9-10 April		26-27 April		11-12 May		4-5 June	
Run	160B-C MB		161C MB		162A MB		163A MB		164A MB	
	V105 Decanter	P171 T102 Ovhd	V105 Decanter	P171 T102 Ovhd	V105 Decanter	P171 T102 Ovhd	V105 Decanter	P171 T102 Ovhd	V105 Decanter	P171 T102 Ovhd
Component or boiling range, °F[(a)]										
100-155	0.8	-	-	-	-	-	-	-	0.1	-
hexane	0.4	-	0.3	-	0.9	-	0.9	-	0.6	-
157-175	-	-	-	-	0.1	-	-	-	-	-
cyclohexane	0.5	0.1	0.4	0.1	-	-	0.4	-	0.9	-
177-230	-	0.1	-	0.1	1.3	0.2	0.6	0.2	-	0.5
toluene	0.9	0.5	1.1	0.6	-	0.4	1.3	0.6	1.9	1.2
232-280	0.2	0.3	0.1	0.5	0.2	0.2	0.1	-	0.2	0.7
xylene (p-,m-)	0.5	0.7	0.3	2.1	0.4	0.7	0.3	2.5	1.3	2.4
o-xylene	-	-	-	-	-	-	0.1	-	-	-
282-349	1.0	4.1	0.9	10.2	0.2	7.2	-	10.5	3.3	9.7
indane	2.1	9.9	1.3	11.7	0.5	11.4	0.9	12.6	2.6	12.5
351-359	-	-	-	-	1.5	-	-	-	8.7	-
phenol	1.0	8.3	0.7	14.1	0.7	12.3	0.2	15.8	0.2	16.7
360-383	0.8	26.3	0.9	21.5	0.3	29.0	0.3	26.7	3.4	25.9
c-decalin	-	-	-	-	-	-	-	-	-	-
385-395	3.9	7.2	6.1	3.3	7.1	10.4	6.2	9.0	12.7	4.5
cresol	-	-	-	-	-	-	-	-	-	-
396-404	-	4.6	-	4.9	-	-	-	-	-	4.5
tetralin	0.8	9.9	1.1	4.0	1.0	10.1	1.1	7.4	0.8	1.4
406-423	-	-	-	9.1	-	-	1.9	2.0	1.6	8.6
naphthalene	2.9	10.1	2.1	2.0	1.9	8.2	1.3	4.9	6.7	4.9
425-459	4.6	5.8	6.2	9.9	6.8	4.6	5.5	4.1	6.4	3.0
quinoline	3.3	5.6	3.5	3.7	4.5	4.1	3.7	3.2	4.1	2.2
461-465	-	0.2	2.0	-	2.3	-	2.0	0.2	1.4	-
2-methylnaphthalene	7.3	4.2	8.2	0.2	7.5	1.0	10.8	1.1	12.9	0.6
1-methylnaphthalene	-	0	-	-	-	-	-	-	-	-
473-491	6.1	0.7	8.7	1.8	9.2	-	7.1	-	-	-
biphenyl	7.0	0.7	6.8	0.2	13.6	0.2	10.6	0.2	1.9	0.1
diphenyl-ether	-	0	-	-	-	-	-	-	-	-
497-531	13.9	0.7	15.0	-	14.4	-	15.3	-	17.0	-
acenaphthene	4.9	-	4.4	-	4.3	-	4.5	-	2.3	-
532-548	-	-	-	-	-	-	3.1	-	-	-
dibenzofuran	4.7	-	3.9	-	1.9	-	2.8	-	1.9	-
549-568	2.9	-	3.9	-	5.6	-	1.2	-	1.4	-
fluorene	1.4	-	5.4	-	3.3	-	4.3	-	2.3	-
569-629	18.2	-	9.3	-	7.9	-	10.4	-	1.2	-
dibenzothiophene	-	-	-	-	-	-	-	-	-	-

Table 26 (continued)
Organic Liquid Compositions, (wt %)
Kentucky 9 Coal

Date, 1979	25-26 March		9-10 April		26-27 April		11-12 May		4-5 June	
Run	160B-C MB		161C MB		162A MB		163A MB		164A MB	
	V105 Decanter	P171 T105 Ovhd	V105 Decanter	P171 T102 Ovhd	V105 Decanter	P171 T102 Ovhd	V105 Decanter	P171 T102 Ovhd	V105 Decanter	P171 T102 Ovhd
Component or boiling range, °F(a)										
phenanthrene	3.6	-	2.6	-	1.6	-	0.3	-	0.8	-
644-675	1.5	-	1.0	-	0.6	-	1.4	-	-	-
1-methylphenanthrene	2.5	-	1.7	-	0.3	-	0.2	-	0.4	-
677-684	-	-	-	-	-	-	-	-	-	-
9-methylanthracene	-	-	0.2	-	0.1	-	0.7	-	-	-
686-721	0.9	-	0.9	-	-	-	-	-	-	-
fluoranthene	0.3	-	0.4	-	-	-	0.3	-	-	-
722-739	-	-	-	-	-	-	-	-	-	-
pyrene	0.6	-	0.1	-	-	-	-	-	-	-
741-837	0.5	-	0.4	-	-	-	0.1	-	-	-
chrysene	-	-	0.1	-	-	-	0.1	-	-	-
unknown > chrysene	-	-	-	-	-	-	-	-	0.1	0.6

(a) Fisher 4800 gas chromatograph.

Table 27
T104 Light Solvent Recovery Column Operating Data
Kentucky 9 Coal

Date, 1979	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160B-C MB	161C MB	162A MB	163A MB	164A MB
Operating Conditions					
Pressure, psig	6.7	9.4	6.5	8.2	6.0
Flow rates, lb/hr					
Feed					
from V105	139	160	204	209	75
from T102	27	137	111	66	53
Overhead					
Product	14	14	17	17	28
Reflux[(a)]	-	-	-	-	-
Vent[(b)]	0	0	0	0	0
Temperature, °F					
Top	310	201	262	274	374
Bottom	500	500	505	503	500
Feed	311	196	250	265	368
Composition, wt %					
Feed					
IBP-350°F	3.2	8.7	4.7	7.3	5.3
350-450°F	52.1	35.6	32.1	36.2	59.8
450°F, EP	44.7	55.7	63.2	56.5	34.9
Water in feed					
from V105	0	0.03	0.40	0.06	0.7
from T102	1.0	0.04	0.40	0.05	0.8
Overhead oil					
IBP-350°F	57.8	98.7	92.2	92.2	16.9
350-450°F	42.2	1.3	7.8	7.8	83.1
450°F, EP	0	0	-	-	-
Bottom					
IBP-350°F	4.5	5.1	8.2	8.0	0.5
350-450°F	34.7	38.2	32.5	38.8	54.2
450°F, EP	60.8	56.7	59.3	53.2	45.3
Specific gravity					
Overhead	0.798	0.758	0.768	0.776	0.891
Bottom	0.968	0.963	0.966	0.960	0.962
Feed	0.924	0.945	0.945	0.929	0.941

(a) T104 reflux not in use.
(b) T104 vent closed.

Table 28
Organic Liquid Product Analyses
Kentucky 9 Coal

Date, 1979	25-26 March	9-10 April	26-27 April	11-12 May	4-5 June
Run	160B-C MB	161C MB	162A MB	163A MB	164A MB
Recycle solvent (V131B)					
Boiling fractions, wt %					
(IBP, °F)	(405)	(405)	(401)	(383)	(335)
IBP-350°F	0	0.1	0	0.1	1.4
350-450°F	3.4	4.0	8.1	6.2	29.7
450-550°F	25.0	30.7	37.2	39.8	35.3
550-650°F	29.8	29.1	27.5	27.2	16.8
650°F-EP	41.8	36.1	27.2	26.7	16.8
(EP, °F)	(918)	(937)	(909)	(892)	(838)
Specific Gravity	1.070	1.020	1.011	1.009	0.996
Ultimate Analysis, wt %					
Carbon	88.33	86.98	86.17	86.69	85.07
Hydrogen	8.63	8.89	8.71	8.70	8.89
Nitrogen	0.97	1.43	1.40	0.99	1.40
Chlorine	-	-	-	-	-
Sulfur	0.41	0.44	0.37	0.39	0.28
Ash	<0.01	<0.01	<0.01	<0.01	0.04
Oxygen (by difference)	1.66	2.25	3.35	3.23	4.32
Light Organic Liquid from T104 ovhd					
Boiling fractions, wt %					
(IBP, °F)	(148)	(136)	(156)	(164)	(210)
IBP-200°F	25.1	36.6	40.8	14.6	0
200-350°F	32.7	62.0	51.4	77.6	16.9
350-450°F	42.2	1.4	7.8	7.8	83.1
450°F-EP	-	-	-	-	-
(EP, °F)	(405)	(360)'	(362)	(360)	(420)
Specific Gravity	0.798	0.758	0.768	0.776	0.891
Ultimate Analysis, wt %					
Carbon	84.76	84.83	85.05	84.98	83.80
Hydrogen	13.58	12.90	13.27	13.46	11.33
Nitrogen	0.74	0.48	0.66	0.88	1.53
Chlorine	-	-	-	-	-
Sulfur	0.11	0.19	0.14	0.21	0.27
Ash	<0.01	<0.01	<0.01	<0.01	0.06
Oxygen (by difference)	1.81	1.60	0.88	0.47	3.01

Table 29
Organic Liquid Product Compositions,(wt %)
Kentucky 9 Coal

Date, 1979	25- 6 March		9-10 April		26-27 April		11-12 May		4-5 June	
Run	160B-C MB		161C MB		162A MB		163A MB		164A MB	
	V131B	T104 Ovhd	V131B	T104 Ovhd	V131B	T104 Ovhd	V131B	T104 Ovhd	V131B	T104 Ovhd
Component or boiling range, °F[(a)]										
100-155	-	1.0	-	4.9	-	-	-	-	-	-
hexane	-	10.6	-	9.1	-	4.7	-	-	-	-
157-175	-	-	-	-	-	-	-	13.5	-	-
cyclohexane	-	12.3	-	3.0	-	14.6	-	1.0	-	-
177-230	-	1.2	-	24.2	-	21.5	-	23.2	-	0.9
toluene	-	9.6	0.1	32.3	-	22.7	0.1	9.3	-	2.9
232-280	-	2.5	-	6.7	-	5.9	-	26.4	-	0.5
xylene(p-,m-)	-	7.0	-	15.0	-	14.9	-	3.9	-	3.3
o-xylene	-	-	-	-	-	-	-	-	-	-
292-349	-	13.6	-	3.5	-	7.9	-	14.9	1.4	9.4
indane	-	4.1	0.1	-	-	0.8	-	0.6	5.3	16.1
351-359	-	6.5	-	-	-	-	-	-	-	-
phenol	-	22.5	-	1.3	-	6.5	-	7.0	0.8	21.8
360-383	-	8.5	0.1	-	0.3	0.5	2.1	0.2	2.3	30.0
c-decalin	-	-	-	-	-	-	-	-	-	-
385-395	0.1	-	-	-	-	-	-	-	7.6	1.3
cresol	-	-	-	-	-	-	-	-	-	-
396-404	0.1	-	-	-	0.6	-	-	-	-	3.5
tetralin	0.8	0.6	1.1	-	2.6	-	0.4	-	2.2	4.4
406-423	-	-	-	-	-	-	-	-	6.0	6.2
naphthalene	0.8	-	0.7	-	1.1	-	0.6	-	2.0	-
425-459	1.5	-	2.0	-	3.2	-	3.1	-	3.7	-
quinoline	1.1	-	1.2	-	2.3	-	1.8	-	4.5	-
461-465	-	-	0.9	-	1.6	-	-	-	1.2	-
2-methylnaphthalene	5.7	-	3.8	-	4.2	-	9.0	-	9.8	-
1-methylnaphthalene	-	-	-	-	-	-	-	-	-	-
471-491	-	-	4.3	-	5.0	-	2.4	-	1.3	-
biphenyl	3.4	-	5.6	-	9.1	-	7.6	-	5.3	-
diphenyl-ether	-	-	-	-	-	-	-	-	-	-
495-531	7.6	-	9.7	-	9.7	-	11.4	-	8.0	-
acenaphthene	3.5	-	3.7	-	3.7	-	4.4	-	2.8	-
532-548	-	-	-	-	-	-	-	-	-	-
dibenzofuran	3.7	-	1.7	-	1.8	-	3.3	-	2.4	-
549-568	3.0	-	2.6	-	4.6	-	3.8	-	2.0	-
fluorene	6.9	-	1.4	-	5.0	-	5.1	-	4.1	-
569-642	20.3	-	17.6	-	13.2	-	13.6	-	7.2	-
dibenzothiophene	-	-	-	-	-	-	-	-	-	-

Table 29 (continued)
Organic Liquid Product Compositions, (wt %)
Kentucky 9 Coal

Date, 1979	25-26 March		9-10 April		26-27 April		11-12 May		4-5 June	
Run	160B-C MB		161C MB		162A MB		163A MB		164A MB	
	V131B	T104 Ovhd	V131B	T104 Ovhd	V131B	T104 Ovhd	V131B	T104 Ovhd	V131B	T104 Ovhd
Component or boiling range, °F[(a)]										
phenanthrene	6.5	-	5.5	-	4.6	-	4.7	-	3.5	-
644-675	3.7	-	2.9	-	3.5	-	2.8	-	1.8	-
1-methylphenanthrene	4.0	-	3.5	-	2.3	-	4.6	-	3.7	-
677-684	-	-	-	-	-	-	-	-	1.4	-
9-methylanthracene	3.3	-	1.5	-	1.1	-	1.1	-	0.4	-
686-721	3.7	-	4.4	-	4.1	-	3.8	-	0.7	-
fluoranthene	1.4	-	1.2	-	3.2	-	2.4	-	1.3	-
722-739	-	-	-	-	-	-	-	-	-	-
pyrene	3.3	-	2.9	-	2.5	-	1.2	-	1.2	-
741-837	13.1	-	10.6	-	5.4	-	7.6	-	3.6	-
chrysene	0.2	-	1.1	-	1.6	-	0.1	-	0.9	-
unknowns > chrysene	2.3	-	8.1	-	3.7	-	3.0	-	1.6	-

(a) Fisher 4800 gas chromatograph.

Table 30
Ash Concentrate Analyses (KM-CSD Unit)
Kentucky 9 Coal

Date, 1979	9-10 April	26-27 April	11-12 May	4-5 June
Run	161 MB	162 MB	163 MB	164 MB
Composition, wt %				
Ash	38.4	44.0	42.1	18.8
Unreacted coal	24.8	22.0	29.8	52.4
Solvent refined coal	30.3	15.3	15.0	15.2
Solvent	3.2	6.1	4.1	5.3
Deashing solvent	3.3	12.6	8.9	8.3
Solvent Extraction Analyses, wt %				
Oil	6.1	8.8	7.9	5.8
Asphaltenes	5.4	8.6	5.4	4.8
Benzene insoluble (cresol soluble)	25.3	16.6	14.8	18.2
Cresol insoluble	24.8	22.0	29.8	52.4
Ash	38.4	44.0	42.1	18.8
Ultimate Analysis, wt %				
Carbon	51.40	45.35	48.04	68.70
Hydrogen	2.89	2.63	2.62	3.60
Nitrogen	1.79	0.96	1.05	1.39
Ash	38.40	43.96	42.10	18.80
Sulfur	2.62	2.60	2.67	2.00
Chlorine	0.71	0.78	0.30	0.30
Oxygen (by difference)	2.19	3.72	3.08	5.21

Table 31
Dissolver Solids Withdrawal
Kentucky 9 Coal

Date, 1979	7-10 April		19-20 April	
Run	161		162	
Dissolver solids withdrawal[a]				
lb/hr	70-100		70-85	
% of slurry feed	6-8		5-6	
Settings on control valve XV4078				
Air load, %	2		3	
Valve open, sec	2.5/3.1		2.5	
Valve closed, sec	50/51		55	
Laboratory analyses				
Sample point	V110	R101	V101	R101
Cresol insolubles	8.5	19.2	7.9	25.6
Ash	5.6	12.3	5.4	17.6
Unreacted coal	2.9	6.9	2.5	8.0
SRC	26.6	37.1	24.8	31.1
Distillate (by difference)	64.9	43.7	67.3	43.3
Coal conv, % MAF coal[b]	93.4	92.5	92.9	93.3

Date, 1979	8 May		16 May		25 June		26 June	
Run	163				166			
Dissolver solids, withdrawal[a]								
lb/hr	77		99		127		105	
% of slurry feed	5.9		7.2		10.0		9.1	
Settings on control valve XV4078								
Air load, %	2.5		3.0		70		65	
Valve open, sec	2		2.5		6		5	
Valve closed, sec	59		59		33		33	
Laboratory analyses								
Sample point	V110	R101	V110	R101	V110	R101	V110	R101
Cresol insolubles	8.1	26.7	8.7	26.6	8.1	18.7	7.6	18.6
Ash	5.5	17.9	5.8	17.6	5.1	11.8	4.7	10.1
Unreacted coal	2.6	8.8	2.9	9.0	3.0	6.9	2.9	8.5
SRC	27.2	30.1	28.4	31.8	31.9	43.8	35.4	42.7
Distillate (by difference)	64.7	43.2	62.9	41.6	60.0	37.5	57.0	38.7
Coal conv, % MAF coal[b]	92.9	92.6	92.7	92.5	94.5	94.6	94.2	92.2

(a) R101 Dissolver withdrawal calibration pot fill rate.

(b) $$\% \text{ conversion} = 100 \left[\frac{100 - \% \text{ ash in MF feed coal} \times \frac{\% \text{ solids in sample}}{\% \text{ ash in sample}}}{100 - \% \text{ ash in MF feed coal}} \right]$$

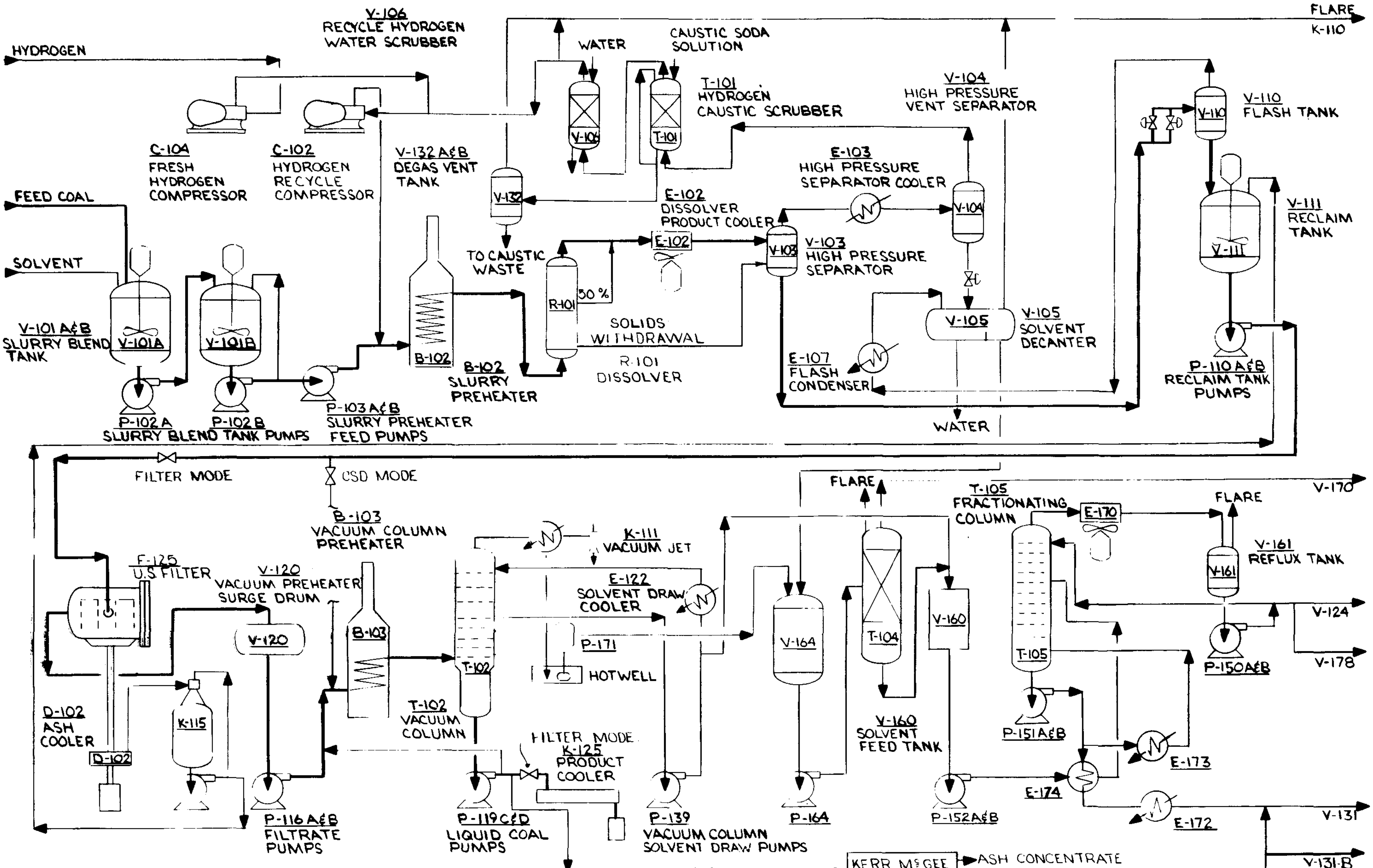

FIGURE I SRC FLOWSHEET

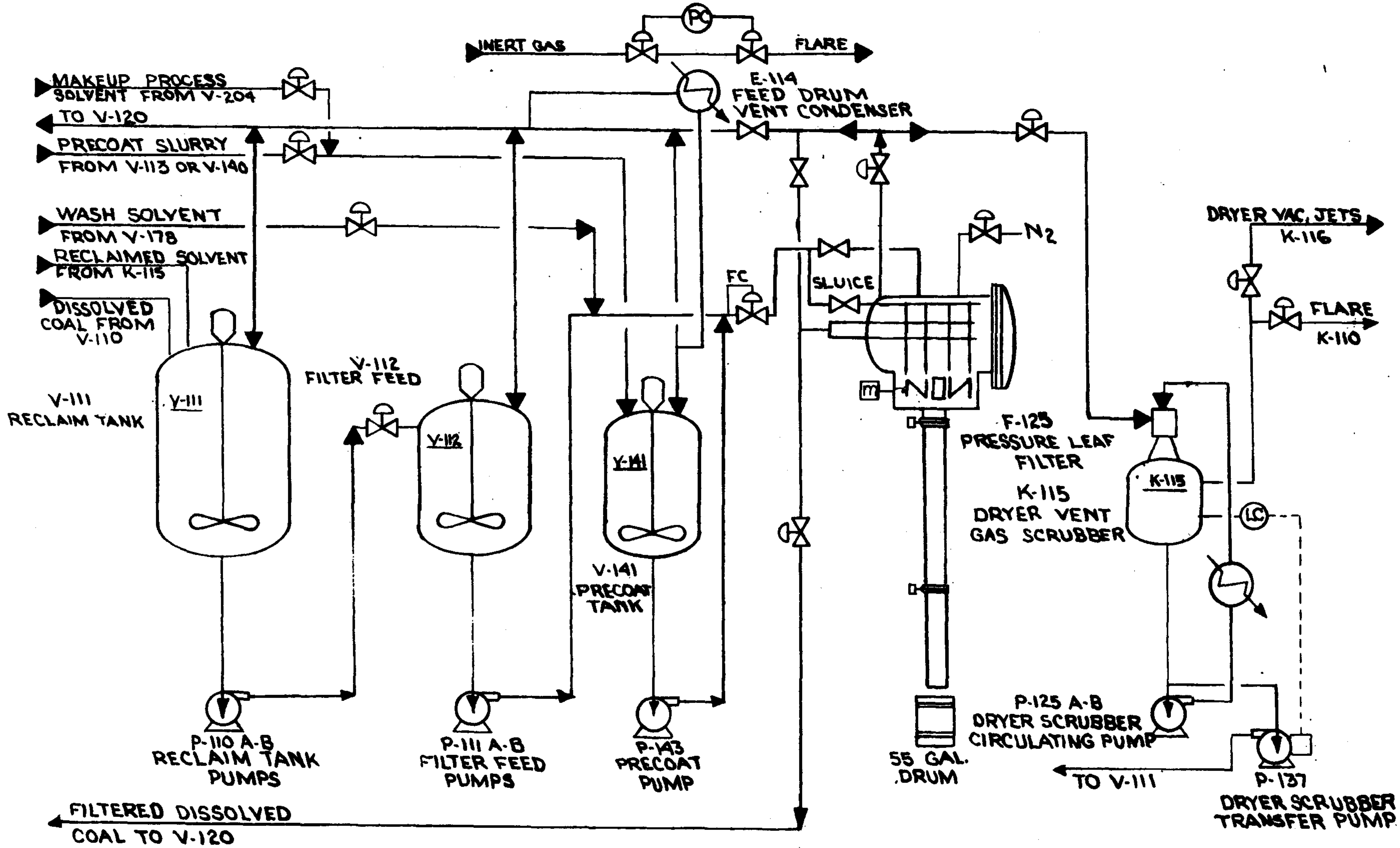

FIGURE 2 FILTRATION FLOWSHEET (U.S.F. FILTER)

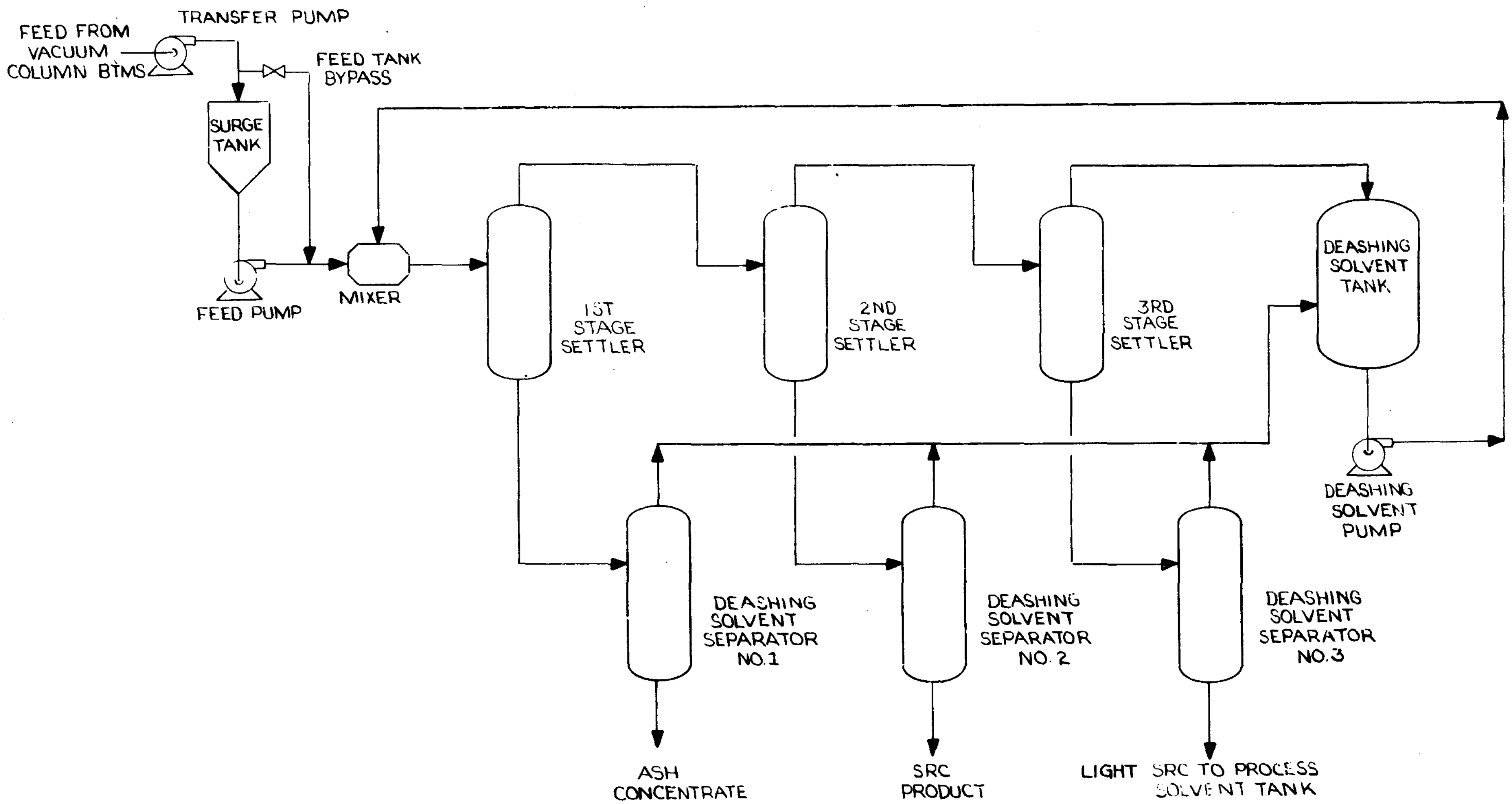

FIGURE 3 CRITICAL SOLVENT DEASHING PROCESS FLOW DIAGRAM

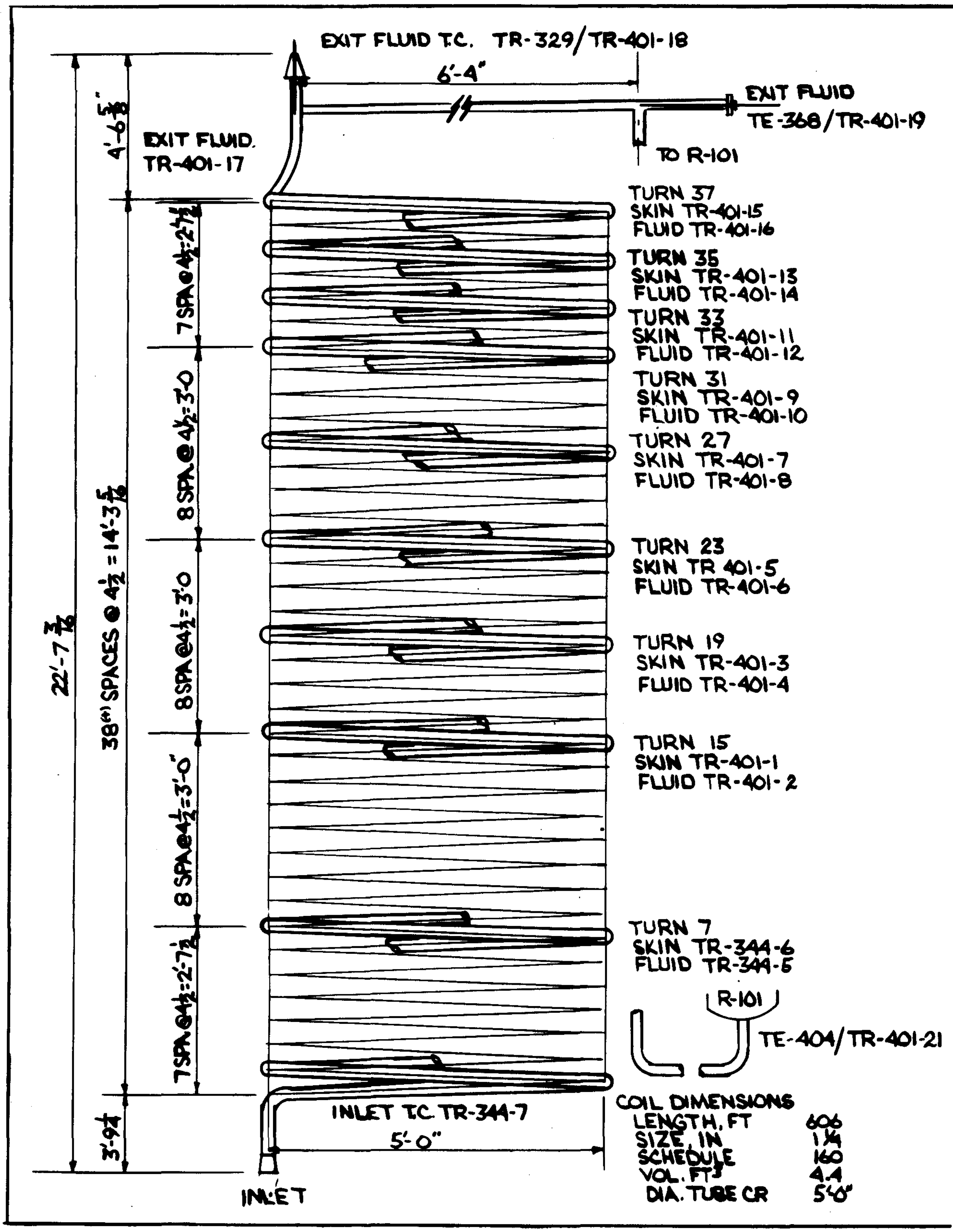

FIGURE 4 B-102 SLURRY PREHEATER THERMOCOUPLE LOCATIONS

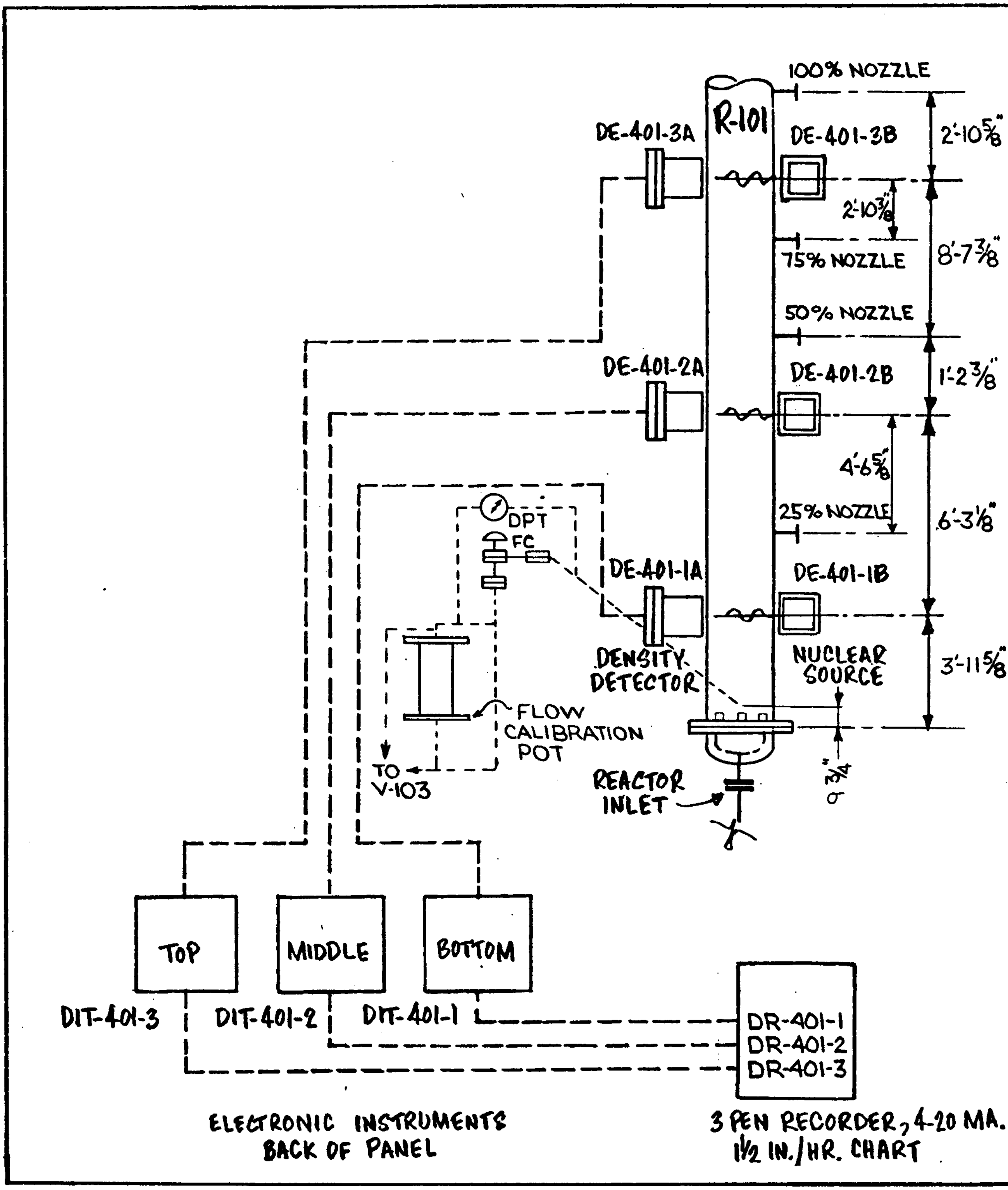

FIGURE 5 DISSOLVER SOLIDS MEASUREMENT AND CONTROL SYSTEM

COAL FEED, LB/HR: 400, H2 PURITY %: 85, OUTLET TEMPERATURE, °F: 825
FULL DISSOLVER CALIBRATION AT: PRESSURE = 1700 PSIG, GAS FLOW = 10,000 SCFH

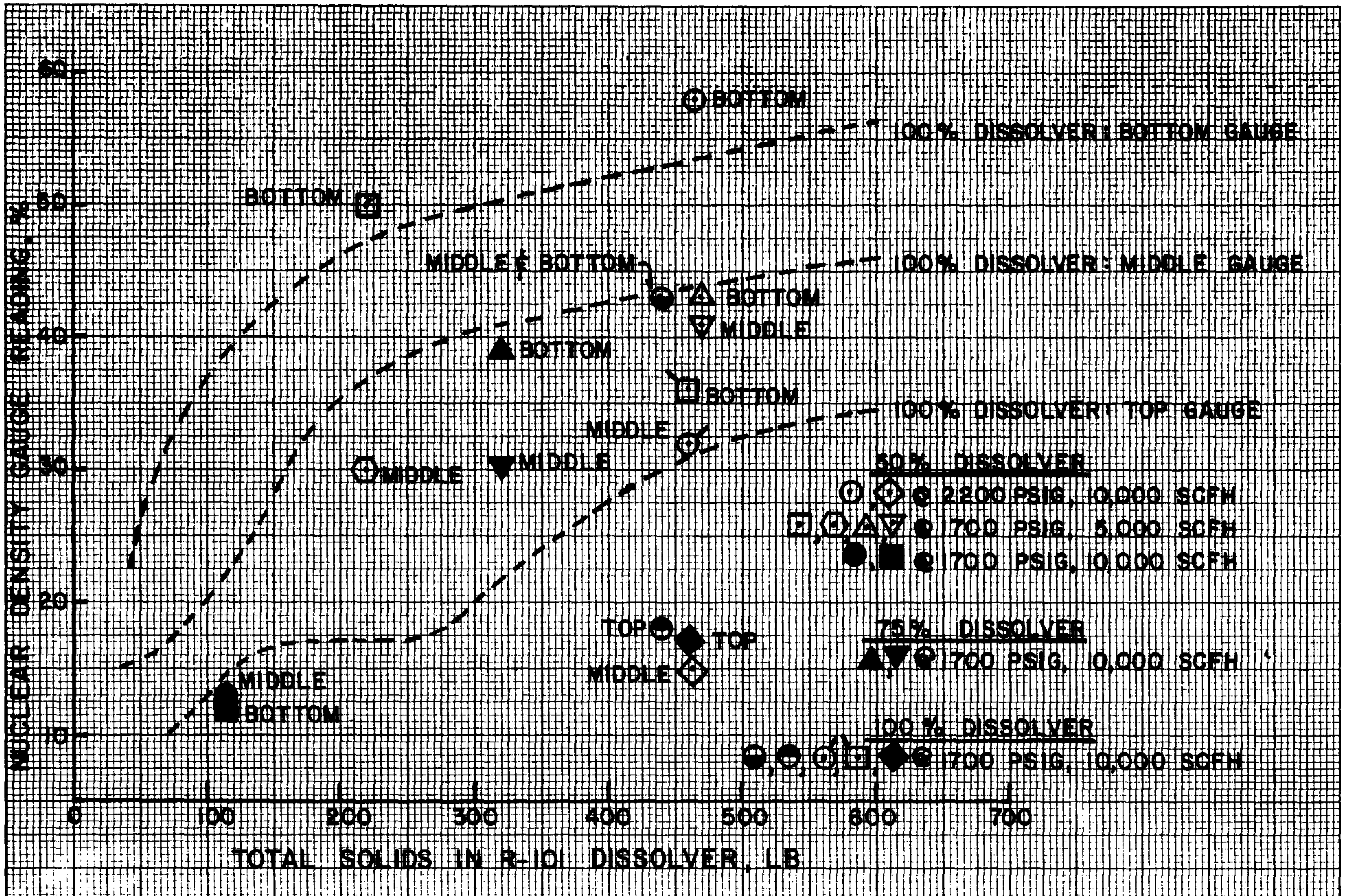

FIGURE 6 EFFECT OF DISSOLVER SOLIDS INVENTORY ON R-101 DENSITY GAUGE READINGS

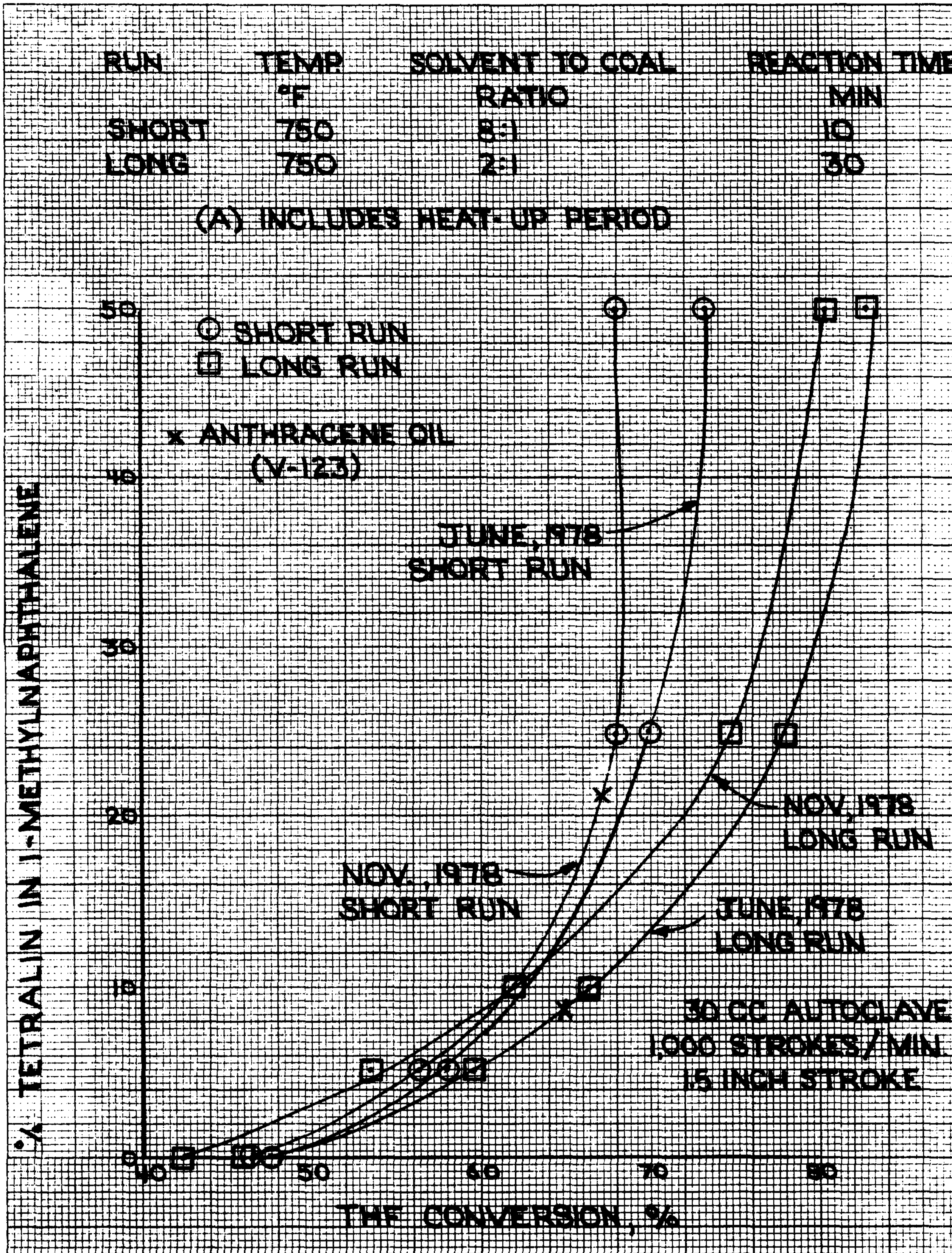

FIGURE 7. MICROAUTOCLAVE CALIBRATION CURVES

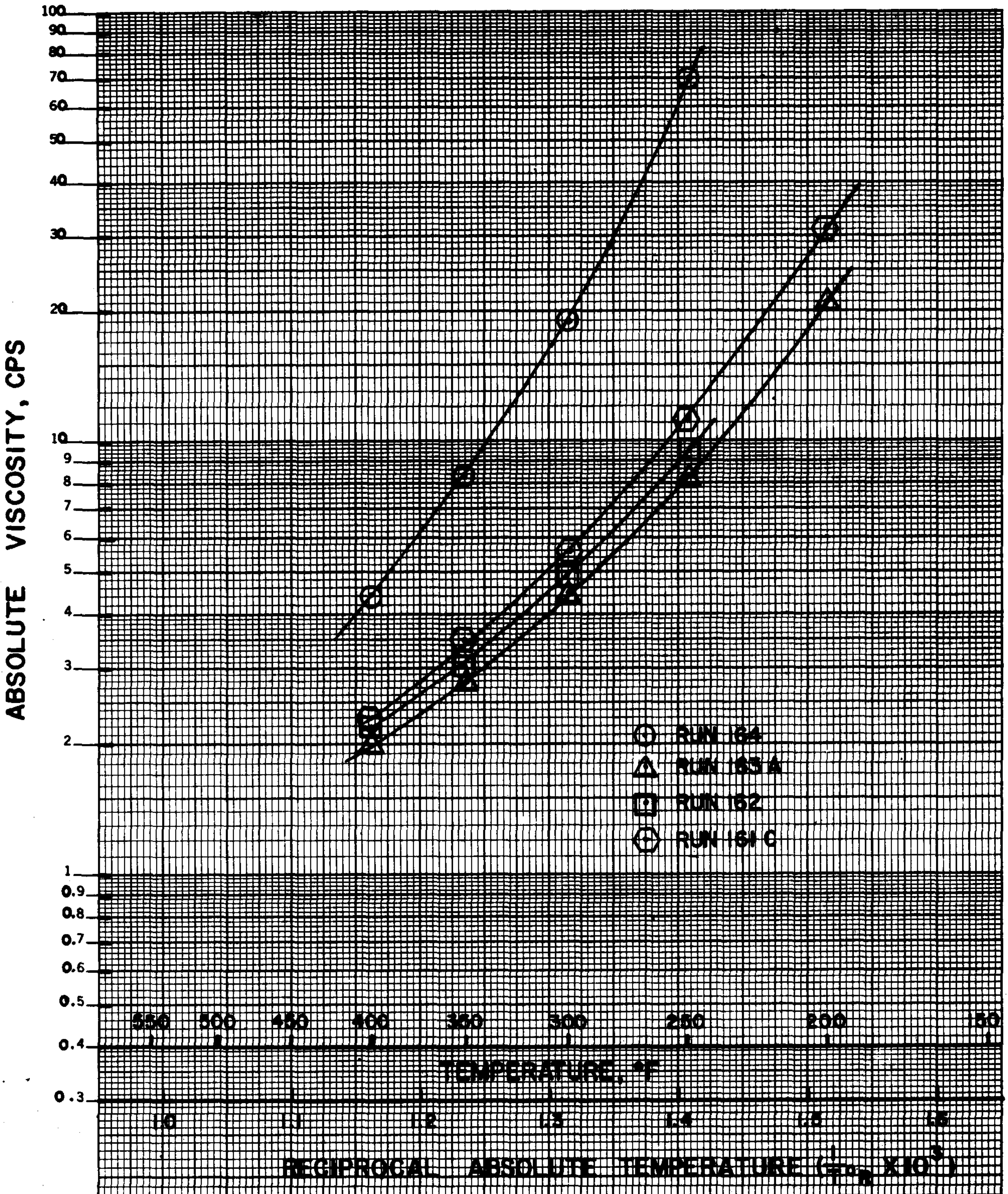

FIGURE 8 EFFECT OF TEMPERATURE ON VISCOSITY OF REACTION PRODUCTS

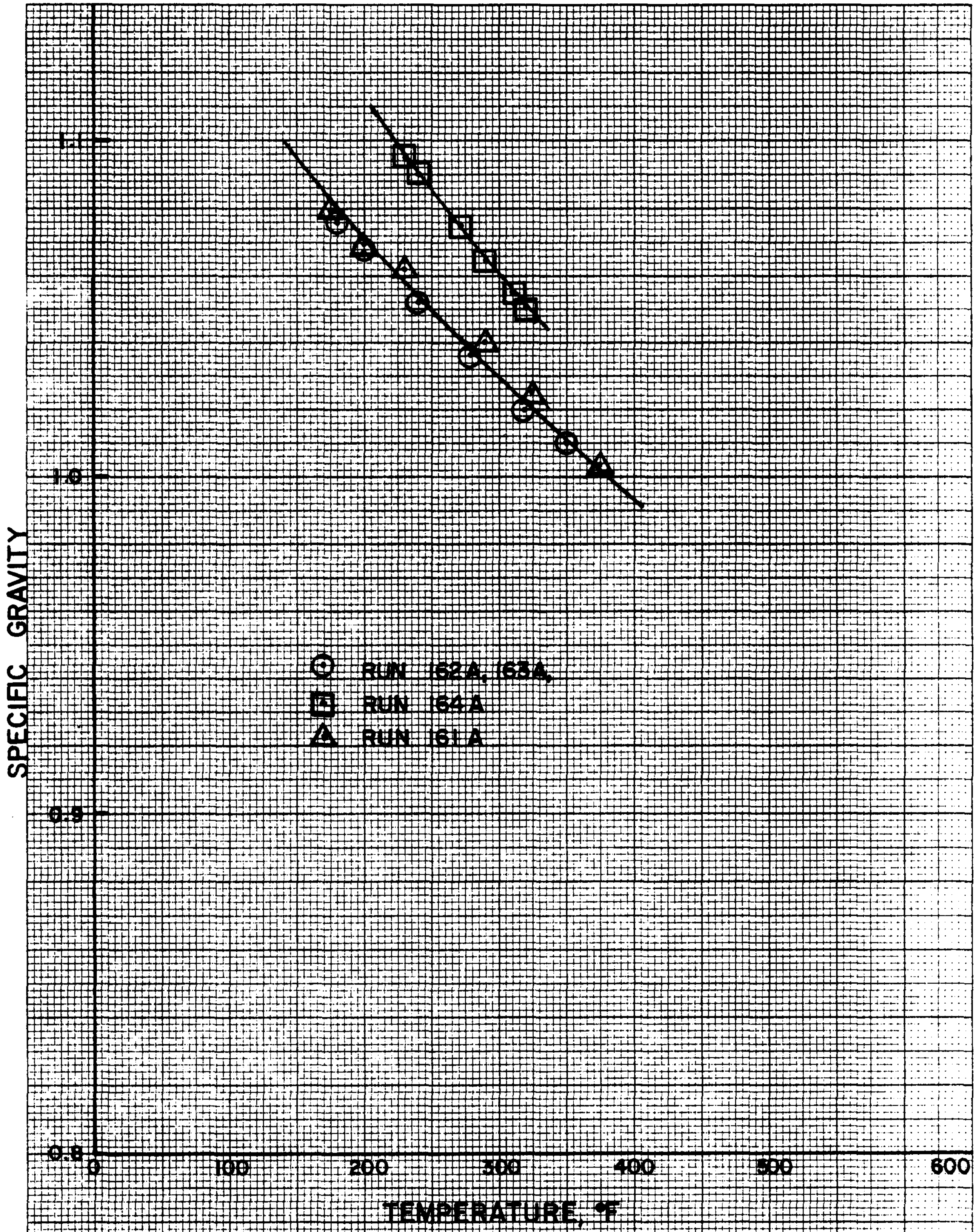

FIGURE 9 SPECIFIC GRAVITY VERSUS TEMPERATURE FOR REACTION PRODUCTS

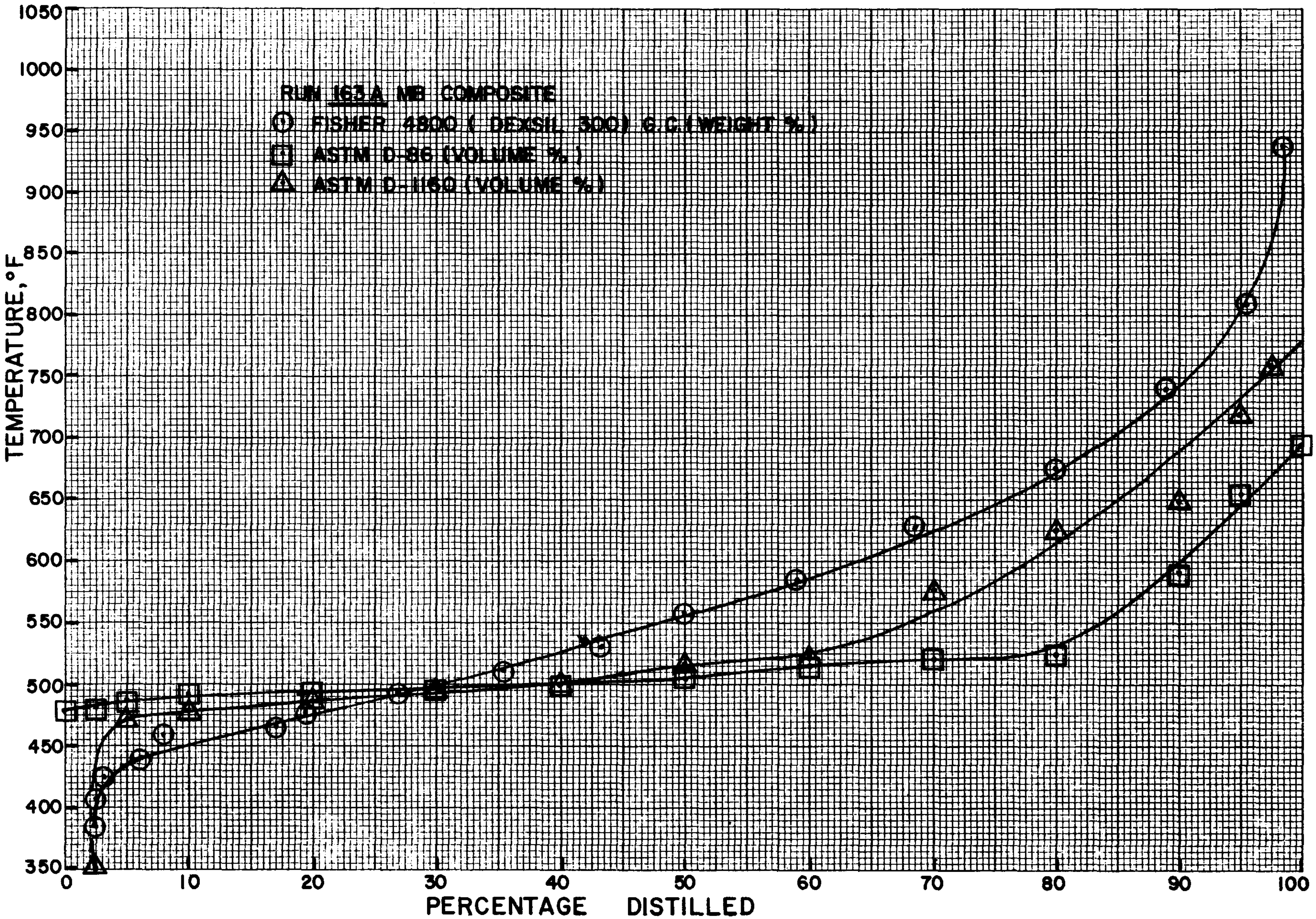

FIGURE 10 PROCESS SOLVENT DISTILLATION CURVES.

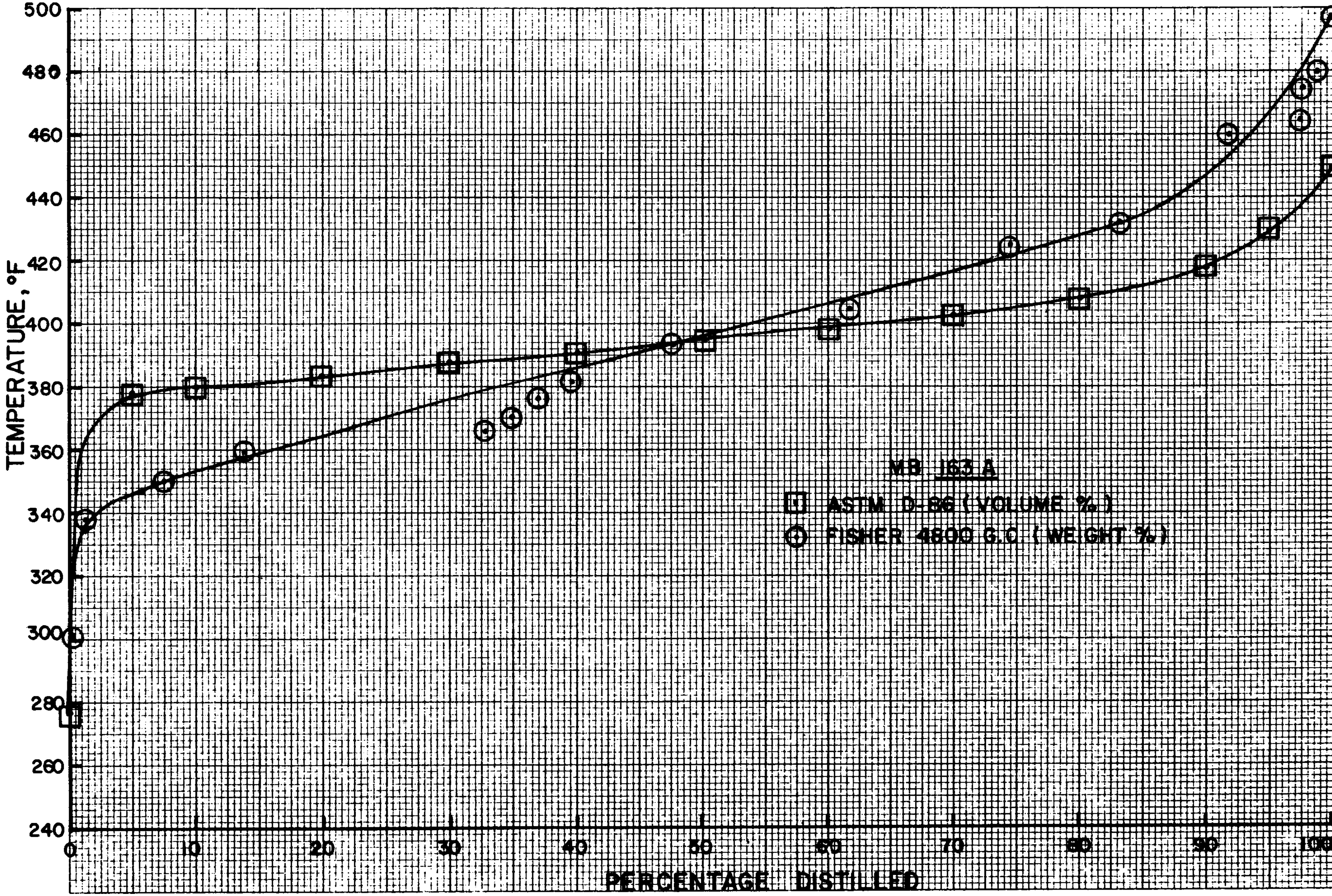

FIGURE 11 WASH SOLVENT DISTILLATION CURVES

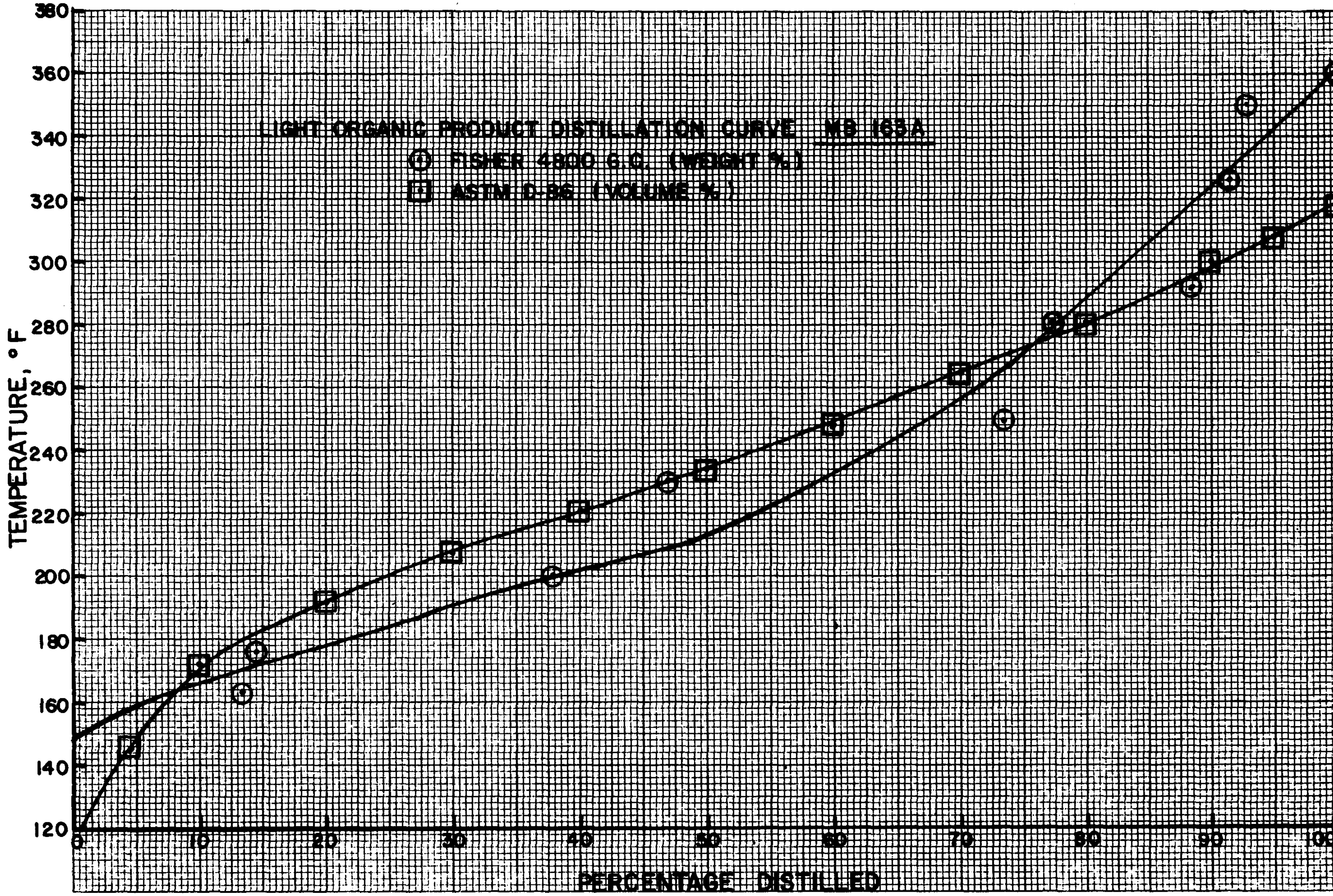

FIGURE 12 LIGHT ORGANIC PRODUCT DISTILLATION CURVES

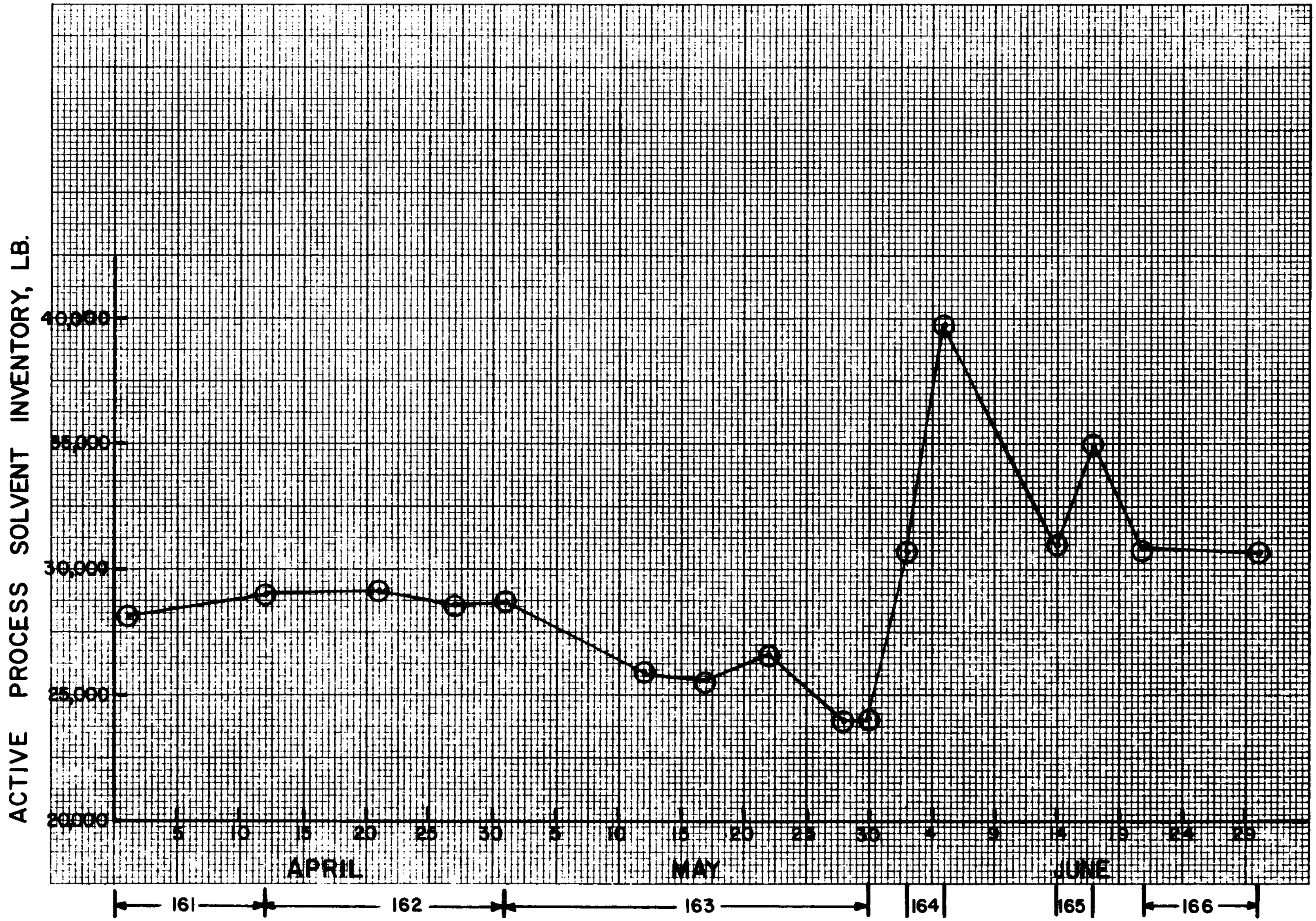

FIGURE 13 ADJUSTED SOLVENT INVENTORY

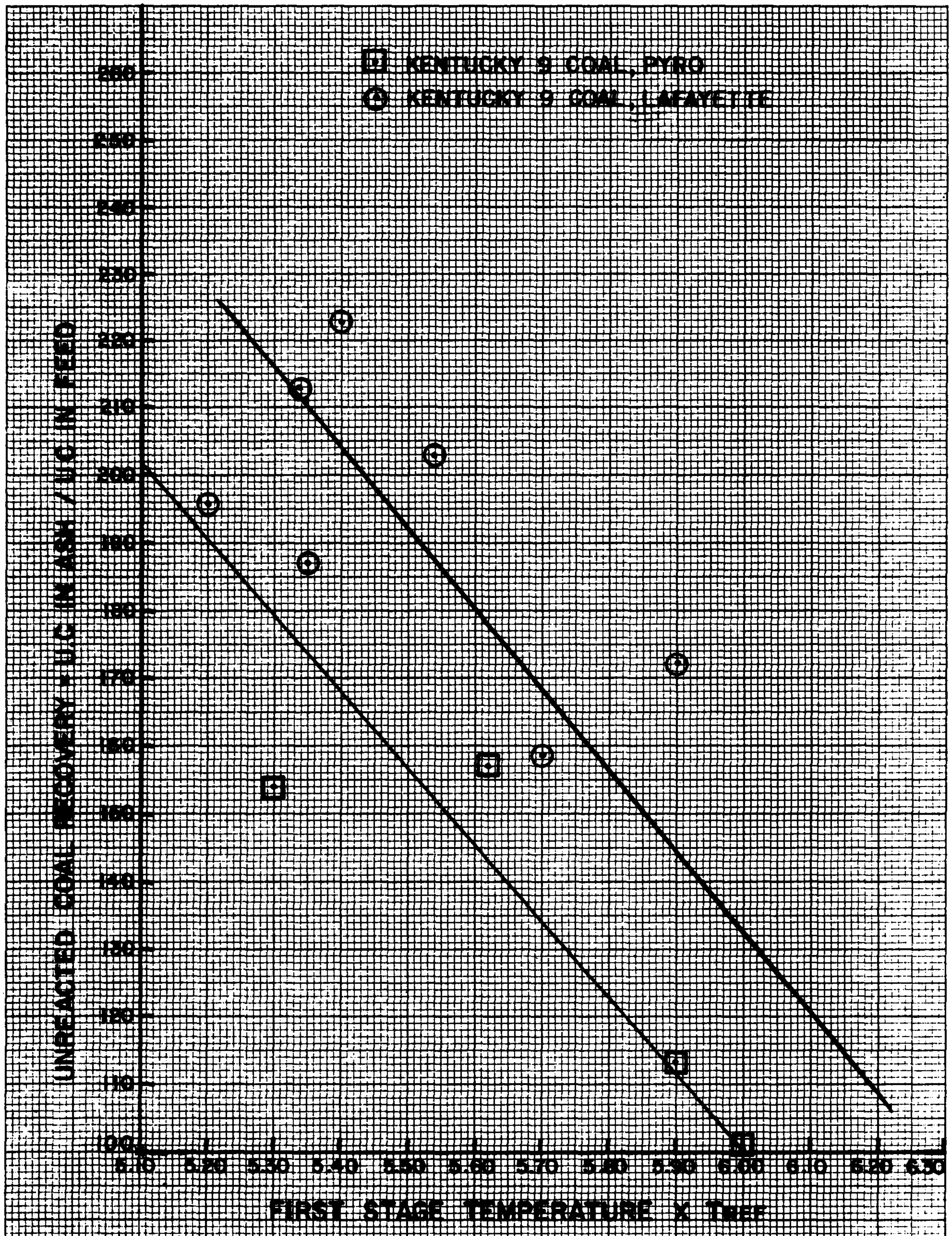

FIGURE 14 UNREACTED COAL RECOVERY VERSUS CSD FIRST STAGE TEMPERATURE

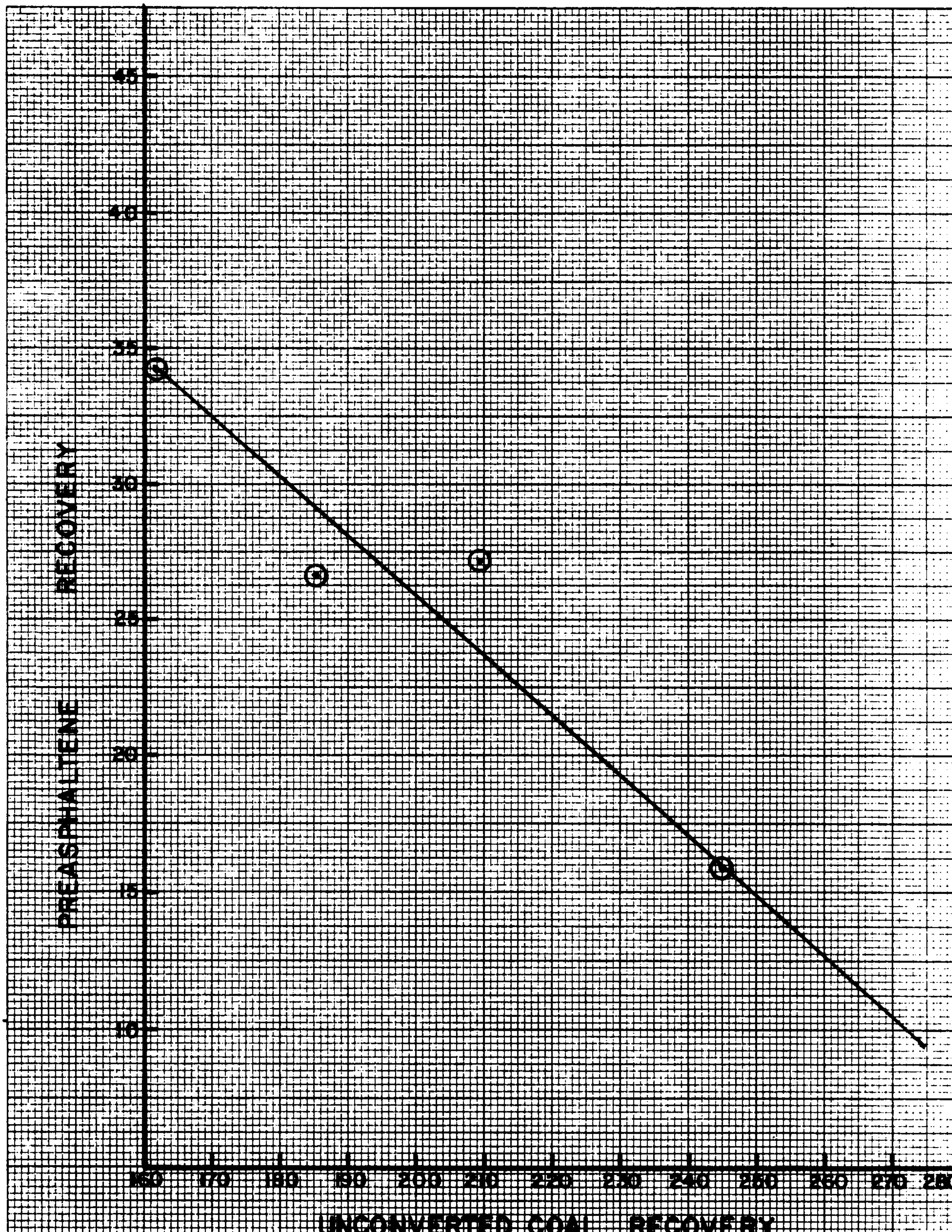

FIGURE 15 PREASPHALTENE VERSUS UNREACTED COAL RECOVERY