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SOLVENT REFINED LIGNITE PROCESS DEVELOPMENT

QUARTERLY TECHNICAL PROGRESS REPORT NO. 1

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I. OBJECTIVES AND SCOPE

Project Lignite was established in 1972 in the Department of Chemical Engineering at the University of North Dakota for the purpose of determining the appropriate technological approach to the conversion of Northern Great Plains lignite to premium solid, liquid and gaseous fuels. The ultimate goal of the work was to make recommendations for a refinery based on lignite as feedstock. The experimental portion of the program was intended to develop data and know-how to carry out technological steps in the refinery processes for which information for scaleup was insufficient.

In keeping with this objective, laboratory and benchscale work were carried out and a continuous process development unit (PDU) was constructed and operated to demonstrate the feasibility of continuous liquefaction of lignite. Economic studies were made, and under a project subcontract, the Department of Chemistry of UND developed information on catalytic hydrogenation of solvent refined lignite.

The continuous process originally envisioned was the two stage conversion of lignite to fuel liquids, with solvent refined lignite as an intermediate and useful fuel product. The first stage is a unit converting 50 pounds per hour of raw lignite into solvent refined lignite by reaction with synthesis gas (carbon monoxide and hydrogen) in the presence of a hydrogen donor solvent that is continually regenerated from the lignite during processing. The mineral separations system is a countercurrent decantation process carried out at elevated temperature and pressure. The second stage was to be the catalytic hydrogenation to premium liquid fuels of the solvent refined lignite produced in the first stage. However, this latter step was not implemented, and the program has been directed at developing the liquefaction and solid-liquid separation stages.

Project Lignite was originally undertaken in accordance with Office of Coal Research Contract No. 14-32-0001-1224, later changed to ERDA Contract No. E(49-18)-1224, for the period March 28, 1972, through March 27, 1977. The period was later extended to June 15, 1977. In early 1977, a supplemental agreement was made under ERDA Contract No. EF-77-C-02-4189 to provide for the continuation of Project Lignite for the period June 1, 1977, through June 15, 1978.

The continuation basically provides for extended runs in the liquefaction section of the Process Development Unit, together

with some operation of the gas clean-up and recycle sections, the evaluation of the solid/liquid separation section, corrosion coupon testing, the determination of solids accumulation on the dissolvers, the production of clean solvent refined lignite, and data collection and analysis.

This report is the first of the required quarterly progress reports. The work statement for the supplemental agreement for the continuation of Project Lignite is attached as Appendix A.

II. SUMMARY

Approximately 900 hours of liquefaction operation were accumulated with the PDU most of which was in two extended runs scheduled for 28 days each. Relatively high conversions were maintained with potential solvent recoveries of over 100 percent of solvent charged. Actual solvent recoveries, however, were about 90 percent. Product distribution changed with time of operation with relatively more SRL and less liquids produced while total conversion remained high. Buildup of solids in the reactor resulted in deposits on reactor walls and reduction in residence time giving a higher melting point product. Process upsets and higher melting point SRL caused plugs in piping and process vessels as well as pumping difficulties. Product gas cleanup and recycle were accomplished without difficulty and with no significant difference noted in liquefaction characteristics.

In a short run (83 hours), Gascoyne lignite was found to have the greatest response to liquefaction of the lignites tested so far. Conversions were high and yields of SRL were high at the expense of light oil production.

Operation of the solids-liquid separation unit gave significant separation of SRL from the mineral matter and unreacted lignite although the separation was variable and less effective than desired.

Distillation of solvent by the routine laboratory method and equipment was compared with results using standard ASTM procedure. The routine distillation gave slightly lower distillate volumes at a given vapor temperature.

III. TECHNICAL PROGRESS

A. PDU OPERATIONS

1. General

Run M-33, the last of the short tests (nominally a week), was completed, and the long test series (nominally a month) was started. During Run M-33, four yield periods were established totaling 83 hours of operation on lignite. This run continued the investigation of the effects of different sources (mines) of the feed lignite on liquefaction and plant operability.

The extended runs were given a different code designation, that of the "L" series. Two runs, L-1 and L-2, of the three planned for the program were completed. Each run was scheduled for 28 days and lignite was processed for approximately 75 percent of actual operating time for a total of 860 hours. Operation of the PDU for extended periods was established with relatively high conversion and indicated potential recovery of solvent over 100 percent. Mechanical problems were still troublesome and upsets in operation often resulted in formation of plugs in the lines which usually could be corrected without shutdown. Build-up of solids in the reactor was also noted.

Summary data for Run M-33 are included in Table 1 and that for Runs L-1 and L-2 in Tables 2 and 3. Detailed write-ups for the runs are included in the Appendix with Run M-33 in Appendix B, Run L-1 in Appendix C, and Run L-2 in Appendix D. Each run is reviewed and average results discussed in the following sections.

Emphasis in laboratory work was directed towards analytical support of the PDU operations. Some special work was done on distillation procedures for recycle solvent in comparing results using ASTM procedures with those from the routine laboratory distillations.

2. Run M-33

Lignite from the Gascoyne mine of the Knife River Coal Mining Company near Gascoyne, ND was used as feedstock in the continuing investigation of the effects of coal source on liquefaction yields and plant operability. Ash and moisture content of the Gascoyne lignite was significantly higher than those of the lignites previously used with the PDU, being approximately 9 and 35 percent, respectively.

TABLE 1: SUMMARY DATA FOR RUN M-33

Lignite Source	← Gascoyne →			
Yield Period	M-33A	M-33B	M-33C	M-33D
Symbols	○ →			
Hours on Coal at end of Y.P.				
During Run	23.0	35.0	71.0	83.0
Cumulative	1925.8	1937.8	1973.8	1985.8
Reactors Used			R-1B	
Coal Charged, lbs/hr	41	45	47	42
Gas Charged, SCF/hr	413	430	430	437
Solvent/Coal Ratio	2.18	2.04	1.94	2.16
LHSV, Hr^{-1}	1.34	1.37	1.49	1.43
GHSV, Hr^{-1}	289	301	301	306
Coal Rate, lbs/hr/CF	28.8	31.3	32.7	29.3
Gas Rate, SCF/lb Coal	10.0	9.7	9.2	10.4
Gas Consumed, SCF/lb Coal	2.4	2.7	2.4	1.9
Mol% H_2 in Gas Consumed	19.2	19.1	6.7	-19.4*
Yields, Wt% MAF Coal				
Net Gas	39.9	34.2	34.1	39.1
Net Oil	58.1	66.6	63.4	62.0
(Lt Oil)	(-4.6)	(2.8)	(6.0)	(17.6)
(SRL)	(62.7)	(63.8)	(57.4)	(44.4)
Net H_2O and Ash	-5.6	-6.4	-9.3	-11.8
Unconverted MAF Coal	7.6	5.5	11.8	10.7
Solvent Recycle, %				
Actual	89.8	94.2	86.2	98.6
Potential (Calc.)	98.9	100.7	101.7	104.4
Potential (Excluding Lt Oil)	96.5	96.4	95.1	100.2
Material Balance, %	99.5	96.8	97.0	98.6
Conditions				
Temperatures, °F				
Slurry Preheater Outlet	762	752	741	749
Dissolver Inlet	735	725	717	721
R-1A 3 ft	NIU	NIU	NIU	NIU
R-1A 15 ft	NIU	NIU	NIU	NIU
R-1B 3 ft	768	762	765	768
R-1B 15 ft	822	815	822	828
Dissolver Outlet	751	743	751	748
Flash Preheat	629	642	650	657
Flash Vapor	513	513	515	523
Pressures				
Dissolver, psig	2500	2500	2500	2500
Inter, Sep., psig	300	300	300	300
Vacuum Flash Vapor, Torr	15	15	15	15
SLS System in Use?	No	No	Yes	No
Percent H_2 in Feed Gas	52.4	49.6	51.1	50.5
CO_2 Yield, Wt% MAF Coal	56.2	55.6	57.1	60.6
C_1-C_3 Yield, Wt% MAF Coal	9.1	7.9	6.7	6.6
Gas Consumed (H_2 Equiv) Wt% MAF Coal	2.36	2.64	2.34	1.80

* Negative value indicates a net hydrogen production.

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TABLE 2: SUMMARY DATA FOR EXTENDED RUN L-1

Yield Period Symbols	L-1B □	L-1C	L-1D	L-1E	L-1F	L-1H	L-1I	L-1J	L-1K
Hours on Coal @ End of Y.P.									
Since Reactor Cleaning	70.0	82.0	31.5	43.5	60.0	101.0	113	152.5	164.5
During Run	70.0	82.0	162.4	174.4	313.9	354.9	366.9	406.3	418.3
Cumulative	2055.8	2067.8	2148.2	2160.2	2299.7	2340.9	2352.7	2392.1	2404.1
Reactor Used	←		R-1B	→	←		R-1A		→
Coal Charged, lbs/hr	47	50	50	48	50	52	51	51	50
Gas Charged, SCF/hr (Recycle Gas, SCF/hr)	472	489	454	434	462	469	469	487	481
Solvent/Coal Ratio	1.96	1.88	1.85	1.92	1.87	1.76	1.75	1.77	1.81
LHSV, Hr^{-1}	1.38	1.44	1.41	1.46	1.44	1.43	1.41	1.40	1.42
GHSV, Hr^{-1}	330	342	318	304	323	328	328	341	336
Coal Rate, lbs/hr/CF	32.7	35.2	34.8	33.8	35.1	36.2	35.9	35.3	35.2
Gas Rate, SCF/lb Coal	10.1	9.7	9.1	8.9	9.2	9.1	9.1	9.6	9.6
Gas Consumed, SCF/lb Coal	2.7	2.3	2.8	2.9	3.1	1.7	2.1	1.4	1.7
Mol% H_2 in Gas Consumed	25.6	19.6	26.8	21.6	27.6	32.2	24.3	13.3	19.6
Yields, Wt % MAF Coal									
Net Gas	36.8	28.2	33.3	31.0	40.3	27.1	30.0	28.5	26.9
Net Oil	74.0	73.0	62.6	71.6	56.1	65.0	65.0	61.8	65.8
(Dist Oil)	(23.0)	(24.2)	(9.0)	(15.7)	(4.1)	(3.9)	(5.9)	(10.5)	(22.2)
(SRL)	(51.0)	(48.8)	(53.6)	(55.9)	(52.0)	(61.1)	(59.1)	(51.3)	(43.6)
Net H_2O & Ash	-11.6	-8.5	-3.2	-5.8	-5.3	-4.1	-4.4	-0.9	-3.5
Unconverted MAF Coal	0.8	7.3	7.3	3.2	8.9	12.0	9.4	10.6	10.8
Solvent Recycle, %									
Actual	89.7	95.0	93.4	91.4	86.8	93.3	93.2	83.5	86.4
Potential (Calc)	107.3	108.0	103.0	105.2	101.4	101.4	102.1	103.7	107.6
Potential (Excluding Lt Oil)	100.5	103.9	-	99.3	-	-	-	97.2	101.4
Material Balance, %	100.2	100.2	98.1	99.6	99.5	101.3	101.0	98.6	99.3
Conditions									
Temperatures, °F									
Slurry Preheater Outlet	717	715	718	721	715	736	741	754	757
Dissolver Inlet	698	695	693	697	702	710	715	729	733
R-1A 3 ft	NIU	NIU	NIU	NIU	770	745	746	755	758
R-1A 15 ft	NIU	NIU	NIU	NIU	828	823	824	815	804
R-1B 3 ft	757	757	745	742	NIU	NIU	NIU	NIU	NIU
R-1B 15 ft	827	829	824	822	NIU	NIU	NIU	NIU	NIU
Dissolver Outlet	779	767	-	-	-	-	-	-	-
Flash Preheat	646	647	650	655	650	626	626	636	641
Flash Vapor	526	526	530	528	507	505	504	508	504
Pressures									
Dissolver, psig	2500	2500	2500	2500	2500	2500	2500	2500	2500
Inter. Sep., psig	300	300	300	308	273	296	290	290	297
Vacuum Flash, Torr	15	14	14	15	14	14	14	14	14
SLS System in Use?	No	No	No	No	Yes	No	No	Yes	Yes
Mole Percent H_2 in Feed Gas	53.2	52.8	52.4	52.4	53.4	54.1	52.2	52.2	52.5
Mole Percent CO in Feed Gas	46.3	46.8	47.1	47.0	46.0	45.5	47.1	47.2	47.0
CO_2 Yield, Wt % MAF Coal	52.6	43.4	51.0	50.7	59.5	41.0	42.6	38.1	38.6
C_1-C_3 Yield, Wt % MAF Coal	7.9	6.6	7.0	6.8	8.1	5.9	6.7	4.6	4.8
Gas Consumed (H_2 Equiv), Wt % MAF Coal	2.30	1.97	2.41	2.42	2.68	2.09	1.82	1.21	1.48

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TABLE 3: SUMMARY DATA FOR EXTENDED RUN L-2

Yield Period Symbols	L-2B ◇	L-2C	L-2D	L-2E	L-2F	L-2G	L-2H	L-2I	L-2 Overall
Hours on Coal @ End of Y.P.									
Since Reactor Cleaning	33.5	45.5	109.5	121.5	68.5	80.5	99.0	110.8	-
During Run	80.3	92.3	156.0	168.0	306.1	318.1	429.6	441.4	441.4
Cumulative	2521.7	2533.7	2597.4	2609.4	2747.5	2759.5	2871.0	2882.8	2882.8
Reactor Used	←	R-1A	→		←	R-1B	→	← R-1A →	-
Coal Charged, lbs/hr	49	46	47	48	46	47	47	50	49
Gas Charged, SCF/hr (Recycle Gas, SCF/hr)	459(210)	458(234)	457(240)	442(252)	506(292)	511(263)	475(168)	486(221)	465(184)
Solvent/Coal Ratio	1.82	1.97	1.92	1.87	1.99	1.93	1.91	1.83	1.90
LHSV, Hr^{-1}	1.38	1.37	1.38	1.48	1.41	1.40	1.40	1.42	1.42
GHSV, Hr^{-1}	321	320	320	309	354	358	332	340	325
Coal Rate, lbs/hr/CF	34.1	32.4	33.0	33.9	32.5	33.0	33.0	35.0	34.0
Gas Rate, SCF/lb Coal	9.4	9.9	9.7	9.1	10.9	10.8	10.1	9.7	9.6
Gas Consumed, SCF/lb Coal	2.0	1.0	3.7	1.5	2.9	3.6	4.3	3.2	2.4
Mol% H_2 in Gas Consumed	33.8	-48.7*	59.1	12.8	40.4	55.0	35.6	38.1	29.0
Yields, Wt % MAF Coal									
Net Gas	36.6	38.3	23.6	21.8	38.2	36.7	28.4	22.3	30.6
Net Oil	49.6	49.6	58.6	62.0	58.8	61.6	70.4	75.7	63.5
(Dist Oil)	(9.0)	(13.7)	(-0.1)	(3.7)	(17.7)	(22.6)	(21.3)	(14.3)	(15.6)
(SRL)	(40.6)	(35.9)	(58.7)	(58.3)	(41.1)	(39.0)	(49.1)	(61.4)	(47.9)
Net H_2O & Ash	-2.0	-1.9	0.7	-0.8	-5.8	-6.7	-8.1	-6.5	-5.4
Unconverted MAF Coal	15.8	14.0	17.1	17.0	8.8	8.4	9.3	8.5	11.3
Solvent Recycle, %									
Actual	89.1	92.3	93.1	91.6	101.0	92.7	100.2	98.5	92.6
Potential (Calc)	103.0	104.2	100.0	101.2	105.4	107.2	107.0	104.8	105.0
Potential (Excluding Lt Oil)	94.3	92.8	91.9	89.5	95.6	94.7	95.7	96.7	90.7
Material Balance, %	98.5	98.7	99.9	99.2	96.7	96.7	97.9	96.0	94.7
Conditions									
Temperatures, °F									
Slurry Preheater Outlet	746	751	747	741	726	721	729	738	737
Dissolver Inlet	735	736	746	739	711	714	710	718	726
R-1A 3 ft	778	776	752	739	NIU	NIU	777	699	752(3 ft)
R-1A 15 ft	820	822	808	798	NIU	NIU	785	787	799(7 ft)
R-1B 3 ft	NIU	NIU	NIU	NIU	747	745	NIU	NIU	802(11 ft)
R-1B 15 ft	NIU	NIU	NIU	NIU	832	829	NIU	NIU	810(15 ft)
Dissolver Outlet	817	812	813	803	824	828	792	781	809
Flash Preheat	630	639	644	641	643	646	656	654	644
Flash Vapor	512	505	503	496	509	505	496	492	502
Pressures									
Dissolver, psig	2460	2460	2450	2450	2460	2460	2450	2450	2460
Inter. Sep., psig	250	250	250	250	238	240	240	240	245
Vacuum Flash, Torr	14	14	15	15	14	14	14	14	14
SLS System in Use?	No	No	No	No	No	No	No	No	No
Mole Percent H_2 in Feed Gas	54.0	55.2	57.4	50.1	45.2	45.2	48.3	53.4	51.1
Mole Percent CO in Feed Gas	31.6	29.6	33.4	41.6	36.7	38.7	43.9	40.0	36.9
CO_2 Yield, Wt % MAF Coal	37.8	42.7	37.9	33.3	46.9	44.6	54.1	41.8	41.0
C_1-C_3 Yield, Wt % MAF Coal	14.7	12.7	5.1	4.6	12.4	11.9	7.4	4.3	10.5
Gas Consumed (H_2 Equiv), Wt % MAF Coal	1.71	0.87	3.18	1.32	2.55	3.10	3.66	2.74	2.12

*Negative value indicates a net hydrogen production.

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One reactor was used with nominal process conditions of 820-830°F maximum temperature of liquefaction at 2500 psig dissolver operating pressure. Hourly space velocities of liquid and gas were 1.41 and 301, respectively. All recoverable organic distillates with atmospheric boiling points above about 400°F were recycled for use as solvent. The molar ratio of hydrogen to carbon monoxide was maintained at 1 and product gases were not recycled. The solids-liquid separation unit was operated during the later part of the run.

Four yield periods were completed, M-33A through M-33D, during which 83 hours of balanced operation was achieved. Material balances of from 96.8 to 99.5 percent were adjusted to 100 percent closure by compensating for known errors followed by normalizing to 100 percent recovery. Conversion of MAF lignite to gas, oil and SRL averaged 91.1 percent for the four yield periods. Consumption of reducing gases was 2.4 SCF per pound of as-charged lignite. Actual recovery of solvent for recycle averaged 92.2 percent while the calculated potential recovery was 101.3 percent. Average of SRL yields was 57.4 weight percent while yield of net organic liquids averaged 62.5 weight percent of the MAF lignite charged. These results indicate the Gascoyne lignite to be one of the more reactive of the lignite samples tested.

The liquids-solids separation unit was operated during yield period M-33C. Results were favorable with unconverted coal and ash concentrations in the vacuum bottoms product (SRL) being reduced to 0 to 0.2 weight percent, respectively.

Operating problems during the run included oil-water separation, plugging of the F-1 bottoms leg, failure of gaskets and check valves in pumps P-5 and P-11A of the deashing unit, and difficulty in removing accumulated solids from the solids precipitation tower.

Oil-water separation was not always effective and continuous monitoring of the effluent streams was required. Some of the difficulty in separation was caused by the partial miscibility of the oil-water phases and by apparent changes in oil density during the run. Variation in density of the oil phase affected the position of the oil-water interface in the separation vessel. A low interface position results in oil withdrawal in the waste water underflow, and a high position causes water to be contained in the oil overflow.

Plugging of the F-1 vacuum bottoms discharge line occurred several times. Most of the difficulty was caused by the temperature control of the heating elements in the line tracing. Too

high a temperature promotes coking while too low a temperature allows product solidification. Fluctuations in the melting point (250-450°F) of the vacuum bottoms additionally complicate temperature control. The problems of changes in oil density and in melting point of the vacuum bottoms were not unique to liquefaction of Gascoyne lignite. Similar problems had been encountered in use of Zap lignite.

Failure of the gasket in the toluene-slurry circulating pump P-5 and plugging of the F-0 vacuum bottoms discharge pump P-11A initially prevented integration of the liquid-solids separation system with the liquefaction section of the PDU. After repairs, the deashing unit was brought on stream. Following 28 hours of operation, the collar connecting the valve stem on the V-8 bottoms withdrawal valve and the actuator was loosened and became misaligned so that the actuator could not operate the valve. Before the actuator was reconnected to the valve, the line had plugged so that the deashing operations were stopped. However, the operation of the liquefaction section continued until the scheduled shut-down.

3. Run L-1

A series of three runs, each scheduled for 28 days of continuous operation, was planned for the PDU with the general objectives of testing plant performance for longer periods of operation on lignite, determining the effects of solvent recycle on liquefaction yield, and testing the effects of off-gas cleaning on the process. Additionally, the solids-liquids separation unit was to operate intermittently to produce a quantity of low-ash content SRL.

Run L-1, the first in the series, used normal process conditions which were thought to be optimum for minimizing production of gases and maximizing yields of SRL. Lignite from North American Coal Company's mine near Zap, ND was liquefied with a nominal maximum reactor temperature of 820-840°F at a pressure of 2500 psig. Charge rates of lignite and solvent were at the design capacity. One reactor was used and all recoverable organic distillates with boiling points above about 400°F were recycled. An equimolar mixture of hydrogen and carbon monoxide was used at a total feed rate of about 9.4 SCF per lb of as-charged lignite. The deashing section was operated at 300 psig and 450°F using toluene as the solvent. Toluene to slurry ratio was approximately four to one by volume.

Nine yield periods, each of a nominal 12 hours duration, were completed. Quantitative material balances were made for each period.

Elemental balances were made for two of the periods. Actual material balance closures were from 98.1 to 101.3 percent and were normalized to 100 percent recovery. A forced carbon balance was necessary in yield period L-1E and was made by adjusting the oil-water ratio of the waste water stream. V-8 bottoms compositions were calculated for yield periods L-1J and L-1K, which involved deashing, by making material balances around the deashing unit assuming average ash loss obtained when the deashing unit was not in use.

Conversion of MAF lignite to gas, oil and SRL was high, averaging 92.2 percent with a range from 88 to 99.2 weight percent. In the first yield period, pyridine soluble content of the F-1 vacuum bottoms was unusually high. Such high conversion was not expected, and it is believed that the conversions over 93 percent are not representative of typical results for solvent refining of lignite. Net gas yields averaged 31 weight percent of the MAF lignite charged and were close to the expected yields. The average net hydrocarbon liquid yield of 66 weight percent is considered typical. The hydrocarbon liquids were 20 percent distillable oil and 80 percent SRL. On a hydrogen equivalent basis, consumption of reducing gases was 2.0 weight percent of the MAF lignite or 2.35 SCF per lb of as-charged lignite.

Three of the nine yield periods were completed with the deashing system in operation. The ash content of the F-1 vacuum bottoms varied from 0.9 to 6.4 percent while the unconverted lignite content ranged from 0.3 to 2.9 weight percent.

Actual solvent recovery for recycle averaged about 90 percent for the nine yield periods. The longest period of operation without fresh solvent make-up was 120 hours which is approximately 24 turnovers of solvent inventory.

Run L-1 was scheduled for 672 hours of continuous operation of which 652 hours were to be devoted to liquefaction of lignite. Lignite was actually charged for 460.5 hours which was about 75 percent of the actual operating time. Approximately 11.4 tons of lignite was processed at an average feed rate of 49.5 lb/hr.

Operating problems exclusive of equipment malfunctions were in the three categories of F-1 vacuum bottoms withdrawal, solids build-up in the reactor and process lines, and solvent recovery. Product solidification in the vacuum-flash leg on two occasions was caused by a malfunction in the heat tracing tapes resulting in nonuniform heating. This can be avoided by careful control of temperatures provided the melting point of the product remains below 450^{o}F. Solids also collected on the walls of the bottom

drawoff leg and in the vessel because of localized coking and adhesion to the walls of a thick sand-like material discharged from the reactor.

About halfway through the run, and after Reactor R-1B had been about 76 hours on lignite, the pressure within the reactor began to rise slowly, and the pressure drop between the reactor outlet and the high pressure flash separator increased to between 300-400 psi indicating solids buildup in the 5/16-inch ID tubing. Attempts to clear the line by flushing with solvent were not successful and operations were continued in spite of the pressure drop. After 85 additional hours on lignite, the line plugged and operations were switched to Reactor R-1A which was utilized for the remainder of the run. Upon disassembly of Reactor R-1A after the run, it was found that this reactor was also partially plugged with material in a sort of long pitch spiral; the thickness of the plug was up to 2 inch in the 3-5/8 inch ID reactor. The decrease in reactor volume because of buildup and the corresponding decrease in residence time caused a reduced conversion resulting in a lower reactor temperature. The lower conversion may also have caused the higher melting point of the vacuum bottoms observed near the end of the run. The air cooler tubing from the top of the reactor also had significant reduction in effective volume due to deposits. Lignite was processed for a total of 201 hours in Reactor R-1A and for a total of 259 hours in Reactor R-1B. The longest continuous periods of operation without interruptions in the lignite feed were 136 hours for Reactor R-1A and 134 hours for Reactor R-1B.

Solvent recovery data indicated that for the entire run about 4 percent more organic liquid was generated than charged, but in the course of the run an average of 90 percent was recycled. Loss of organic liquid (oil) occurred in the oil-water separation system, in the light ends column and in the F-1 bottoms product.

4. Run L-2

The second of the three scheduled extended runs used nominal run conditions similar to those employed for L-1 of 820-830^{o}F maximum reaction temperature, 2500 psig operating pressure, and liquid and gas hourly space velocities of 1.43 and 336, respectively. The recovered organic distillates boiling above about 350^{o}F were recycled. In addition to the objective of Run L-1 of evaluating plant operability during extended operation using continuous liquefaction recycle, the effects of off-gas clean-up and recycle on liquefaction yields were to be determined. One reactor volume was used throughout the run.

Eight yield periods were established. Quantitative material balances were made for all yield periods and elemental balances done for six of the nine periods including an overall yield period of 441.4 hours. Material balance closures varied from 94.7 percent for the overall balance to an average of 98 percent for the eight standard yield periods. For comparison purposes the 12-hour yield periods were adjusted and normalized to 100 percent recovery. Adjustements in the calculations for three yield periods and the overall balance are discussed in detail in Appendix D.

The net gas yield was 30.6 weight percent of the MAF lignite charged and that of net hydrocarbon liquids, 63.5 percent. Distillable oil was 24.6 percent of the total organic liquid yield while SRL comprised the remaining 75.4 percent. Conversion of MAF lignite to oil, gas and SRL varied from 83 to 91.5 percent while overall conversion for the entire run was 88.7 percent. Actual recovery of solvent for recycle during processing was 92.6 percent. The potential solvent recovery on a total oil basis was calculated to be 104 to 105 percent. On a light-oil free basis (about 520°F plus boiling point material) solvent recovery was 90 to 94 percent. Consumption of reducing gases on a hydrogen equivalent basis was 2.1 weight percent of the MAF lignite or 4 SCF per pound of MAF lignite charged. Operating with gas recycle presented no problems and approximately the same net yields were obtained as when operating with once-through gas. Lignite was processed approximately 75 percent of the actual operating time or 54 percent of the total scheduled time. Nearly 11 tons of lignite were processed at an average rate of 48.6 lbs/hr.

The run was initially delayed because of plugging in some process lines believed clear after Run L-1. After processing started, a solid state contactor in the heating tape circuit for the F-1 vacuum-bottoms draw-off leg failed closed allowing overheating of the bottoms to coking temperature. Leakage also developed in the S-1 high-pressure slurry-let-down valves. Correction of these and other minor problems accounted for the first 155 hours of the scheduled 672. To compensate for the lost time, planned run time was increased to 816 hours. After being at temperature for approximately 30 hours, problems developed with the slurry charge pumps which had worked well pumping solvent, but would not pump the lignite-solvent slurry. The difficulty is believed to be caused by the presence of larger size material in the pulverized lignite. Comparison of sieve analysis for the material charged during Run L-2 when pumping problems existed to those of the M-Series when no difficulty was encountered indicated that nearly 22 percent of the pulverized lignite was larger than 65 US mesh for L-2 and only 0.4 percent for the M-Series. The particle size

distribution for L-2 indicated significantly larger material which interferred with proper sealing of the slurry pump check valves. When a new pulverizer screen was installed and a finer feed material prepared, the pumps performed satisfactorily.

The problem with solids build-up in the reactor, noted in Run L-1, was also encountered in L-2. After 220 hours of processing using Reactor R-1A, the melting point of F-1 vacuum bottoms had increased to approximately 450°F, and operations were switched to dissolver R-1B. The effects of a clean reactor were quickly apparent in reduced melting temperature of the vacuum bottoms of less than 350°F, improved operation of the vacuum bottoms discharge system, and increased conversion. Reactor R-1A was cooled by flushing with solvent, disassembled and cleaned of solids. Collected solids amounted to about one third of the reactor volume.

The system continued to operate smoothly for about 70 hours until the back pressure control valve plugged causing a major upset in the liquefaction section which resulted in a forced shutdown. After 40 hours spent to clear or replace plugged lines, the unit was restarted and processing resumed when operating pressure and temperature were reached. For an additional 110 hours, smooth operation was achieved, but then plugging in the vacuum-flash-drum F-1 and its bottoms discharge line resulted in slurry overflow of the vacuum flash tower, plugging of the overhead condenser, the condensate accumulator S-7, the line from S-7 to the condensate bottoms pump, the pump and the line to the solvent accumulator A-5A. The run was terminated and 94 hours were spent in complete disassembly of the vacuum-flash-solvent recovery system, cleaning and reassembly.

5. Discussion of Results

a. General

A total of 980.5 hours were completed in processing lignite in the Process Development Unit with 897.5 hours being achieved in two extended runs. High average conversion of lignite to gas, oil and SRL was achieved in the last scheduled short run investigating effects of lignite source; Gascoyne lignite was liquefied for 83 hours at the highest conversion of any lignite processed up to that time. While the PDU could be operated smoothly at high yields with solvent and gas recycle, mechanical and operating problems persisted. The major operating problems were related to solids buildup in the reactors and to oil-water phase separations. Correlations and observations of the liquefaction operations are discussed in the following.

b. Source of Lignite

Lignite from three different North Dakota mines have been liquefied in the PDU under similar process conditions. One, from the Zap Mine of the North American Coal Co. near Zap, ND in Mercer County, has been used as a "standard" lignite in most runs. The second lignite was from the Larson Mine of Baukol-Noonan, Inc. near Larson, ND in Burke County, and third, from the Gascoyne Mine of the Knife River Coal Mining Co. near Gascoyne, ND in Bowman County. Nominal process conditions were 825°F maximum reactor temperature, 2500 psig reactor pressure and hourly space velocities of liquid and gas, 1.4 and 280, respectively. Reducing gases were equimolar in hydrogen and carbon monoxide. Comparisons are made graphically and summary tables presented in Appendix B. Major results from the average of the first two yield periods of comparable runs are summarized in the following:

Lignite	Zap Average (M-29)	Larson Average (M-32)	Gascoyne Average (M-33)
Yields, Wt% MAF Lignite			
Net Gas	36	33	37
Light Oil	13	-3	-1
SRL	46	58	63
Conversion, Wt% MAF Lignite	90	80	93
Reducing Gas Consumption, SCF/lb lignite	3.1	1.8	2.6
Solvent Recovery possible %	104	99	100

The gross yield data indicate significant differences in response to liquefaction depending on the source of lignite. Larson lignite appears to be the least reactive for the process conditions selected with an average overall conversion of 81 percent while the Gascoyne lignite is most reactive with an indicated conversion of 93 percent. Total yield of liquids and gas were also the highest using Gascoyne lignite and the lowest with the Larson. However, separation of the net organic liquids into distillable and SRL components indicates that Zap lignite had the highest yield of the distillable fraction (light oil). Both Larson and Gascoyne lignites actually exhibited a net loss in

distillable oil because of loss of more solvent boiling range material by cracking, polymerization, or condensation than is produced from the lignite. The highest overall solvent production was with the Zap lignite. The Larson and Gascoyne lignites showed a slight net loss or an essential balance of solvent, respectively.

A comparison of yields per unit conversion of MAF lignite for the same averaged yield periods is given in the following tabulation:

Lignite	Zap	Larson	Gascoyne
Average ratio of yield to total conversion			
Net Gas	0.402	0.409	0.396
Net Liquid	0.658	0.688	0.668
Net Distillable Oil	0.145	-0.038	-0.010
Net SRL	0.513	0.726	0.678

Per unit of lignitic matter converted, the three lignites exhibit similar distribution to liquid and gaseous components. However, more of the Zap lignite was converted to lower molecular weight liquids as shown by the highest distillable oil yield, and lowest yield of SRL. The Gascoyne and Larson lignites produced more SRL but results in lower yields of distillable oils and losses of solvent.

The liquefaction tests indicate that lignites do respond differently although the lignites are from generally the same geological age and formation. Gascoyne lignite appears to be the most responsive to liquefaction, Zap lignite responds slightly less, and the Larson lignite the least active. Test conditions were those believed to be nearly optimum for Zap lignite. No attempt has been made to determine optimum conditions for the Larson or Gascoyne lignites.

Except for variations in moisture and ash content, and some differences in ash composition, the lignites were similar as shown in the following selected typical analytical values:

Lignite	Zap	Larson	Gascoyne
Proximate analysis, Wt%, as charged			
Moisture	30.9	26.8	34.0
Fixed Carbon	25.4	24.1	26.3
Ash	6.0	5.5	8.9

Lignite	Zap	Larson	Gascoyne
Ultimate analysis, Wt%, dry			
Carbon	68.8	67.8	62.2
Hydrogen	4.1	4.5	4.1
Sulfur	0.7	0.4	1.4
Nitrogen	0.9	0.7	1.0
Ash	8.7	7.5	13.4
Oxygen (diff)	16.7	19.1	17.9
Ash Component, Wt% of ash			
SiO_2	20.2	19.0	37.6
Al_2O_3	10.5	17.7	12.9
CaO	26.7	22.4	20.5
Na_2O	6.7	14.3	4.1

The moisture and ash as well as fixed carbon contents followed the apparent order of indicated activity being highest for the Gascoyne lignite followed by the Zap lignite and lower for the Larson lignite. Except for the high SiO_2 content in the ash of the Gascoyne lignite, no gross differences between the lignites is apparent from the ash and dry ultimate analyses.

c. Effect of Solvent Recycle on Liquefaction

A major objective of the extended runs in regards to process effects was to determine if there would be any progressive changes in product yields or distribution because of solvent recycle. The effects of extended periods of solvent recycle were more apparent during Run L-2 than during Run L-1 because of improved and longer periods of operation without addition of make-up solvent. The approximate number of solvent cycles through the reactor was estimated at the middle of each yield period for Run L-2 and net yields for each data period were plotted depending on the number of solvent passes. The graphs are presented in Appendix D, Figure 1. Generally, total conversion is little influenced by the number of solvent cycles being fairly constant at about 88 percent of the MAF lignite despite a somewhat reduced reaction temperature.

In Run M-29, data had indicated an increase in total conversion until about eight recycles of solvent, after which conversion remained nearly constant. Previous data have indicated that in the range of operational temperature, a temperature reduction decreases total conversion. Thus if it had been possible to control the reaction temperature nearer the desired level, an improved conversion could have been realized. Although total conversion remained essentially constant, increased total net liquid yields occur at the expense of decreased gas yields as the liquefaction solvent becomes more lignite derived. Again this relationship is also temperature dependent. Water consumption by reaction also seems independent of the number of cycles.

With increasing number of cycles for the solvent, and with the decrease in reaction temperature, the net SRL yield increased while the net distillable oil yield decreased (See Figure 2, Appendix D) being less than 15 percent of the MAF lignite after 18 cycles. If this trend is the result of solvent recycle rather than lowered temperature and continued, production of coal derived solvent might be reduced below that required for solvent balance.

During Run L-2, the feed solvent was monitored by infrared spectroscopy to determine variations in the aromatic-to-aliphatic carbon ratio, called the IR ratio, depending on hours of operation (number of solvent recycles). Sulfur concentration of solvent was also measured. (See Figures 3 and 4, Appendix D.) Aromaticity of the solvent, as indicated by the infrared ratio, increased with time of operation for the first 150 hours of operation after start-up which was equivalent to about 11 solvent cycles. After this time, the infrared ratio was essentially constant indicating an approach to equilibrium between solvent charged and solvent produced. Sulfur content decreased with time of operation from nearly 1.5 percent to about 0.5 percent. Batch autoclave tests had indicated approximately 0.3 percent for the sulfur content of lignite derived solvent. With a longer test period the sulfur concentration should become constant at some equilibrium value, perhaps slightly higher than that found in the batch autoclave tests.

d. Effect of Solids Accumulation in Reactors

A major unresolved problem in maintaining continuous long term operation of the PDU is the accumulation of solids in the reactor. With the present dissolver design featuring upflow of slurry at low space velocities, unreacted lignitic material and ash tend to agglomerate and are not removed with the slurry. Not only do the accumulated solids reduce the available reaction volume and consequently the slurry residence time, but at intervals some of the solids are discharged and plug the downstream lines. The problem is compounded because of the reduced residence time which results in lowered production of liquids in the solvent boiling range and an increase in the melting point of the vacuum bottoms. The higher melting point causes solidification of the SRL and plugging in subsequent processing resulting in process upsets and often in shutdown of operations. Major modifications in reactor design seem necessary to prevent the accumulation of solids.

The longest period of operation using one reactor, 220 hours, was accomplished during Run L-2 using Reactor R-1A. Shutdown in operations was required because the increase in the melting point of the F-1 bottoms presented many operating problems. After cooling, the reactor was disassembled and 43 pounds of solids were removed

by drilling. Samples were taken at various elevations in the reactor and analyzed for ash and pyridine insoluble contents with the following results:

Height from Reactor Base, ft	Ash, Wt%	Pyridine Insoluble, Wt%
Bottom	28.2	43.9
3	21.5	62.7
6	19.1	69.7
9	18.1	73.5
12	15.9	73.7

Typically, ash content of the deposits decreased with height, while the pyridine insolubles increased. Higher ash content near the bottom indicate that the more reacted residue from liquefaction being heavier and perhaps more agglomerated, tends to settle against the upward flow of slurry. The increase in pyridine insolubles is indicative of coking of SRL material at the higher temperatures.

Comparison of the residue in the reactor remaining after 48 hours and after 220 hours of operation indicated the same general trend with reactor height in ash content and pyridine insolubles (See Appendix D), although the ash and pyridine insolubles contents were higher after 220 hours than after 48.

It appears that the total solids in the reactor after initial buildup remains fairly constant with time at about 29 lb/cu ft of reactor volume. Also it is not clear what would happen in the present reactors with longer periods of lignite processing. Under the present conditions, the accumulation is sufficient to decrease conversion and change distribution of products significantly after 220 hours of processing.

e. Effect of Gas Recycle

In Run L-2, the product gas stream was washed with caustic to remove carbon dioxide and hydrogen sulfide. Approximately 75 percent of the cleaned gas was recycled to the process and the remainder was vented to the thermal oxidizer to reduce accumulation of other gases such as methane in the recycle gas stream. Makeup gas was added to the recycle stream as required. This portion of the pilot plant system operated without difficulty.

The effect, if any, of gas recycle on liquefaction was limited as indicated by the comparisons on the following page of yield data for the average of Run L-1, without gas recycle, with the averages from Run L-2, with gas recycle.

	Without Gas Recycle	With Gas Recycle
Average Temp., °F	822	810
Yields, Wt% MAF Lignite		
Net Gas	31.3	30.7
Net Liquid	66.1	60.8
Net Water & Ash	-5.2	-3.9
Unconverted Lignite	7.8	12.4
Possible solvent for Recycle, %	104.0	104.1

For these average data obtained under somewhat similar process conditions, the effects of solvent reuse should be approximately the same and differences could be attributable to gas recycle or to changes in other variables. There are some differences in conversions and liquid yields but these are of the range to be expected because of the differences in average temperatures. Consequently, the results appear to be equivalent.

f. Deashing of Vacuum Bottoms (SRL)

Three yield periods during Run L-1 were completed with the toluene extraction-settling separation system integrated with the liquefaction operations. In addition to mechanical and plugging problems within the deashing system itself, operational problems in the liquefaction system were also reflected in adverse operation of the deashing unit, and resulted in erratic separation. Separation was achieved with ash contents of the product being as low as 0.9 percent while the unconverted lignite content was as low as 0.3 percent. The ash content of the initial vacuum bottoms is from 10 to 12 percent and the bottoms also contain up to 10 percent unconverted lignite as determined by the pyridine solubility test.

While the extraction deashing method is attractive, more work has to be done in modification of the present system and to insure that the vacuum bottoms feed to deashing can be handled by the pumping system.

g. Solvent Recovery

With the Zap lignite, sufficient possible solvent is generated from the lignite to sustain the process. However, because of recovery problems, sampling, and decrease in distillable material with solids buildup, solvent is lost, and makeup solvent must be added. During Run L-1, an average of 4 percent more organic liquid

was generated than charged, although throughout the run an average of only 90 percent was recovered and recycled.

The 14 percent average loss occurred mainly in three areas: with the F-1 vacuum bottoms, with the waste water and light oil streams, and in operation of the small light ends column. Most of the losses could be remedied in larger scale operations.

h. PDU Operability

The liquefaction unit was operated on lignite for approximately 900 hours, most of which was accumulated during the two extended tests. Although lignite was processed for about 75 percent of the actual operating time, the objective of long term smooth operability of the PDU was not completely achieved. Failure of equipment such as that of heat tracing lines contributed to down time. Any malfunction causing process upsets compounded operating problems as the reacted slurry or vacuum bottoms would solidify on loss of temperature, would coke if temperatures were too high resulting in plugged lines and process vessels, or otherwise would cause trouble in transfer of material. The vacuum bottoms withdrawal system was particularly troubled by product solidification and buildup as was the high pressure piping. The separation system for light oil and water operated with variable efficiency, and often carryover of oil was as high as 25 to 30 percent of the water. The small light ends column, because of unfavorable area-volume relationship, had high heat loss which made it very sensitive to changes in cooling water rates to the partial condenser, and at times excessive reflux condensation caused column flooding.

The major non-correctable problem hindering operability was solid accumulation in the reactor. Such accumulation is not unique to liquefaction of lignite as similar problems have been encountered in processes using higher rank coal and upflow dissolvers. Accumulation of solids in the reactor caused difficulties in two ways. With time, the solids tended to deposit on the walls of the dissolver and coke into a hard mass which plugged the unit preventing flow of the lignite solvent slurry. Retention of solids reduced the effective volume for liquefaction and decreased residence time. This resulted in decreased overall conversion of the lignite and a higher melting point vacuum bottoms. The higher melting point material was more difficult to pump and to separate from the solvent. The higher melting point also contributed to solidification in piping and process equipment downstream from the reactors.

B. PDU MAINTENANCE AND CONSTRUCTION

1. General

With two 28-day runs scheduled, nearly all effort was directed towards maintaining the operability of the unit. Maintaining clean work areas and sound safety practices were stressed during the reporting period. Some activities are discussed in the following subsections, and additional details are available in the monthly reports.

2. Area 00: Buildings and Utilities

The partition to isolate the control-instrumentation area of PDU from the operational areas was completed. A supplementary heating and ventilating system to service the control room is being installed.

3. Area 01A: Coal Preparation and Storage

A small concrete apron was installed adjacent to the Inverta-bin storage pad to facilitate footing for the lift truck to the storage area during inclement weather.

4. Area 01B: Slurry Preparation and Pumping

Before the first scheduled long run the check valve assembles on the two Hills-McCanna slurry-charge pumps were rebuilt with new stainless steel seats and ceramic balls. The removed seats and balls showed some evidence of wear or erosion. All equipment and lines in this section were cleaned and washed with a heavy aromatic solvent.

5. Area 02: Slurry Preheating, Dissolving, and Gas Separation

The bottom closure on dissolver R-1B was removed, the dissolver was cleaned and the corrosion test coupons installed prior to M-33 were removed. Another set of test coupons was installed for the start of Run L-1. Some 316 stainless steel tubing at the outlet of reactor R-1B was replaced with Incoloy 800 tubing before Run M-33. The four slurry letdown valves constituting the primary and auxiliary captive volume letdown systems were cleaned and checked.

6. Area 03: Solids-Liquid Separation

The Teflon seats in both the solids-removal valve and the block valve above it were replaced with Rulon seats which should be more resistant to the severe operating conditions experienced. The valves were set so that the block valve remains open while

the dump valve cycles. The top valve will close automatically when electric power to the air solenoid valve is interrupted. The solids precipitation tower (V-8) was partially disassembled to allow removal of solids which accumulated during Run M-33 after failure of the solids removal valve.

7. Area 04: Liquid Separation and Solvent Recycle

Two 100-gallon solvent storage tanks were installed on weigh cells and piped in series for use as solvent accumulator (A-5A) for Run L-1.

8. Area 05: Gas Purification and Recycle

Equipment, sight glasses and control valves were cleaned.

C. PROJECT LIGNITE LABORATORY

The major effort of the laboratory staff was to provide analytical support for PDU operations. Some special analytical work was done on distillations using ASTM methods D-86 and D-1160 for comparison with results obtained using the routine Project Lignite Laboratory (PLL) distillation procedure. Additionally, a Pensky-Martens closed-cup flash-pump test was performed on a light oil stream (S-8 bottoms from the PDU).

Data from the flash point test showed that the light oil had a low flash temperature of 10°F which indicated that extreme care must be taken with these highly volatile liquids.

The recycle solvent distillation data are presented graphically in Figure 1. Measured temperatures were adjusted to equivalent temperatures at atmospheric pressure (760 mm Hg) using API Procedure 5A1.13 which had been developed for use with petroleum hydrocarbon mixtures. Applicability of the correction to hydrocarbon liquids derived from lignite has not been established although the use of the procedure gave apparently reasonable corrections.

The adjusted vapor temperature scale is nominally cartesian while the recovered volume scale (abscissa) has probability divisions. The general shapes of all curves are similar. However, the data from the PLL distillation indicates that a significantly higher temperature is required to distill a given fraction of the recycle solvent. The discrepancy is more pronounced as the volume of overhead exceeds 50 percent. The tests at the higher vacuums (1.6 mm Hg and 5 mm Hg abs.) gave essentially the same results during the initial stages of distillation, but as the distillation continued, the recovery in the PLL distillation deviates more

FIGURE I

COMPARISON OF ASTM AND PLL DISTILLATIONS ADJUSTED TO EQUIVALENT ATMOSPHERIC BOILING POINTS

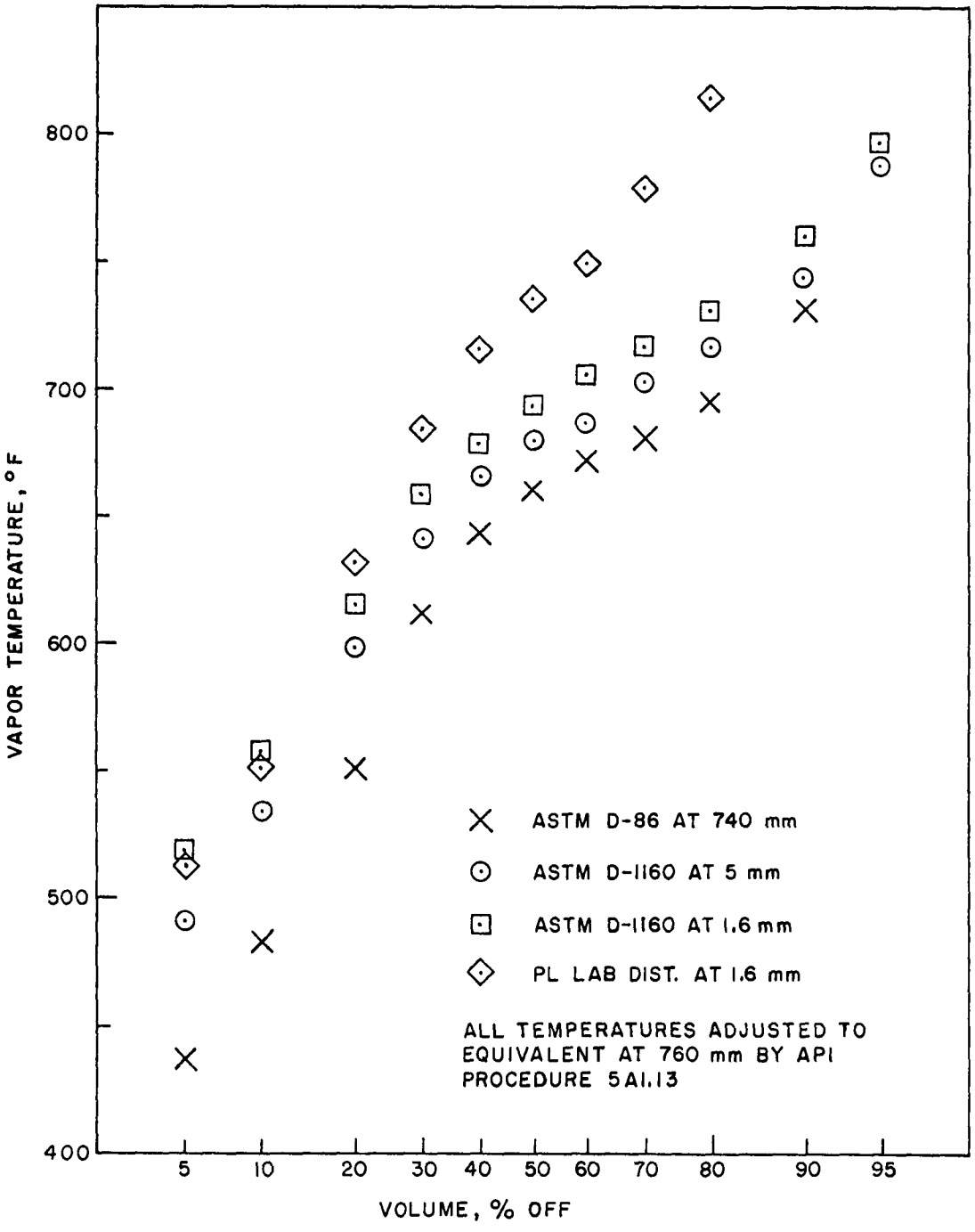
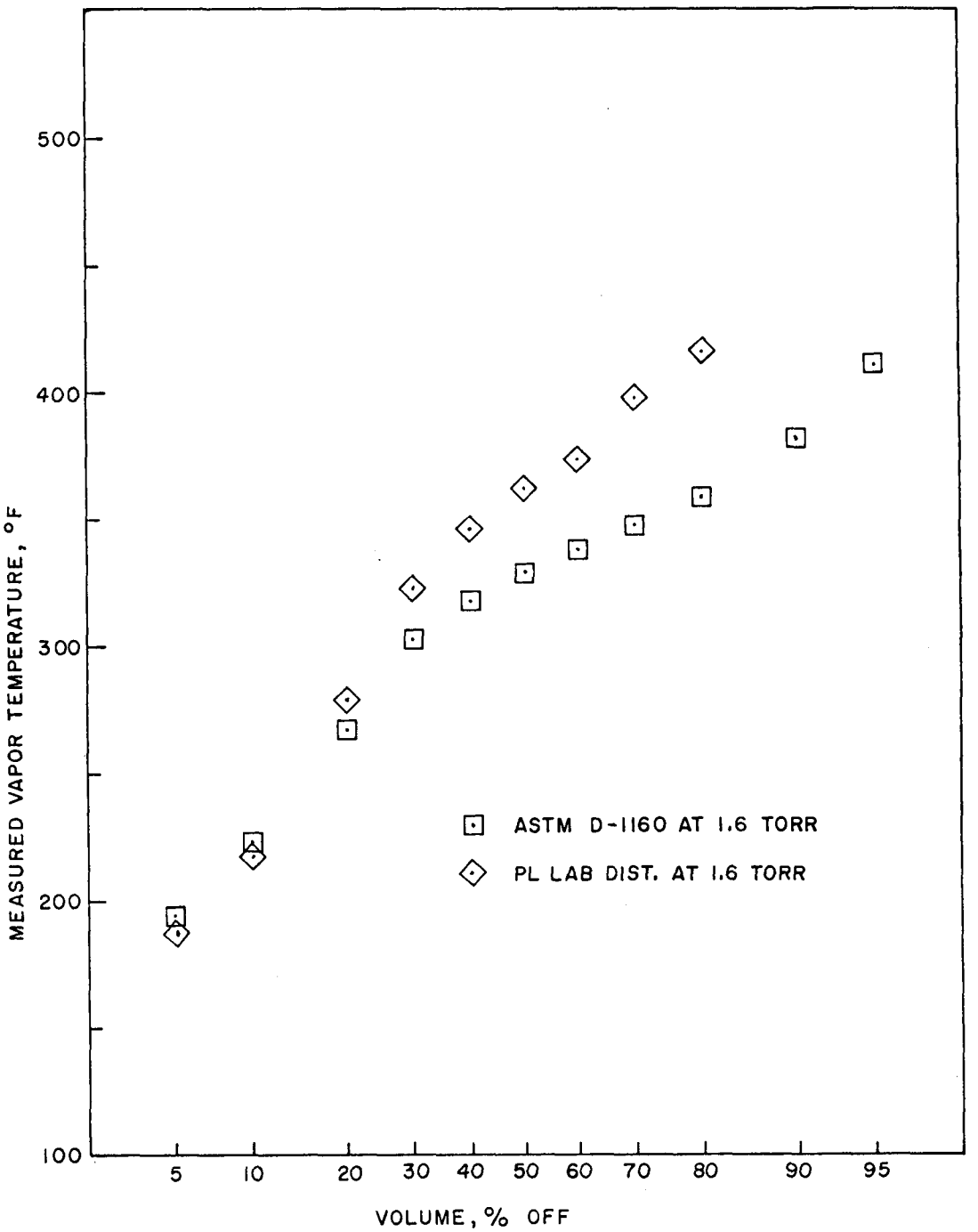


FIGURE 2

COMPARISON OF ASTM AND PLL DISTILLATIONS AT 1.6 TORR



and more from the three ASTM distillations.

Measured vapor temperatures for the two distillation procedures at the same pressure (1.6 mm Hg) as a function of volume distilled are illustrated in Figure 2 using the same plotting procedure as for Figure 1. The PLL distillation gives a lower total volume of distillate at any vapor temperature. Initially, both distillations are nearly the same, but the slope of the PLL distillation curve is greater. This indicates that the longer column used in the PLL method results in more effective fractionation. When 50 percent of the sample has been vaporized, the vapor temperature using the ASTM D-1160 test is 329°F compared to 363°F for the PLL distillation procedure.

IV. CONCLUSIONS

A. PDU OPERATIONS

1. During almost 800 hours of operation in liquefaction of Zap lignite in two runs, relatively high conversions could be maintained during the extended tests with potential solvent recovery of over 100 percent, although actual solvent recovery was about 90 percent.

2. Gascoyne lignite was found to give the highest conversions of any lignite yet tested in the PDU up to that time with high yields of SRL but relatively lower yields of distillable oils, including solvent-type material.

3. Product gas cleanup and recycle were accomplished without undue difficulty and no significant differences were apparent in liquefaction characteristics when compared to similar tests without recycle.

4. The solids-liquid separation unit using toluene extraction-settling was operated for three yield periods with significant separation achieved, although ash content of the SRL was variable and higher than desired.

5. Buildup of solids in the dissolver was found to affect operability of the PDU. In addition to coking and deposition in the reactor, reduction in residence time resulted in a higher melting point product and subsequent solidification in downstream process vessels and piping.

B. PDU MAINTENANCE AND CONSTRUCTION

Because of the scheduled long duration runs, maintenance activities were concentrated on repairs concerned with insuring operation of the unit, during which problems with pumps, valves and control equipment were the major mechanical difficulties encountered.

C. PROJECT LIGNITE LABORATORY

Solvent distillations conducted by ASTM methods for comparison with the routine Project Lignite Laboratory (PLL) distillations indicated the PLL distillations to be somewhat more efficient.

APPENDIX A

STATEMENT OF WORK

Objective

The objective of this one year project is to obtain adequate data on which to base a decision regarding scale up at an existing facility, should it prove desirable. The data also will be available for new economic evaluations.

Tasks

The basic task involves operating the continuous unit processing 0.6 tons per day of lignite and providing support functions to acquire and analyze process data. These process data are required by ERDA in order to make future decisions concerning the desirability of scaling up the process in a larger existing facility for the production of solvent refined lignite. The same data will serve to guide any other development activities which may be required.

Task 1 - Operating of One-Half Ton Per Day Unit for Extended Runs

Under the existing project optimum conditions are being established for possible extended operations. An extended run is defined as covering periods of more than 1 week, preferably about 4 weeks (672 hours) of continuous operation. Such runs will establish the effects of continuing to recycle the lignite generated process solvent and demonstrate the extent of solvent balance achieved under the operating conditions which have been explored to date.

Three such runs conducted over a period of 6 months should be sufficient for this task. Because current operations are limited to a 5 day week, additional manpower will be required. Maximum use of overtime is suggested, due to the short term nature of this work, i.e., possibly 3 months total continuous operation during a period of 6 months. If adequate data is obtained in a short time from the extended runs, and if the ERDA technical project officer agrees, shorter runs may be conducted during this phase of the project, further evaluating construction materials and the effect of varying operating pressures and gas composition.

Task 2 - Operation of Gas Cleanup and Recycle Sections

If possible, this section will be operated as an integral part of the PDU on an extended run to determine makeup gas requirements and the effect of any impurities in the recycle gas. No major design or engineering changes will be introduced in this section.

Task 3 - Solid/Liquid Separation

The separation section will be operated as an integral

part of the PDU, producing a clean solvent refined lignite for characterization. A secondary task is to evaluate operation of the separation unit as designed. No major design or equipment changes will be introduced.

Task 4 - Corrosion Coupon Testing

After appropriate analysis and consultation, as required, the contractor will have a number of coupons of austenitic stainless steels pre-stressed and inserted in the PDU for corrosion testing. The steels to be tested will include selected types from those used in the SRC plants at Tacoma and Wilsonville: stainless steel types 304, 310, 316, and 347. The contractor will prepare a plan for this task explaining his selections of material, the method of pre-stressing and test-site locations. This corrosion coupon test plan will be submitted to ERDA for approval by the Technical Project Office prior to its implementation.

Task 5 - Determine Extent of Solids Accumulation in Dissolvers

The reactors (dissolvers) may accumulate mineral matter and unconverted coal during operation. The contractor will determine the composition of the solids and the rate at which solids are accumulated. The possible existence of a maximum concentration of solids at steady conditions, will also be explored.

Task 6 - Production of Clean Solvent Refined Lignite

The contractor will produce up to one ton of clean solvent refined lignite for shipment in drums to other ERDA contractors, as specified by the Technical Project Officer. This material will be evaluated by the appropriate contractors for various purposes including upgrading to chemical feedstocks, light liquid fuels, and use as a solid fuel. It is anticipated that half of the quantity produced will have a melting point higher than 340^{O}F. Actual quantities and specifications for the product will be established during the contract by agreement between the ERDA Technical Project Officer and the contractor.

Task 7 - Data Collection and Analysis

This task continues to be significant. The contractor will provide material balances (over-all and for major streams and vessels), solvent balance, hydrogen consumption, product yields and product characteristics within 30 days of completion of a PDU run. Properties to be measured and reported for the solvent refined lignite and liquid products include:

1. Distillation Curve
2. Viscosity
3. Specific Gravity

4. Penetration or Melting Point of the Product (at temperatures not suitable for viscosity measurements)
5. Elemental Analysis (including chlorine)
6. Trace Elements
7. Asphaltene Content

Correlation studies will be made of the data obtained from runs to examine the effect of changing different process variables.

The corrosion coupon data will be analyzed as part of this task.

Yield structures and appropriate data summaries will be published in quarterly reports, and a final report will be prepared.

APPENDIX B

Process Development Unit Run M-33

June 20-24, 1977

Run M-33 was made to continue the investigation of the effects of coal variation on plant operability and liquefaction yields. Lignite mined by the Knife River Coal Mining Company near Gascoyne, North Dakota, was used. Gascoyne lignite differed from previous lignites tried in the PDU in that the ash and moisture contents were significantly higher at about 9 percent and 35 percent, respectively. Other significant differences are apparent from the ultimate analysis and X-ray fluorescence analysis of the ash shown in the table on the following page.

Nominal operating conditions in Run M-33 were 820-830°F maximum liquefaction temperature and 2500 psig dissolver operating pressure with liquid and gas hourly space velocities of 1.41 and 301, respectively. One reactor volume was used and all recoverable organic liquids boiling above about 350°F at one atmosphere were recycled. The feed gas contained equal volumes of hydrogen and carbon monoxide. Product gases were not recycled but were sampled, measured and then oxidized. The deashing unit was on stream during part of the run.

Numerous operating problems were encountered during the run, mainly with (1) oil-water separation, (2) plugging of the F-1 vacuum bottoms leg, (3) gaskets and check valves in pumps P-5 and P-11A of the deashing unit and (4) solids removal from the solids precipitation tower.

Oil-water separation proved difficult throughout the run with constant monitoring of effluent streams required. Substantial quantities of oil were lost with the waste water, partly because of partial miscibility of the two phases and partly because of fluctuating oil densities. Changes in oil density affected the position of the oil water interface within the separation vessel. Interface location is critical in the separation process as a low interface results in oil withdrawal with the waste water underflow while a high interface results in water leaving with the oil overflow. It should be noted that this problem is not unique to the processing of Gascoyne lignite as similar problems have been experienced when handling Zap lignite also.

Plugging of the F-1 vacuum bottoms outlet line occurred several times during the run and at least once required drilling to clear. Temperature control of the line tracing elements presents one of the main problems. Over heating promotes coking and under-heating results in product solidification. The sometimes widely fluctuating melting point (250-450°F) of the vacuum bottoms product further complicates temperature control problems. Again this is a problem not unique to Gascoyne lignite.

Analyses of
North Dakota Lignites

Proximate Analysis, Wt %

Mine Location	Zap	Velva	Larson	Gascoyne
Moisture	30.91	29.58	26.85	34.03
Ash	6.04	5.91	5.48	8.87
Volatile Matter	37.65	42.45	43.56	30.76
Fixed Carbon	25.40	22.06	24.11	26.34
Total	100.00	100.00	100.00	100.00

Ultimate Analysis, Wt % (Dry Basis)

Mine Location	Zap	Velva	Larson	Gascoyne
Carbon	68.82	65.99	67.82	62.20
Hydrogen	4.10	4.23	4.49	4.15
Nitrogen	0.88	0.83	0.69	0.96
Oxygen (by diff)	16.72	20.22	19.06	17.86
Sulfur	0.74	0.34	0.45	1.38
Ash	8.74	8.39	7.49	13.45
Total	100.00	100.00	100.00	100.00

X-Ray Fluorescence Analysis of Ash, Wt %

Mine Location	Zap	Velva	Larson	Gascoyne
Loss on ignition @ 800°C	0.4	-	-	-
SiO_2	20.2	28.4	19.0	37.6
Al_2O_3	10.5	14.1	17.7	12.9
Fe_2O_3	10.0	4.5	6.0	5.6
TiO_2	0.5	0.5	0.4	0.8
P_2O_5	0.6	0.9	1.0	0.5
CaO	26.7	31.2	22.4	20.5
MgO	6.8	9.1	5.7	6.9
Na_2O	6.7	1.8	14.3	4.1
K_2O	0.4	0.6	0.4	0.3
SO_2	17.2	8.9	13.1	10.8
Total	100.00	100.00	100.00	100.00

Gasket failure in the toluene-slurry circulating pump P-5 and check valve plugging in the F-0 vacuum bottoms removal pump, P-11A, delayed integration of the solids-liquid separation unit. After the gaskets were replaced and the check valves cleaned, the deashing unit was brought on stream and operated for approximately 26 hours. Yield period M-33C was started and completed during this period. At the end of M-33C, it was found that the collar connecting the V-8 bottoms withdrawal valve stem and the actuator had become loose and misaligned, with the result that movement of the actuator did not operate the valve. The bottoms line had already plugged before the actuator could be reconnected to the valve, and deashing operations were terminated. Liquefaction operations continued through another yield period to a scheduled and orderly shutdown 12 hours later.

Four yield periods were completed and two, M-33C and D, were selected for complete workup including elemental balances and oil phase ASTM D86 and D1160 distillations. The results of these workups along with the quantitative material balance data for yield periods M-33A and B are attached.

Material balance closure for the four yield periods varied from 96.8 to 99.5 percent. The various yield periods were adjusted to 100 percent recovery as follows. In data period M-33A, the one half of one percent error in material balance closure was corrected by increasing the F-1 vacuum bottoms rate. A partial plug had developed at the bottom of the draw off leg and while it was being cleared some F-1 vacuum bottoms sprayed onto the floor and was lost. A similar situation occurred during yield period M-33B with some of the vacuum bottoms material clinging to the walls of the drawoff leg. Consequently, the F-1 bottoms rate was increased so that the ratio of the F-1 vacuum bottoms to feed coal was comparable to that of yield period M-33A. This initially increased the material balance closure from 96.8 percent to 97.5 percent. The remaining loss was then normalized among all outgoing product streams.

In yield period M-33C, during which the deashing unit was on stream, material balance closure was low at 97 percent because the V-8 bottoms draw off line plugged and an indeterminate amount of solids accumulated in the bottom of the precipitation tower. Consequently, the material balance was adjusted to 100 percent recovery first by decreasing the V-9 overhead rate to maintain a constant inventory in the toluene accumulator and then by increasing the V-8 bottoms rate to provide mass balance closure. The V-8 bottoms composition was calculated by making a material balance around the deashing unit assuming that the level in the toluene accumulator remained constant but that the composition changed.

Material balance closure in yield period M-33D was 98.6 percent and was adjusted to 100 percent recovery by normalizing all outgoing

product streams because no particular sources of error were known.

A comparison of the four material balance periods after adjustment is shown on the following page.

Net gas yields averaged 36.8 and net organic liquid yields 62.5 weight percent of the MAF lignite charged. Net distillable oil yields averaged 5.4 weight percent of the MAF lignite fed while SRL yields averaged 57.1 weight percent.

Conversion of MAF lignite to gas, oil and SRL averaged 91.1 percent. Reducing gas consumption averaged 2.4 SCF per pound raw lignite charged.

Actual solvent recovery for recycle averaged 92.2 percent with a calculated possible recovery of 101.4 percent.

Results of the deashing operation during yield period M-33C were quite favorable with the unconverted coal and ash contents of the vacuum bottoms product reduced to 0 and 0.2 weight percent, respectively.

As mentioned earlier, Run M-33 was made to evaluate Gascoyne lignite as feed to the liquefaction process and to determine plant operability. A comparison of results with three different lignites in Runs M-29, M-32 and M-33 are tabulated on a following page. Conversion of MAF coal to gas, oil, and SRL averaged 80.4 weight percent when using Larson lignite (Run M-32) which is significantly lower than that obtained when using either Zap or Gascoyne lignite, and is apparently the result of lower reactivity of the lignite. The Gascoyne lignite seems to be the most reactive of the three coal varieties, yielding MAF lignite conversions of about 93 percent.

A graphical comparison of the results with the three lignites is attached. The highest conversion and gas and liquid yields are obtained with Gascoyne lignite and the lowest with Larson lignite. However, dividing the net organic liquid yield into its distillable oil and SRL components indicates that the Zap lignite provides higher yields of distillable oil, while both Larson and Gascoyne lignite show a net loss of distillable oil, because of the loss of more solvent range material by cracking and/or polymerization and condensation than is produced from the coal.

The graphs of solvent recovery indicate the highest overall solvent production (and also actual recycle) occurs with Zap lignite, and that both Larson and Gascoyne show slight net losses of solvent.

When the yields are calculated as fractions of the MAF coal converted, the following results are obtained:

Process Development Unit Run M-33

Yield Period	M-33A	M-33B	M-33C	M-33D	Average
No. of Reactors	1	1	1	1	1
LHSV	1.34	1.37	1.49	1.43	1.41
GHSV	289	301	301	306	299
Solvent/MAF Coal Ratio	4.08	3.84	3.54	3.95	3.85
H_2/CO Mol Ratio	1.1	1.0	1.0	1.0	1.0
Temperatures, °F					
Preheater Outlet, E-1	762	752	741	749	751
Reactor 3 ft	768	762	765	768	766
Reactor 7 ft	799	794	799	804	799
Reactor 11 ft	797	790	802	806	799
Reactor 15 ft	822	815	822	828	822
Max. Reaction	822	815	822	828	822
Vacuum Flash Ovhd	513	513	515	523	516
Dissolver Pressure, Psig	2500	2500	2500	2500	2500
Solvent Recycle, %					
Actual	89.8	94.2	86.2	98.6	92.2
Possible	98.9	100.7	101.7	104.4	101.4
Yields, Wt % MAF Lignite					
Net Gas	39.9	35.2	34.1	39.1	36.8
Net Liquid	58.1	66.6	63.4	62.0	62.5
(Lt Oil)	(-4.6)	(2.8)	(6.0)	(17.6)	(5.4)
(SRC)	(62.7)	(63.8)	(57.4)	(44.4)	(57.1)
Net H_2O and Ash	-5.6	-6.4	-9.3	-11.8	-8.2
Unconverted Coal	7.6	5.5	11.8	10.7	8.9
Overall Material Balance, %	99.5	96.8	97.0	98.6	98.0

Process Development Unit Runs M-29, 32 and 33

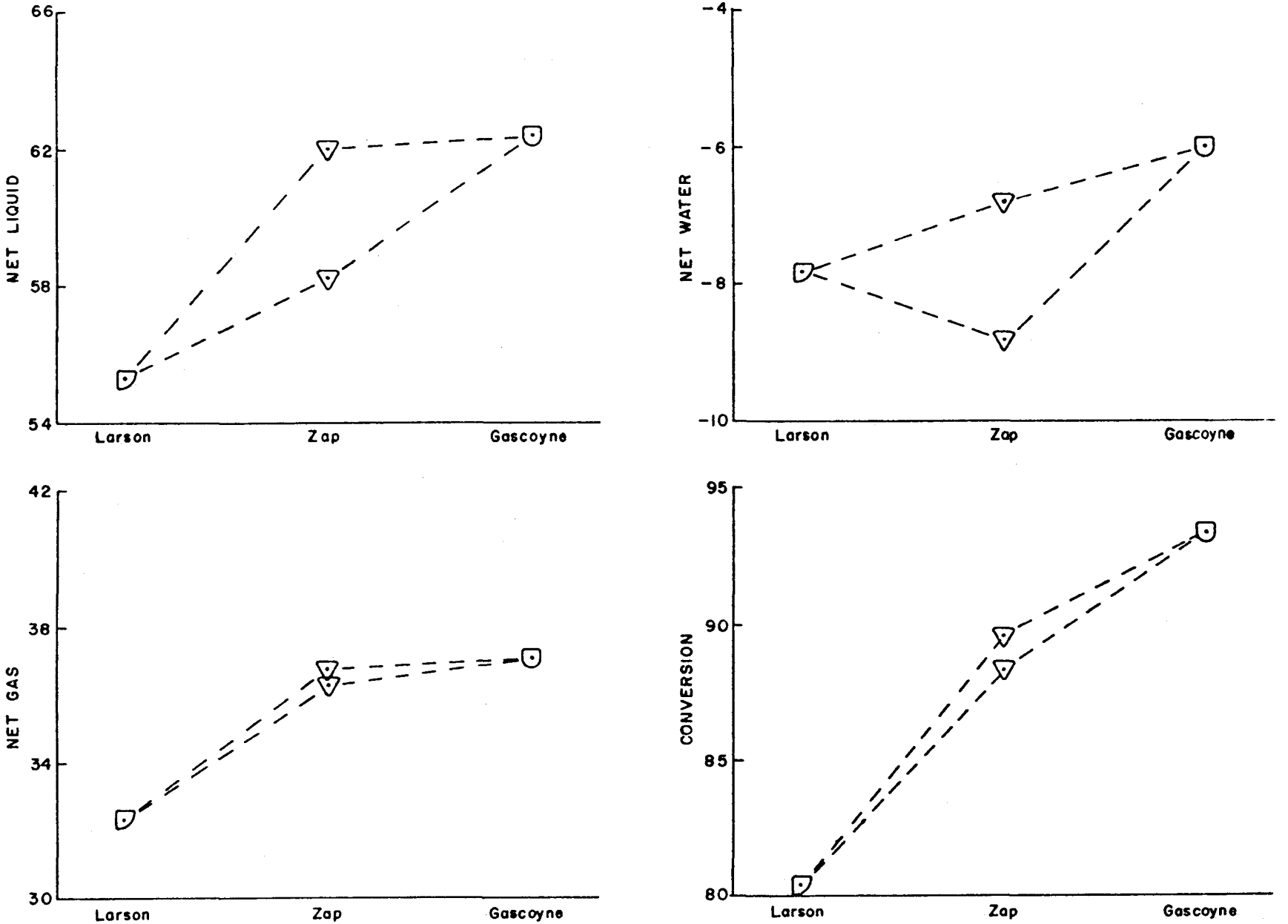
Run	M-29A & B Average	M-29F & G Average	M-32A & B Average	M-33A & B Average
Reactor	B	A	B	B
Type of Lignite	Zap	Zap	Larson	Gascoyne
LHSV	1.38	1.41	1.43	1.36
GHSV	270	268	325	295
Solvent/MAF Coal Ratio	3.00	3.13	2.90	3.96
Percent H_2 in Feed Gas	48.0	49.8	52.9	51.0
Temperatures, ^{o}F				
Preheater Outlet, E-1	710	716	738	757
Maximum Reaction	836	826	824	818
Dissolver Pressure, Psig	2400	2450	2500	2500
Solvent Recycle, %				
Actual	92.4	95.2	87.6	92.0
Possible	105.1	100.8	98.8	99.8
Yields, Wt % MAF Lignite				
Net Gas	36.3	36.8	32.9	37.0
Net Liquid	62.0	58.3	55.3	62.4
(Lt Oil)	(15.6)	(2.9)	(-3.1)	(-0.9)
(SRL)	(46.4)	(55.4)	(58.4)	(63.3)
Net H_2O and Ash	-8.8	-6.8	-7.8	-6.0
Unconverted Coal	10.5	11.7	19.6	6.6
Overall Material Balance, %	98.0	98.6	98.7	98.2
Conversion, Wt % MAF Coal	89.5	88.3	80.4	93.4
Reducing Gas Consumption, SCF/lb Coal	3.2	2.4	1.8	2.6

Lignite Variety	Larson	Gascoyne	Zap AB	Zap FG
Net Gas Yield Conversion	0.409	0.396	0.405	0.417
Net Organic Liquid Yield Conversion	0.688	0.668	0.693	0.660
Net Distillable Oil Yield Conversion	-0.038	-0.010	0.174	0.033
Net SRL Yield Conversion	0.726	0.678	0.519	0.627

For a given degree of MAF lignite conversion, the various lignites do not vary much in gas and organic liquid yields, but the Zap lignite produces the highest net distillable oil yield and consequently the lowest SRL yield. The Gascoyne and Larson lignites produce more SRL, but at the expense of solvent as indicated by the overall net loss of distillable liquids.

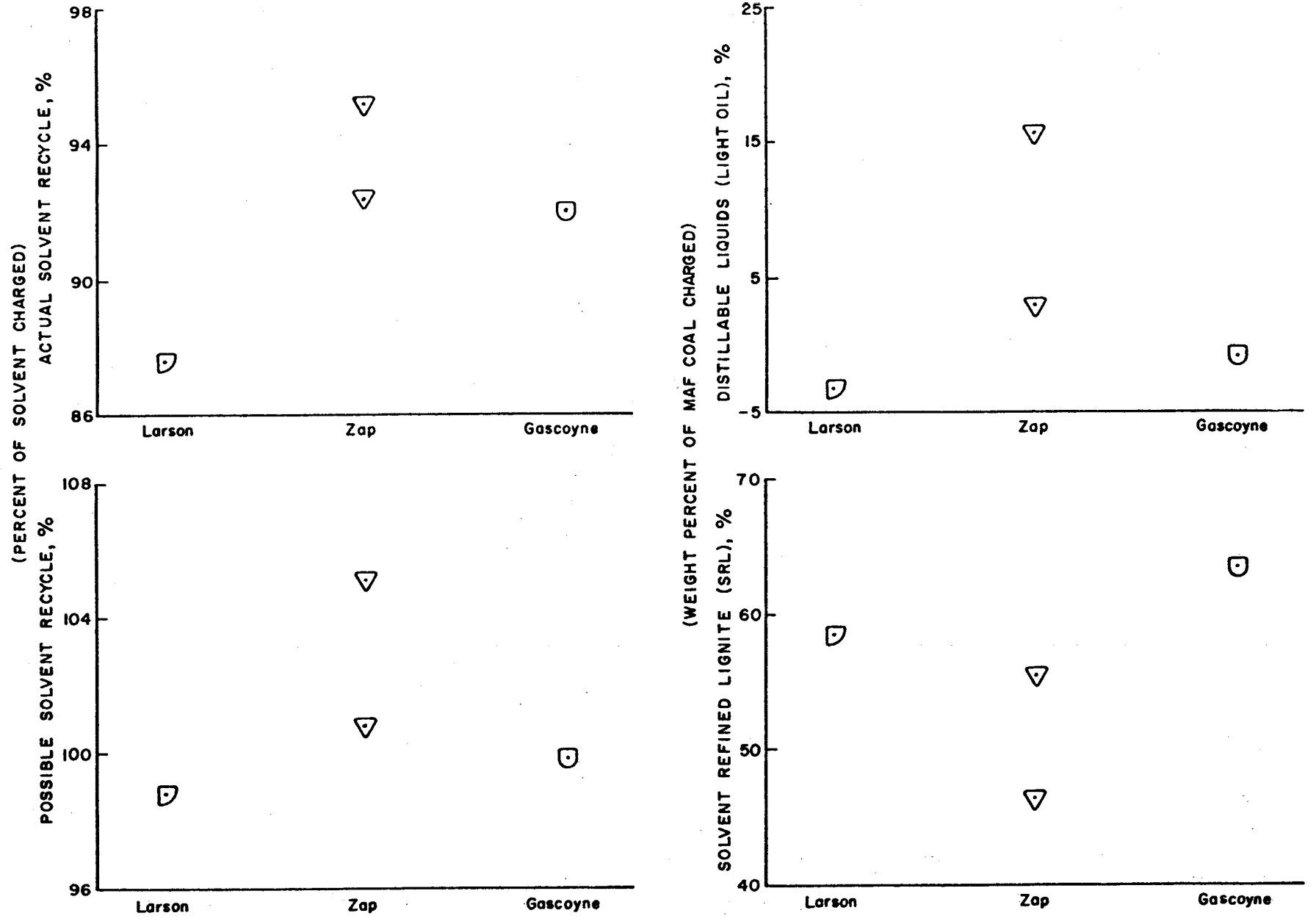
In summary then it appears that the Gascoyne lignite is the more reactive of the three lignites tested followed closely by Zap and then by Larson lignites. It should be noted; however, that Runs M-32 (Larson) and M-33 (Gascoyne) were made at conditions thought to be near optimum for Zap lignite. No attempts have been made yet to find the actual optimum conditions for Larson or Gascoyne lignites.

FIGURE 1 - YIELDS AND CONVERSION WITH THREE NORTH DAKOTA LIGNITES



NET YIELDS AND CONVERSION ARE WEIGHT PERCENT OF MAF COAL CHARGED

FIGURE 2-SOLVENT RECYCLE AND PRODUCT DISTRIBUTION WITH THREE NORTH DAKOTA LIGNITES



RUN CONDITIONS

RUN NO. M-33A
DATE MADE 6/21-22/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 773
- INLET 288
- OUTLET 762

DISSOLVERS
- R-1A (1) —
- (2) —
- (3) —
- (4) —
- R-1B (1) 768
- (2) 799
- (3) 797
- (4) 822

REACTOR PRODUCT SEPARATORS
- S-1 590
- S-2 74
- S-3 487
- S-4A 80
- S-4B 77

PREHEATER E-11
- DOWTHERM 670
- INLET 448
- OUTLET 629

VACUUM FLASH F-1
- OVERHEAD VAPOR 513
- UPPER WALL 576
- LOWER WALL 679
- DOWNCOMER 458
- CONDENSATE ACCUMULATOR, S-7 82

PREHEATER E-13
- DOWTHERM 511
- INLET 76
- OUTLET 340

LIGHT ENDS COLUMN, F-2
- REBOILER 424
- LOWER SECTION 490
- FEED SECTION 322
- OVERHEAD 178
- S-8 83
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION —
- FEED SECTION —
- OVERHEAD —

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION —
- FEED SECTION —
- OVERHEAD —

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS —

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2) —
- (3) —

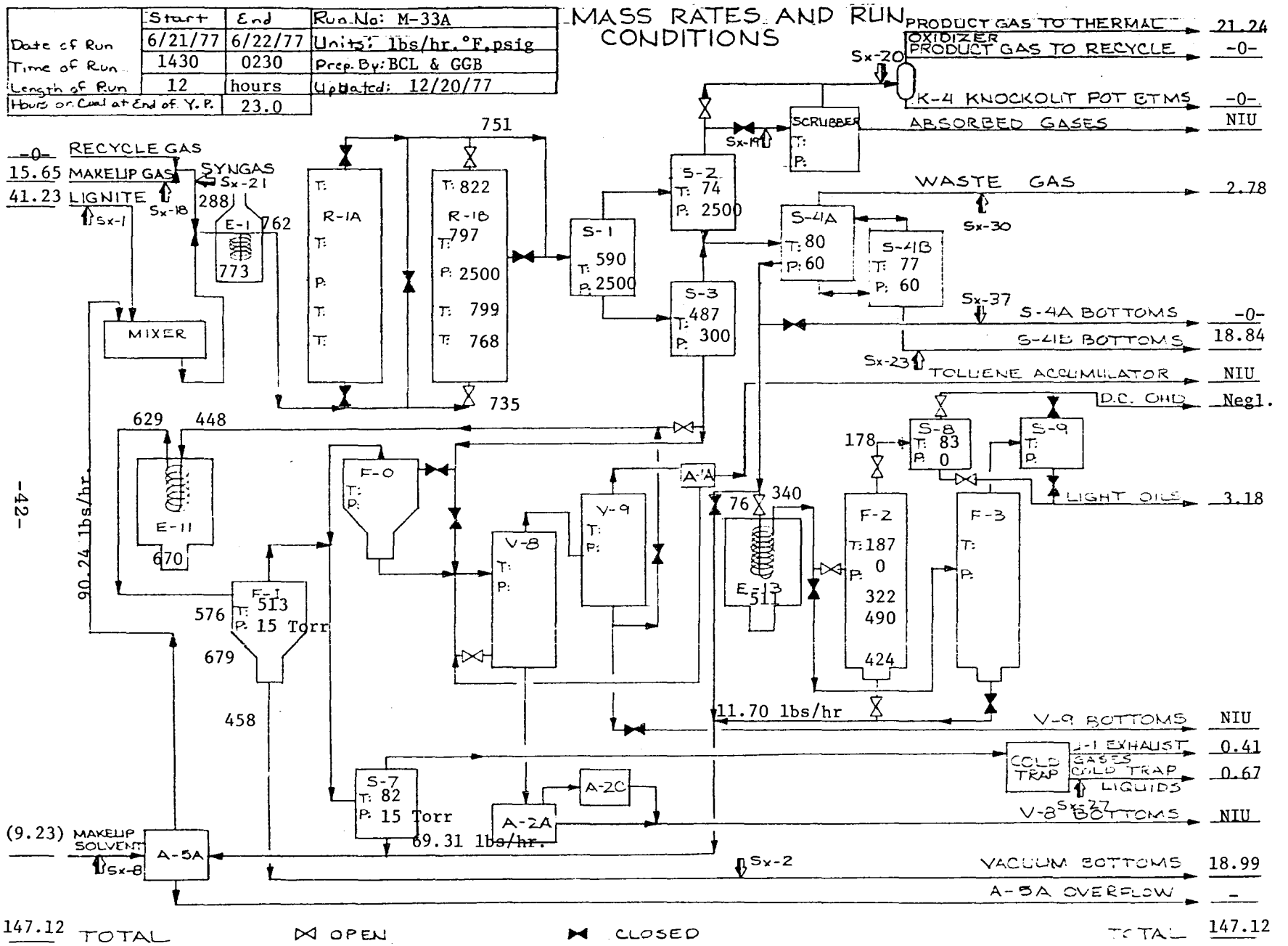
RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD —

PRESSURE, psig

- SEPARATORS S-1 and S-2: 2500
- SEPARATOR S-3: 300
- SEPARATORS S-4A and S-4B: 60
- VACUUM FLASH, F-1: 15 Torr
- LIGHT ENDS COLUMN, F-2: 0
- SOLVENT COLUMN, F-3: NIU
- HEAVY ENDS COLUMN, F-4: NIU
- VACUUM FLASH, F-0: NIU
- SETTLING TOWER, V-8: NIU
- RECOVERY TOWER, V-7: NIU

MASS RATES AND RUN CONDITIONS

	Start	End	Run No: M-33A
Date of Run	6/21/77	6/22/77	Units: lbs/hr. °F, psig
Time of Run	1430	0230	Prep. By: BCL & GGB
Length of Run	12	hours	Updated: 12/20/77
Hours on Coal at End of Y.P.	23.0		



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
F-1 Btms Increased
Revised: 12/20/77

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

SUMMARY

lbs/hour

Temperature: 762°F
Pressure: 2500 psig
LHSV: 1.34
GHSV: 288

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Lignite	
SAMPLE POINT						
Hydrogen - H_2	1.14	1.04	-0.10			
Carbon Monoxide - CO	14.51	8.63	-5.88			
Carbon Dioxide - CO_2		12.39	12.39			
Hydrogen Sulfide - H_2S		0.32	0.32			
Methane - CH_4		1.25	1.25	8.80	39.91	
Ethane - C_2H_6		0.50	0.50			
Propane - C_3H_8		0.26	0.26			
Butane - C_4H_{10}						
Nitrogen - N_2		0.02	0.02			
Ammonia - NH_3		0.04	0.04			
Light Oil - (0-100° C @ 1.6 Torr)	5.08	7.03	1.95			
Solvent - (100-230°C @ 1.6 Torr)	67.86	75.13	7.27	12.80	58.05	
Heavy Oil - (230-255°C @ 1.6 Torr)	17.06	6.81	-10.25			
SRL		13.83	13.83			
Coal (MAF)	22.05	1.68	-20.37		-92.38	
Ash	3.86	3.48	-0.38		-1.72	
Water	15.56	14.71	-0.85		-3.86	
Phenol						
TOTAL	147.12	147.12	-0-			

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED & MEASURED MATERIAL BALANCE
Updated: 12/20/77

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

MATERIAL IN

lbs/hour

Temperature: 762°F
Pressure: 2500 psig
LHSV : 1.34
GHSV: 289

Quantitative

STREAM DESCRIPTION	Feed Gas	Lignite	Feed Solvent			Total In
SAMPLE POINT	Sx-21	Sx-1	Sx-14			
Hydrogen - H_2	1.14					1.14
Carbon Monoxide - CO	14.51					14.51
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)			5.08			5.08
Solvent - (100-230°C @ 1.6 Torr)			67.86			67.86
Heavy Oil - (230-255°C @ 1.6 Torr)			17.06			17.06
SRL						
Coal (MAF)		22.05				22.05
Ash		3.86				3.86
Water		15.32	0.24			15.56
Phenol						
TOTAL	15.65	41.23	90.24			147.12

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJEC LIGNITE
ADJUSTED MATERIAL BALANCE
F-1 Btms Increased

Updated: 12/20/77

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

MATERIAL OUT
lbs/hour

Temperature: 762°F
Pressure: 2500 psig
LHSV: 1.34
GHSV: 289

Quantitative

STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exh.
SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Hydrogen - H_2	0.97	0.06				0.01
Carbon Monoxide - CO	8.02	0.55				0.06
Carbon Dioxide - CO_2	10.23	1.86				0.30
Hydrogen Sulfide - H_2S	0.23	0.09				
Methane - CH_4	1.16	0.08				0.01
Ethane - C_2H_6	0.42	0.07				0.01
Propane - C_3H_8	0.19	0.05				0.02
Butane - C_4H_{10}						
Nitrogen - N_2		0.02				
Ammonia - NH_3	0.02		0.02			
Light Oil - (0-100° C @ 1.6 Torr)			1.68		0.83	
Solvent - (100-230°C @ 1.6 Torr)			3.03		1.90	
Heavy Oil - (230-255°C @ 1.6 Torr)			0.42			
SRL						
Coal (MAF)						
Ash						
Water			13.69		0.45	
Phenol						
TOTAL	21.24	2.78	18.84	Negl.	3.18	0.41

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
F-1 Btms Increased
Revised: 12/20/77

Run No: M-33A
Date: 6/21/22/77
Time: 1430-0230

MATERIAL OUT

lbs/hour

Temperature: 762°F
Pressure: 2500 psig
LHSV: 1.34
GHSV: 289

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-3 Btms		Total Out
SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.04
Carbon Monoxide - CO						8.63
Carbon Dioxide - CO_2						12.39
Hydrogen Sulfide - H_2S						0.32
Methane - CH_4						1.25
Ethane - C_2H_6						0.50
Propane - C_3H_8						0.26
Butane - C_4H_{10}						
Nitrogen - N_2						0.02
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.17		2.55	1.80		7.03
Solvent - (100-230°C @ 1.6 Torr)	0.18		60.58	9.44		75.13
Heavy Oil - (230-255°C @ 1.6 Torr)	0.04		5.89	0.46		6.81
SRL		13.83				13.83
Coal (MAF)		1.68				1.68
Ash		3.48				3.48
Water	0.28		0.29			14.71
Phenol						
TOTAL	0.67	18.99	69.31	11.70		147.12

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/19/77

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Feed Coal	F-1 Btms	Makeup Solvent	F-3 Btms	Feed Solvent	S-8 Oil
	SAMPLE POINT	Sx-1	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			4.93	15.40	5.63	30.26
	Solvent – (100-230° C @ 1.6 Torr)			90.40	80.70	75.20	69.06
	Heavy Oil – (230-255° C @ 1.6 Torr)			4.60	3.90	18.90	
	SRL		72.84				
	Coal (MAF)	53.47	8.86				
	Ash	9.36	18.30				
	Water	37.17		0.07		0.27	0.68
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		89.15				
	Melting Point °F		292				
	Specific Gravity 60/60			1.028	0.997	1.039	
	Viscosity, cp			49.5	14.1		
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	1	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/19/77

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Water	S-4B Oil
	SAMPLE POINT	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Quantitative	Hydrogen – H_2			4.56	7.28		
	Carbon Monoxide – CO			37.78	92.72		
	Carbon Dioxide – CO_2			48.17			
	Hydrogen Sulfide – H_2S			1.06			
	Methane – CH_4			5.45			
	Ethane – C_2H_6			1.96			
	Propane – C_3H_8			0.91			
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)			0.11		0.12	
	Light Oils – (0-100° C @ 1.6 Torr)		26.17				32.52
	Solvent – (100-230° C @ 1.6 Torr)		59.73				58.42
	Heavy Oil – (230-255° C @ 1.6 Torr)						8.08
	SRL						
	Coal (MAF)						
	Ash						
	Water	100	14.10			99.88	0.98
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						0.941
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/19/77

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

WEIGHT PERCENT

Quantitative

SAMPLE DESCRIPTION	S-4B Btms	S-4A Ovhd	J-1 Disch	Cold Trap	S-7 Btms	
SAMPLE POINT	Sx-23	Sx-30	Sx-32	Sx-33	Sx-39	
Hydrogen – H_2		2.21	1.46			
Carbon Monoxide – CO		19.85	13.58			
Carbon Dioxide – CO_2		67.01	73.16			
Hydrogen Sulfide – H_2S		3.06				
Methane – CH_4		2.83	3.16			
Ethane – C_2H_6		2.55	3.46			
Propane – C_3H_8		1.92	5.18			
Butane – C_4H_{10}						
Nitrogen – N_2		0.47				
Ammonia – NH_3 (PPM)	0.09	0.10				
Light Oils – (0-100° C @ 1.6 Torr)	8.94			25.56	3.68	
Solvent – (100-230°C @ 1.6 Torr)	16.07			26.10	87.40	
Heavy Oil – (230-255°C @1.6 Torr)	2.22			5.83	8.50	
SRL						
Coal (MAF)						
Ash						
Water	72.68			42.51	0.42	
Phenol						
TOTAL	100	100	100	100	100	
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60					1.049	
Viscosity, cp					42.4	

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	3	2	

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/19/77

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	43.96	52.35	29.41	22.10		
Carbon Monoxide – CO	26.00	47.65	18.88	14.66		
Carbon Dioxide – CO_2	21.10		40.56	50.24		
Hydrogen Sulfide – H_2S	0.60		2.40			
Methane – CH_4	6.56		4.72	5.96		
Ethane – C_2H_6	1.26		2.26	3.48		
Propane – C_3H_8	0.40		1.16	3.56		
Butane – C_4H_{10}						
Nitrogen – N_2			0.45			
Ammonia – NH_3 (PPM)	0.12		0.16			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Calc Mole Wt.	19.27	14.39	26.63	30.22		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	3	2	2		

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/20/77

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

MATERIAL OUT

lbs/hour

Temperature: 762°F
Pressure: 2500 psig
LHSV: 1.34
GHSV: 289

Quantitative

STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exh.
SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Hydrogen - H_2	0.97	0.06				0.01
Carbon Monoxide - CO	8.02	0.55				0.06
Carbon Dioxide - CO_2	10.23	1.86				0.30
Hydrogen Sulfide - H_2S	0.23	0.09				
Methane - CH_4	1.16	0.08				0.01
Ethane - C_2H_6	0.42	0.07				0.01
Propane - C_3H_8	0.19	0.05				0.02
Butane - C_4H_{10}						
Nitrogen - N_2		0.02				
Ammonia - NH_3	0.02		0.02			
Light Oil - (0-100° C @ 1.6 Torr)			1.68		0.83	
Solvent - (100-230°C @ 1.6 Torr)			3.03		1.90	
Heavy Oil - (230-255°C @ 1.6 Torr)			0.42			
SRL						
Coal (MAF)						
Ash						
Water			13.69		0.45	
Phenol						
TOTAL	21.24	2.78	18.84	Negl.	3.18	0.41

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/20/77

MATERIAL OUT

Run No: M-33A
Date: 6/21-22/77
Time: 1430-0230

Temperature: 762°F
Pressure: 2500 psig
LHSV: 1.34
GHSV: 289

lbs/hour

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-3 Btms		Total Out
SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.04
Carbon Monoxide - CO						8.63
Carbon Dioxide - CO_2						12.39
Hydrogen Sulfide - H_2S						0.32
Methane - CH_4						1.25
Ethane - C_2H_6						0.50
Propane - C_3H_8						0.26
Butane - C_4H_{10}						
Nitrogen - N_2						0.02
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.17		2.55	1.80		7.03
Solvent - (100-230°C @ 1.6 Torr)	0.18		60.58	9.44		75.13
Heavy Oil - (230-255°C @ 1.6 Torr)	0.04		5.89	0.46		6.81
SRL		13.32				13.32
Coal (MAF)		1.62				1.62
Ash		3.34				3.34
Water	0.28		0.29			14.71
Phenol						
TOTAL	0.67	18.28	69.31	11.70		146.41

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

RUN CONDITIONS

RUN NO. M-33B

DATE MADE 6/22/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 755
- INLET 279
- OUTLET 752

DISSOLVERS
- R-1A (1)
- (2)
- (3)
- (4)
- R-1B (1) 762
- (2) 794
- (3) 790
- (4) 815

REACTOR PRODUCT SEPARATORS
- S-1 588
- S-2 73
- S-3 486
- S-4A 73
- S-4B 68

PREHEATER E-11
- DOWTHERM 680
- INLET 445
- OUTLET 642

VACUUM FLASH F-1
- OVERHEAD VAPOR 513
- UPPER WALL 595
- LOWER WALL 586
- DOWNCOMER 460
- CONDENSATE ACCUMULATOR, S-7 78

PREHEATER E-13
- DOWTHERM 575
- INLET 69
- OUTLET 503

LIGHT ENDS COLUMN, F-2
- REBOILER 439
- LOWER SECTION 506
- FEED SECTION 448
- OVERHEAD 191
- S-8 74
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2: 2500

SEPARATOR S-3: 300

SEPARATORS S-4A and S-4B: 60

VACUUM FLASH, F-1: 15 Torr

LIGHT ENDS COLUMN, F-2: 0

SOLVENT COLUMN, F-3: NIU

HEAVY ENDS COLUMN, F-4: NIU

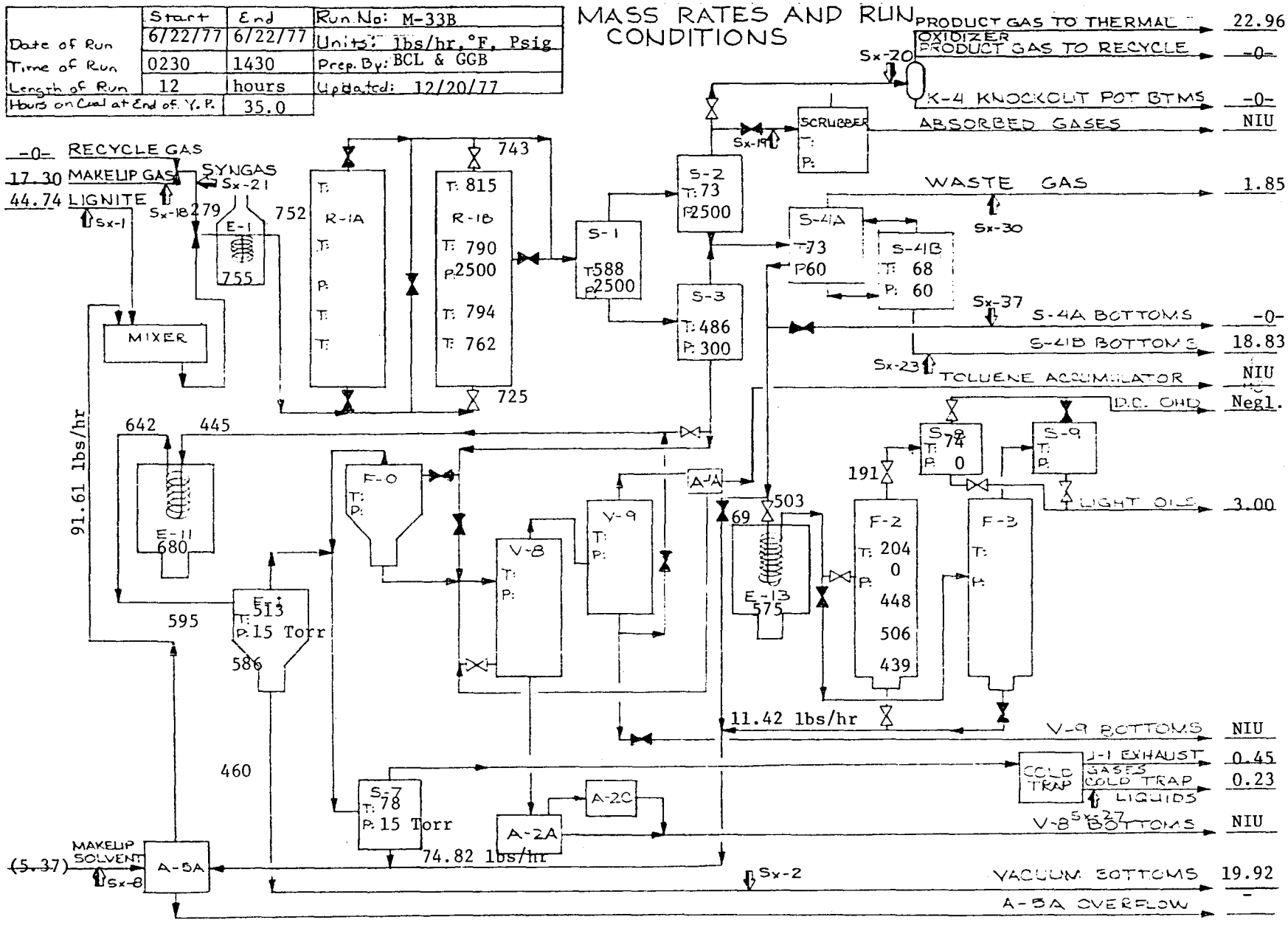
VACUUM FLASH, F-0: NIU

SETTLING TOWER, V-8: NIU

RECOVERY TOWER, V-7: NIU

	Start	End	Run No: M-33B
Date of Run	6/22/77	6/22/77	Units: lbs/hr, °F, Psig
Time of Run	0230	1430	Prep. By: BCL & GGB
Length of Run	12	hours	Updated: 12/20/77
Hours on Coal at End of Y.P.	35.0		

MASS RATES AND RUN CONDITIONS



PRODUCT GAS TO THERMAL	22.96		
OXIDIZER PRODUCT GAS TO RECYCLE	-0-		
K-4 KNOCKOUT POT BTMS	-0-		
ABSORBED GASES	NIU		
WASTE GAS	1.85		
S-4A BOTTOMS	-0-		
S-4B BOTTOMS	18.83		
TOLUENE ACCUMULATOR	NIU		
D.C. OHD	Negl.		
LIGHT OILS	3.00		
V-9 BOTTOMS	NIU		
J-1 EXHAUST GASES	0.45		
COLD TRAP COLD TRAP LIQUIDS	0.23		
V-8 BOTTOMS	NIU		
VACUUM BOTTOMS	19.92		
A-5A OVERFLOW	-		
153.48 TOTAL		TOTAL	153.48

⋈ OPEN ⋈ CLOSED

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
F-1 Btms Increased, then Normalized
Revised: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

SUMMARY

lbs/hour

Temperature: 752°F
Pressure: 2500 psig
LHSV: 1.37
GHSV: 301

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Lignite	
SAMPLE POINT						
Hydrogen - H_2	1.13	1.01	-0.12			
Carbon Monoxide - CO	16.00	8.90	-7.10			
Carbon Dioxide - CO_2		13.23	13.23			
Hydrogen Sulfide - H_2S		0.23	0.23			
Methane - CH_4		1.11	1.11	8.15	34.24	
Ethane - C_2H_6		0.47	0.47			
Propane - C_3H_8		0.29	0.29			
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3		0.04	0.04			
Light Oil - (0-100° C @ 1.6 Torr)	5.62	9.32	3.70			
Solvent - (100-230° C @ 1.6 Torr)	67.29	75.92	8.63	15.86	66.64	
Heavy Oil - (230-255°C @ 1.6 Torr)	18.44	6.77	-11.67			
SRL		15.20	15.20			
Coal (MAF)	23.80	1.31	-22.49		-94.49	
Ash	4.09	3.41	-0.68		-2.86	
Water	17.11	16.27	-0.84		-3.53	
Phenol						
TOTAL	153.48	153.48	-0-			

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

MATERIAL IN

lbs/hour

Temperature: 752°F
Pressure: 2500 psig
LHSV: 1.37
GHSV: 301

Quantitative

STREAM DESCRIPTION	Feed Gas	Lignite	Feed Solvent			Total In
SAMPLE POINT	Sx-21	Sx-1	Sx-14			
Hydrogen - H_2	1.13					1.13
Carbon Monoxide - CO	16.00					16.00
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)			5.62			5.62
Solvent - (100-230° C @ 1.6 Torr)			67.29			67.29
Heavy Oil - (230-255° C @ 1.6 Torr)			18.44			18.44
SRL						
Coal (MAF)		23.80				23.80
Ash		4.09				4.09
Water		16.85	0.26			17.11
Phenol						
TOTAL	17.13	44.74	91.61			153.48

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
F-1 Btms Increased, then Normalized
Revised: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

MATERIAL OUT
lbs/hour

Temperature: 752°F
Pressure: 2500 psig
LHSV: 1.37
GHSV: 301

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	0.97	0.04				
	Carbon Monoxide - CO	8.46	0.38				0.06
	Carbon Dioxide - CO_2	11.64	1.25				0.34
	Hydrogen Sulfide - H_2S	0.19	0.04				
	Methane - CH_4	1.05	0.05				0.01
	Ethane - C_2H_6	0.41	0.04				0.02
	Propane - C_3H_8	0.23	0.04				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3	0.01	0.01	0.02			
	Light Oil - (0-100° C @ 1.6 Torr)			1.08		0.48	
	Solvent - (100-230° C @ 1.6 Torr)			1.96		1.89	
	Heavy Oil - (230-255°C @ 1.6 Torr)			0.27		0.04	
	SRL						
	Coal (MAF)						
	Ash						
	Water			15.50		0.59	
	Phenol						
	TOTAL	22.96	1.85	18.83	Negl.	3.00	* 0.45

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
F-1 Btms Increased, the Normalized
Revised: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

MATERIAL OUT

lbs/hour

Temperature: 752°F
Pressure: 2500 psig
LHSV: 1.37
GHSV: 301

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle Solvent S-7 Btms	F-3 Btms→		Total Out
SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.01
Carbon Monoxide - CO						8.90
Carbon Dioxide - CO_2						13.23
Hydrogen Sulfide - H_2S						0.23
Methane - CH_4						1.11
Ethane - C_2H_6						0.47
Propane - C_3H_8						0.29
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.05		6.63	1.08		9.32
Solvent - (100-230° C @ 1.6 Torr)	0.15		61.88	10.04		75.92
Heavy Oil - (230-255° C @ 1.6 Torr)	0.03		6.13	0.30		6.77
SRL		15.20				15.20
Coal (MAF)		1.31				1.31
Ash		3.41				3.41
Water			0.18			16.27
Phenol						
TOTAL	0.23	19.92	74.82	11.42		153.48

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	Makeup Solvent	F-3 Btms	Feed Solvent	S-8 Oil
	SAMPLE POINT	Sx-1	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			4.53	9.50	6.13	19.86
	Solvent – (100-230° C @ 1.6 Torr)			63.60	87.90	73.45	78.20
	Heavy Oil – (230-255° C @ 1.6 Torr)			31.80	2.60	20.13	1.50
	SRL		76.32				
	Coal (MAF)	53.20	6.59				
	Ash	9.15	17.09				
	Water	37.65		0.07		0.29	0.44
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		92.05				
	Melting Point °F		242				
	Specific Gravity 60/60			1.028	1.004	1.054	
	Viscosity, cp			49.5	18.6	49.3	
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

WEIGHT PERCENT

SAMPLE DESCRIPTION	S-8 Water	S-8 Total	Product Gas	Feed Gas	*S-4B Oil	S-4B Water
SAMPLE POINT	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Hydrogen – H_2			4.20	6.57		
Carbon Monoxide – CO			36.83	93.43		
Carbon Dioxide – CO_2			50.71			
Hydrogen Sulfide – H_2S			0.84			
Methane – CH_4			4.58			
Ethane – C_2H_6			1.80			
Propane – C_3H_8			0.98			
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)			0.06			0.11
Light Oils – (0-100° C @ 1.6 Torr)		16.00			32.03	
Solvent – (100-230° C @ 1.6 Torr)		62.99			58.42	
Heavy Oil – (230-255° C @ 1.6 Torr)		1.21			8.08	
SRL						
Coal (MAF)						
Ash						
Water	100	19.80			1.47	99.89
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60					0.958	
Viscosity, cp						

Quantitative

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

*Insufficient oil sample for distillation. Analysis assumed the same as M-33A

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

WEIGHT PERCENT

SAMPLE DESCRIPTION	S-4B Total	S-4A Ovhd	J-1 Disch.	Cold Trap	S-4A Oil	S-4A Water
SAMPLE POINT	Sx-23	Sx-30	Sx-32	Sx-33	Sx-37	Sx-37
Hydrogen – H_2		1.97	1.12			
Carbon Monoxide – CO		20.27	12.81			
Carbon Dioxide – CO_2		67.70	76.44			
Hydrogen Sulfide – H_2S		2.23				
Methane – CH_4		2.92	2.64			
Ethane – C_2H_6		2.37	3.24			
Propane – C_3H_8		2.27	3.75			
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.09	0.27				0.15
Light Oils – (0-100° C @ 1.6 Torr)	5.72			20.21	28.60	
Solvent – (100-230°C @ 1.6 Torr)	10.43			63.80	71.40	
Heavy Oil – (230-255°C @ 1.6 Torr)	1.44			13.30		
SRL						
Coal (MAF)						
Ash						
Water	82.32			2.69		99.85
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60					0.942	
Viscosity, cp					5.6	

Quantitative

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	1	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

WEIGHT PERCENT

Quantitative

SAMPLE DESCRIPTION	S-4A Total	Recycle Solvent				
SAMPLE POINT	Sx-37	Sx-39				
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2						
Hydrogen Sulfide – H_2S						
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.01	8.86				
Light Oils – (0-100° C @ 1.6 Torr)	27.52	82.70				
Solvent – (100-230° C @ 1.6 Torr)	68.69	8.20				
Heavy Oil – (230-255° C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water	3.78	0.24				
Phenol						
TOTAL	100	100				
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60		1.059				
Viscosity, cp		42.5				

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2				

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

MOLE PERCENT

	SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Exhaust		
	SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Quantitative	Hydrogen – H_2	42.28	49.62	27.02	17.98		
	Carbon Monoxide – CO	26.50	50.38	19.88	14.70		
	Carbon Dioxide – CO_2	23.22		42.26	55.82		
	Hydrogen Sulfide – H_2S	0.50		1.80			
	Methane – CH_4	5.77		5.01	5.29		
	Ethane – C_2H_6	1.21		2.17	3.47		
	Propane – C_3H_8	0.45		1.42	2.74		
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.07		0.44			
	Light Oils – (0-100° C @ 1.6 Torr)						
	Solvent – (100-230° C @ 1.6 Torr)						
	Heavy Oil – (230-255° C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water						
	Phenol						
	TOTAL	100	100	100	100		
	Calc Mole Wt	20.15	15.10	27.47	32.13		
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2		

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

MATERIAL OUT

lbs/hour

Temperature: 752°F
Pressure: 2500 psig
LHSV: 1.37
GHSV: 301

Quantitative

STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Hydrogen - H_2	0.91	0.03				0.01
Carbon Monoxide - CO	7.98	0.35				0.05
Carbon Dioxide - CO_2	10.99	1.18				0.32
Hydrogen Sulfide - H_2S	0.18	0.04				
Methane - CH_4	0.99	0.05				0.01
Ethane - C_2H_6	0.39	0.04				0.01
Propane - C_3H_8	0.21	0.04				0.02
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3	0.01	0.01	0.02			
Light Oil - (0-100° C @ 1.6 Torr)			1.02		0.45	
Solvent - (100-230° C @ 1.6 Torr)			1.85		1.78	
Heavy Oil - (230-255° C @ 1.6 Torr)			0.25		0.04	
SRL						
Coal (MAF)						
Ash						
Water			14.62		0.56	
Phenol						
TOTAL	21.66	1.74	17.76	Negl.	2.83	0.42

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/20/77

Run No: M-33B
Date: 6/22/77
Time: 0230-1430

MATERIAL OUT

Temperature: 752°F
Pressure: 2500 psig
LHSV: 1.37
GHSV: 301

lbs/hour

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-3 Btms		Total Out
SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						0.95
Carbon Monoxide - CO						8.38
Carbon Dioxide - CO_2						12.49
Hydrogen Sulfide - H_2S						0.22
Methane - CH_4						1.05
Ethane - C_2H_6						0.44
Propane - C_3H_8						0.27
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.04		6.63	1.08		9.22
Solvent - (100-230° C @ 1.6 Torr)	0.14		61.88	10.04		75.69
Heavy Oil - (230-255° C @ 1.6 Torr)	0.03		6.13	0.30		6.75
SRL		13.49				13.49
Coal (MAF)		1.16				1.16
Ash		3.02				3.02
Water	0.01		0.18			15.37
Phenol						
TOTAL	0.22	17.67	74.82	11.42		148.54

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

RUN CONDITIONS

RUN NO. M-33C

DATE MADE 6/23-24/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 753
- INLET 266
- OUTLET 741

DISSOLVERS
- R-1A (1)
- (2)
- (3)
- (4)
- R-1B (1) 765
- (2) 799
- (3) 802
- (4) 822

REACTOR PRODUCT SEPARATORS
- S-1 607
- S-2 75
- S-3 440
- S-4A 89
- S-4B 87

PREHEATER E-11
- DOWTHERM 685
- INLET 376
- OUTLET 650

VACUUM FLASH F-1
- OVERHEAD VAPOR 515
- UPPER WALL 621
- LOWER WALL 615
- DOWNCOMER 453
- CONDENSATE ACCUMULATOR, S-7 91

PREHEATER E-13
- DOWTHERM 571
- INLET 99
- OUTLET 505

LIGHT ENDS COLUMN, F-2
- REBOILER 426
- LOWER SECTION 504
- FEED SECTION 422
- OVERHEAD 192
- S-8 90
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD 440
- BOTTOMS 470

PRECIPITATION TOWER, V-8
- ZONE (1) 433
- (2) 437
- (3) 442

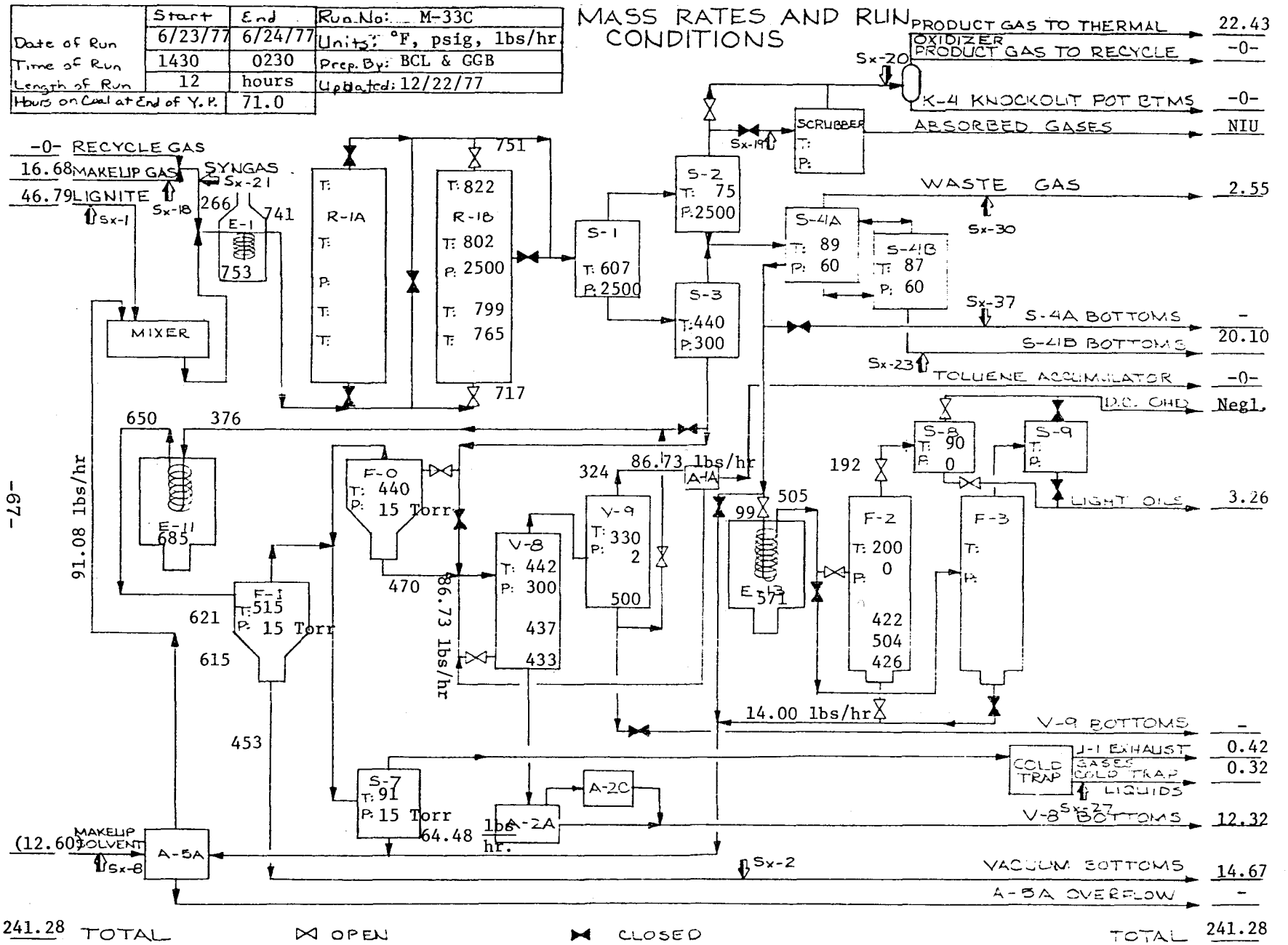
RECOVERY TOWER V-9
- REBOILER 500
- OVERHEAD 324

PRESSURE, psig

- SEPARATORS S-1 and S-2: 2500
- SEPARATOR S-3: 300
- SEPARATORS S-4A and S-4B: 60
- VACUUM FLASH, F-1: 15 Torr
- LIGHT ENDS COLUMN, F-2: 0
- SOLVENT COLUMN, F-3: NIU
- HEAVY ENDS COLUMN, F-4: NIU
- VACUUM FLASH, F-0: 15 Torr
- SETTLING TOWER, V-8: 300
- RECOVERY TOWER, V-7: 2

	Start	End	Run No: M-33C
Date of Run	6/23/77	6/24/77	Units: °F, psig, lbs/hr
Time of Run	1430	0230	Prep. By: BCL & GGB
Length of Run	12	hours	Updated: 12/22/77
Hours on Coal at End of Y.P.	71.0		

MASS RATES AND RUN CONDITIONS



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
V-9 Ovhd and V-8 Btms Adjusted with Forced Ash Balance
Revised 12/22/77

Run No: M-33C
Date: 6/23/77
Time: 1430-0230

SUMMARY

lbs/hour

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.49
GHSV: 301

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Lignite	
	SAMPLE POINT						
Quantitative	Hydrogen - H_2	1.16	1.12	-0.04			
	Carbon Monoxide - CO	15.52	7.69	-7.83			
	Carbon Dioxide - CO_2		14.65	14.65			
	Hydrogen Sulfide - H_2S		0.23	0.23	8.74	34.06	
	Methane - CH_4		0.96	0.96			
	Ethane - C_2H_6		0.42	0.42			
	Propane - C_3H_8		0.33	0.33			
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3		0.02	0.02			
	Light Oil - (0-100° C @ 1.6 Torr)	98.89	104.27	5.38			
	Solvent - (100-230°C @ 1.6 Torr)	74.81	70.69	-4.12	16.27	63.40	
	Heavy Oil - (230-255°C @ 1.6 Torr)	3.92	4.20	0.28			
	SRL		14.73	14.73			
	Coal (MAF)	25.66	3.03	-22.63		-88.19	
	Ash	3.97	3.97	-0-		-0-	
	Water	17.35	14.97	-2.38		-9.27	
	Phenol						
	TOTAL	241.28	241.28	-0-			
Elemental	Carbon	182.52	182.84	0.32			
	Hydrogen	19.15	19.26	0.11			
	Nitrogen	0.26	0.37	0.11			
	Sulfur	1.80	1.68	-0.12			
	Oxygen (by diff)	33.58	33.16	-0.42			
	Ash	3.97	3.97	-0-			
	TOTAL	241.28	241.28	-0-			

PROJECT LIGNITE
ADJUSTED & MEASURED MATERIAL BALANCE
Updated: 12/22/77

Run No: M-33C
Date: 6/23/77
Time: 1430-0230

MATERIAL IN

lbs/hr

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.49
GHSV: 301

	STREAM DESCRIPTION	Feed Gas	Lignite	Feed Solvent	Feed Toluene		Total In
	SAMPLE POINT	Sx-21	Sx-1	Sx-14	Sx-40		
Quantitative	Hydrogen - H_2	1.16					1.16
	Carbon Monoxide - CO	15.52					15.52
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)			13.29	85.60		98.89
	Solvent - (100-230°C @ 1.6 Torr)			73.68	1.13		74.81
	Heavy Oil - (230-255°C @ 1.6 Torr)			3.92			3.92
	SRL						
	Coal (MAF)		25.66				25.66
	Ash		3.97				3.97
	Water		17.16	0.19			17.35
	Phenol						
	TOTAL	16.68	46.79	91.08	86.73		241.28

Elemental	Carbon	6.65	17.91	78.83	79.13		182.52
	Hydrogen	1.16	3.20	7.25	7.54		19.15
	Nitrogen		0.24	0.02			0.26
	Sulfur		0.33	1.45	0.02		1.80
	Oxygen (by diff)	8.87	21.14	3.53	0.04		33.58
	Ash		3.97				3.97
	TOTAL	16.68	46.79	91.08	86.73		241.28

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

V-9 Ovhd and V-8 Btms Adjusted with Forced Ash Balance

Revised: 12/22/77

Run No: M-33C
Date: 6/23/77
Time: 1430-0230

MATERIAL OUT

lbs/hour

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.49
GHSV: 301

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
Quantitative	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
	Hydrogen - H_2	1.08	0.04				
	Carbon Monoxide - CO	7.30	0.35				0.04
	Carbon Dioxide - CO_2	12.42	1.89				0.34
	Hydrogen Sulfide - H_2S	0.16	0.07				
	Methane - CH_4	0.89	0.06				0.01
	Ethane - C_2H_6	0.35	0.06				0.01
	Propane - C_3H_8	0.23	0.08				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3			0.02			
	Light Oil - (0-100° C @ 1.6 Torr)			2.49		3.11	
	Solvent - (100-230°C @ 1.6 Torr)			2.81		0.13	
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water			14.78		0.02	
	Phenol						
	TOTAL	22.43	2.55	20.10	Negl.	3.26	0.42
Elemental	Carbon	7.66	0.82	4.70		2.60	0.14
	Hydrogen	1.42	0.09	2.11		0.34	0.01
	Nitrogen			0.02		0.01	
	Sulfur	0.15	0.07	0.04		0.01	
	Oxygen (by diff)	13.20	1.57	13.23		0.30	0.27
	Ash						
	TOTAL	22.43	2.55	20.10	Negl	3.26	0.42

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

V-9 Ovhd and V-8 Btms Adjusted With Forced Ash Balance

Revised: 12/22/77

Run No: M-33C
Date: 6/23/77
Time: 1430-0230

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.49
GHSV: 301

MATERIAL OUT

lbs/hour

	STREAM DESCRIPTION	Cold Trap	V-8 Btms	F-1 Btms	V-9 Ovhd	←Recycle S-7 Btms	Solvent→ F-3 Btms
	SAMPLE POINT	Sx-33	Calc	Sx-2	Sx-28	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	0.31	2.95		82.65	11.75	1.01
	Solvent - (100-230° C @ 1.6 Torr)	0.01	1.94	0.37	4.08	48.88	12.47
	Heavy Oil - (230-255°C @1.6 Torr)					3.68	0.52
	SRL		0.46	14.27			
	Coal (MAF)		3.03				
	Ash		3.94	0.03			
	Water					0.17	
	Phenol						
	TOTAL	0.32	12.32	14.67	86.73	64.48	14.00
Elemental	Carbon	0.25	6.88	12.57	78.99	55.74	12.49
	Hydrogen	0.03	0.59	0.88	7.51	5.09	1.19
	Nitrogen		0.04	0.12		0.14	0.04
	Sulfur	0.01	0.07	0.14	0.07	0.93	0.19
	Oxygen (by diff)	0.03	0.80	0.93	0.16	2.58	0.09
	Ash		3.94	0.03			
	TOTAL	0.32	12.32	14.67	86.73	64.48	14.00

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
V-9 Ovhd and V-8 Btms Adjusted with Forced Ash Balance
Revised: 12/22/77

Run No: M-33C
Date: 6/23/77
Time: 1430-0230

MATERIAL OUT

lbs/hour

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.49
GHSV: 301

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.12
Carbon Monoxide - CO						7.69
Carbon Dioxide - CO_2						14.65
Hydrogen Sulfide - H_2S						0.23
Methane - CH_4						0.96
Ethane - C_2H_6						0.42
Propane - C_3H_8						0.33
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						0.02
Light Oil - (0-100° C @ 1.6 Torr)						104.27
Solvent - (100-230°C @ 1.6 Torr)						70.69
Heavy Oil - (230-255°C @ 1.6 Torr)						4.20
SRL						14.73
Cool (MAF)						3.03
Ash						3.97
Water						14.97
Phenol						
TOTAL						241.28

Elemental

Carbon						182.84
Hydrogen						19.26
Nitrogen						0.37
Sulfur						1.68
Oxygen (by diff)						33.16
Ash						3.97
TOTAL						241.28

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: M-33C
Date: 1430-0230
Time: 6/23-24/77

WEIGHT PERCENT

Quantitative

SAMPLE DESCRIPTION	Lignite	F-1 Btms	Makeup Solvent	F-2 Btms	Feed Solvent	S-8 Oil
SAMPLE POINT	Sx-1	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2						
Hydrogen Sulfide – H_2S						
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)						
Light Oils – (0-100° C @ 1.6 Torr)			5.01	7.20	14.59	95.33
Solvent – (100-230°C @ 1.6 Torr)		2.50	84.50	89.10	80.90	4.00
Heavy Oil – (230-255°C @1.6 Torr)			10.20	3.70	4.30	
SRL		97.32				
Coal (MAF)	54.84					
Ash	8.48	0.18				
Water	36.68		0.29		0.21	0.67
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)		100				
Melting Point °F		193				
Specific Gravity 60/60			1.038	1.008	1.034	
Viscosity, cp			57.4	16.8	28.2	

Elemental

Carbon	38.28	85.73	87.58	89.21	86.55	79.84
Hydrogen	6.83	5.98	8.18	8.54	7.96	10.41
Nitrogen	0.51	0.80	0.12	0.28	0.02	0.24
Sulfur	0.71	0.94	2.00	1.34	1.59	0.19
Oxygen (by diff)	45.19	6.37	2.12	0.63	3.88	9.32
Ash	8.48	0.18				
TOTAL	100	100	100	100	100	100
Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: M-33C
Date: 6/23-24/77
Time: 1430-0230

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water
	SAMPLE POINT	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Quantitative	Hydrogen – H_2			4.81	6.95		
	Carbon Monoxide – CO			32.53	93.05		
	Carbon Dioxide – CO_2			55.37			
	Hydrogen Sulfide – H_2S			0.70			
	Methane – CH_4			3.97			
	Ethane – C_2H_6			1.57			
	Propane – C_3H_8			1.03			
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)			0.02			0.11
	Light Oils – (0-100° C @ 1.6 Torr)		95.33			44.94	
	Solvent – (100-230° C @ 1.6 Torr)		4.00			50.79	
	Heavy Oil – (230-255° C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water	100	0.67			4.27	99.89
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60					0.954	
	Viscosity, cp						
Elemental	Carbon		79.84	34.12	39.88	84.88	
	Hydrogen	11.11	10.41	6.34	6.95	8.76	11.12
	Nitrogen		0.24	0.02		0.22	0.09
	Sulfur		0.19	0.66		0.74	
	Oxygen (by diff)	88.89	9.32	58.86	53.17	5.40	88.79
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: M-33C
Date: 6/23-24/77
Time: 1430-0230

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Total	V-8 Btms	V-9 Ovhd	S-4A Ovhd	J-1 Exhaust	Cold Trap
Quantitative	SAMPLE POINT	Sx-23	Sx-27	Sx-28	Sx-30	Sx-32	Sx-33
	Hydrogen – H_2				1.80	1.17	
	Carbon Monoxide – CO				13.74	8.43	
	Carbon Dioxide – CO_2				74.01	80.85	
	Hydrogen Sulfide – H_2S				2.76		
	Methane – CH_4				2.42	2.42	
	Ethane – C_2H_6				2.17	3.02	
	Propane – C_3H_8				2.96	4.11	
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.08			0.14		
	Light Oils – (0-100° C @ 1.6 Torr)	12.38		95.30			96.40
	Solvent – (100-230°C @ 1.6 Torr)	13.99		4.70			2.35
	Heavy Oil – (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						0.35
	Water	73.55					0.90
	Phenol						
	TOTAL	100	NA	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60			0.868			
	Viscosity, cp						
Elemental	Carbon	23.38		91.08	32.05	33.26	78.60
	Hydrogen	10.47		8.66	3.55	3.12	10.53
	Nitrogen	0.12			0.12		0.36
	Sulfur	0.20		0.08	2.60		1.84
	Oxygen (by diff)	65.83		0.18	61.68	63.62	8.32
	Ash						0.35
	TOTAL	100	NA	100	100	100	100
	Number of Sample Avg.	2		2	2	2	1

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: M-33C
Date: 6/23-24/77
Time: 1430-0230

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-7 Btms	Feed Toluene		V-8 Btms		
	SAMPLE POINT	Sx-39	Sx-40		*Calc.		
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)	18.23	98.70		23.94		
	Solvent – (100-230°C @ 1.6 Torr)	75.80	1.30		15.75		
	Heavy Oil – (230-255°C @1.6 Torr)	5.70					
	SRL				3.73		
	Coal (MAF)				24.60		
	Ash				31.98		
	Water	0.27	0.27				
	Phenol						
	TOTAL	100	100		100		
	Pyridine Solubles (Wt % Ash free)				57.51		
	Melting Point °F						
	Specific Gravity 60/60	1.033					
	Viscosity, cp	22.7					
Elemental	Carbon	86.44	91.24		55.84		
	Hydrogen	7.89	8.69		4.77		
	Nitrogen	0.22			0.30		
	Sulfur	1.45	0.02		0.59		
	Oxygen (by diff)	4.00	0.05		6.52		
	Ash				31.98		
	TOTAL	100	100		100		
	Number of Sample Avg.	2	2		-		

*Analysis calculated by material balance around the deashing unit.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: M-33C
Date: 6/23-24/77
Time: 1430-0230

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	46.53	51.11	26.11	19.10		
Carbon Monoxide – CO	22.46	48.89	14.20	9.81		
Carbon Dioxide – CO_2	24.33		48.68	59.85		
Hydrogen Sulfide – H_2S	0.40		2.35			
Methane – CH_4	4.80		4.38	4.92		
Ethane – C_2H_6	1.01		2.09	3.28		
Propane – C_3H_8	0.45		1.95	3.04		
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.02		0.24			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230° C @ 1.6 Torr)						
Heavy Oil – (230-255° C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Mole Wt (Calc)	19.33	14.71	28.94	32.57		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2		

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: M-33C
DATE: 6/23-24/77
TIME: 1430-0230

SAMPLE DESCRIPTION	F-1 Btms	Makeup Solv	F-3 Btms	Feed Solv	S-8 Oil
SAMPLE POINT	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5	5	
IBP		70.2	89.5	70.2	
5%		121.0	114.2	98.8	
10%		142.6	116.0	114.8	
20%		185.2	123.6	137.8	
30%		188.8	131.6	162.0	
40%		191.0	145.4	168.6	
50%		196.2	160.4	183.3	
60%		203.0	173.4	189.2	
70%		212.0	182.4	195.6	
80%		230.0	190.6	203.6	
90%		248.6	206.8	223.8	
95%		260.0	222.2	231.0	
DRY PT.			222.2	231.0	
VOLUME PERCENT — TEMPERATURE, °C					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR					744
IBP					79
5%					99
10%					130
20%					152
30%					168
40%					184
50%					191
60%					199
70%					208
80%					216
90%					223
95%					-
DRY PT.					216
VOLUME PERCENT — TEMPERATURE, °C					
ASPHALTENE TEST					
WT % ASH	0.18				
WT % UNCONVERTED COAL	-				
WT % PRE-ASPHALTENES	21.20				
WT % ASPHALTENES	36.46				
WT % MALTENES & DIST. OIL	42.16				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		16.1	11.1	12.7	
210° F		8.8	8.6	8.7	
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)		0.29	0.00	0.21	1.16
INFRARED RATIO					
SP. GRAV. 60/60 F		1.038	1.008	1.034	

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION. USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: M-33C
DATE: 6/23-24/77
TIME: 1430-0230

SAMPLE DESCRIPTION	V-9 Btms	Cold TRap	S-7 Btms	S-4A Oil	Recycle Solv
SAMPLE POINT	Sx-28	Sx-33	Sx-34	Sx-37	Sx-39
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5		5		5
IBP	123.0		81.0		63.6
5%	170.0		106.5		95.4
10%	180.0		121.0		114.8
20%	188.5		144.7		136.5
30%	195.0		169.3		158.6
40%	204.0		178.3		170.8
50%	213.0		185.0		179.5
60%	225.0		191.0		184.3
70%	245.0		199.0		192.8
80%	260.0		209.0		200.6
90%			229.0		223.0
95%					239.3
DRY PT.			229.0		239.3
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR		742		742	
IBP		69		80	
5%		78		164	
10%		96		190	
20%		125		200	
30%		146		208	
40%		162		212	
50%		176		217	
60%		187		231	
70%		193		268	
80%		201		308	
90%		211		336	
95%					
DRY PT.		215		340	
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					11.8
210° F					8.6
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)		0.90			0.27
INFRARED RATIO					
SP. GRAV. 60/60 F				0.960	1.033

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION. USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: M-33C
DATE: 6/23-24/77
TIME: 1430-0230

SAMPLE DESCRIPTION	Deashing Solv.				
SAMPLE POINT	Sx-40				
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR					
IBP					
5%					
10%					
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
95%					
DRY PT.					
VOLUME PERCENT — TEMPERATURE, °C					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	744				
IBP	111				
5%	112				
10%	112				
20%	112				
30%	112				
40%	112				
50%	112				
60%	112				
70%	112				
80%	113				
90%	114				
95%					
DRY PT.	130				
VOLUME PERCENT — TEMPERATURE, °C					
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)					
INFRARED RATIO					
SP. GRAV. 60/60 F	0.867				

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES - BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES - N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION, USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/22/77

Run No: M-33C
Date: 6/23/77
Time: 1430-0230

MATERIAL OUT

lbs/hour

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.49
GHSV: 301

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
Quantitative	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
	Hydrogen - H_2	1.08	0.04				
	Carbon Monoxide - CO	7.30	0.35				0.04
	Carbon Dioxide - CO_2	12.42	1.89				0.34
	Hydrogen Sulfide - H_2S	0.16	0.07				
	Methane - CH_4	0.89	0.06				0.01
	Ethane - C_2H_6	0.35	0.06				0.01
	Propane - C_3H_8	0.23	0.08				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3			0.02			
	Light Oil - (0-100° C @ 1.6 Torr)			2.49		3.11	
	Solvent - (100-230°C @ 1.6 Torr)			2.81		0.13	
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water			14.78		0.02	
	Phenol						
	TOTAL	22.43	2.55	20.10	Negl	3.26	0.42
Elemental	Carbon	7.66	0.82	4.70		2.60	0.14
	Hydrogen	1.42	0.09	2.11		0.34	0.01
	Nitrogen			0.02		0.01	
	Sulfur	0.15	0.07	0.04		0.01	
	Oxygen (by diff)	13.20	1.57	13.23		0.30	0.27
	Ash						
	TOTAL	22.43	2.55	20.10	Negl.	3.26	0.42

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/22/77

Run No: M-33C
Date: 6/23/77
Time: 1430-0230

MATERIAL OUT

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.49
GHSV: 301

lbs/hour

	STREAM DESCRIPTION	Cold Trap	*V-8 Btms	F-1 Btms	V-9 Ovhd	← Recycle S-7 Btms	Solvent → F-3 Btms
	SAMPLE POINT	Sx-33	Sx-27	Sx-2	Sx-28	Sx-39	**Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	0.31			87.49	11.75	1.01
	Solvent - (100-230°C @ 1.6 Torr)	0.01		0.37	4.31	48.88	12.47
	Heavy Oil - (230-255°C @1.6 Torr)					3.68	0.52
	SRL			14.27			
	Coal (MAF)						
	Ash			0.03			
	Water					0.17	
	Phenol						
	TOTAL	0.32	-0-	14.67	91.80	64.48	14.00
Elemental	Carbon	0.25		12.57	83.61	55.74	12.49
	Hydrogen	0.03		0.88	7.95	5.09	1.19
	Nitrogen			0.12		0.14	0.04
	Sulfur	0.01		0.14	0.07	0.93	0.19
	Oxygen (by diff)	0.03		0.93	0.17	2.58	0.09
	Ash			0.03			
	TOTAL	0.32	-0-	14.67	91.80	64.48	14.00

* Settling tower bottoms line plugged. Unable to remove solids.
** Flow rate estimated.

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/22/77

Run No: M-33C
Date: 6/23/77
Time: 1430-0230

MATERIAL OUT

lbs/hour

Temperature: 741°F
Pressure: 2500 psig
LHSV 1.49
GHSV: 301

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.12
Carbon Monoxide - CO						7.69
Carbon Dioxide - CO_2						14.65
Hydrogen Sulfide - H_2S						0.23
Methane - CH_4						0.96
Ethane - C_2H_6						0.42
Propane - C_3H_8						0.33
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						0.02
Light Oil - (0-100° C @ 1.6 Torr)						106.16
Solvent - (100-230° C @ 1.6 Torr)						68.98
Heavy Oil - (230-255°C @ 1.6 Torr)						4.20
SRL						14.27
Coal (MAF)						
Ash						0.03
Water						14.97
Phenol						
TOTAL						234.03

Elemental

Carbon						180.58
Hydrogen						19.11
Nitrogen						0.33
Sulfur						1.61
Oxygen (by diff)						32.37
Ash						0.03
TOTAL						234.03

RUN CONDITIONS

RUN NO. M-33D
DATE MADE 6/24/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 756
- INLET 266
- OUTLET 749

DISSOLVERS
- R-1A (1) ____
- (2) ____
- (3) ____
- (4) ____
- R-1B (1) 768
- (2) 804
- (3) 806
- (4) 828

REACTOR PRODUCT SEPARATORS
- S-1 607
- S-2 73
- S-3 492
- S-4A 81
- S-4B 79

PREHEATER E-11
- DOWTHERM 685
- INLET 434
- OUTLET 657

VACUUM FLASH F-1
- OVERHEAD VAPOR 523
- UPPER WALL 616
- LOWER WALL 619
- DOWNCOMER 456
- CONDENSATE ACCUMULATOR, S-7 86

PREHEATER E-13
- DOWTHERM 571
- INLET 82
- OUTLET 479

LIGHT ENDS COLUMN, F-2
- REBOILER 416
- LOWER SECTION 502
- FEED SECTION 424
- OVERHEAD 193
- S-8 83
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION ____
- FEED SECTION ____
- OVERHEAD ____

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION ____
- FEED SECTION ____
- OVERHEAD ____

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS ____

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2) ____
- (3) ____

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD ____

PRESSURE, psig

SEPARATORS S-1 and S-2
2500

SEPARATOR S-3
300

SEPARATORS S-4A and S-4B
60

VACUUM FLASH, F-1
15 Torr

LIGHT ENDS COLUMN, F-2
0

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

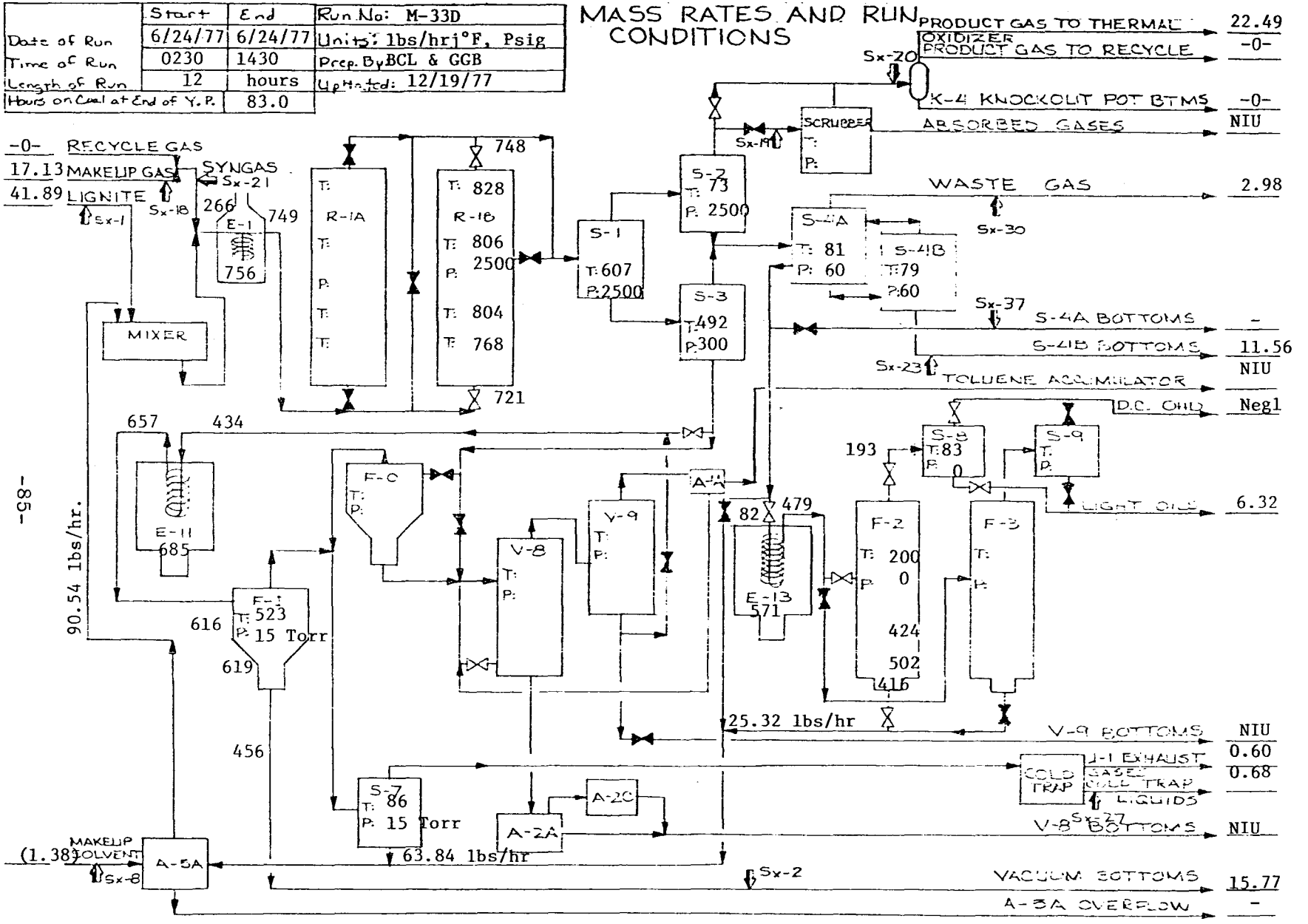
VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU

	Start	End	Run No: M-33D
Date of Run	6/24/77	6/24/77	Units: lbs/hr j °F, Psig
Time of Run	0230	1430	Prep. By BCL & GGB
Length of Run	12	hours	Updated: 12/19/77
Hours on Coal at End of Y.P.	83.0		

MASS RATES AND RUN CONDITIONS



PRODUCT GAS TO THERMAL OXIDIZER	22.49	149.56 TOTAL	
PRODUCT GAS TO RECYCLE	-0-		
K-4 KNOCKOUT POT BTMS	-0-		
ABSORBED GASES	NIU		
WASTE GAS	2.98		
S-4A BOTTOMS	-		
S-4B BOTTOMS	11.56		
TOLUENE ACCUMULATOR	NIU		
D.C. OHD	Negl		
LIGHT OIL	6.32		
V-9 BOTTOMS	NIU		
J-1 EXHAUST GASES	0.60		
COLD TRAP CUT TRAP LIQUIDS	0.68		
V-8 BOTTOMS	NIU		
VACUUM BOTTOMS	15.77		
A-3A OVERFLOW	-	TOTAL	149.56

⋈ OPEN ⋈ CLOSED

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

SUMMARY

Temperature: 749°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 306

lbs/hour

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Lignite	
Quantitative	SAMPLE POINT						
	Hydrogen - H_2	1.16	1.24	0.08			
	Carbon Monoxide - CO	15.97	9.08	-6.89			
	Carbon Dioxide - CO_2		13.86	13.86			
	Hydrogen Sulfide - H_2S		0.36	0.36			
	Methane - CH_4		0.93	0.93			
	Ethane - C_2H_6		0.37	0.37	8.95	39.15	
	Propane - C_3H_8		0.21	0.21			
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3		0.03	0.03			
	Light Oil - (0-100° C @ 1.6 Torr)	5.89	9.79	3.90			
	Solvent - (100-230°C @ 1.6 Torr)	77.49	78.08	0.59	14.18	62.03	
	Heavy Oil - (230-255°C @ 1.6 Torr)	7.00	6.54	-0.46			
	SRL		10.15	10.15			
	Coal (MAF)	22.86	2.44	-20.42		-89.32	
	Ash	3.92	3.18	-0.74		-3.24	
	Water	15.27	13.30	-1.97		-8.62	
	Phenol						
	TOTAL	149.56	149.56	-0-			
Elemental	Carbon	102.16	101.70	-0.46			
	Hydrogen	11.17	11.71	0.54			
	Nitrogen	0.37	0.44	0.07			
	Sulfur	1.96	1.91	-0.05			
	Oxygen (by diff)	29.98	30.62	0.64			
	Ash	3.92	3.18	-0.74			
	TOTAL	149.56	149.56	-0-			

PROJECT LIGNITE
ADJUSTED & MEASURED MATERIAL BALANCE
Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

MATERIAL IN

lbs/hour

Temperature: 749°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 306

	STREAM DESCRIPTION	Feed Gas	Lignite	Feed Solvent			Total In
Quantitative	SAMPLE POINT	Sx-21	Sx-1	Sx-14			
	Hydrogen - H_2	1.16					1.16
	Carbon Monoxide - CO	15.97					15.97
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)			5.89			5.89
	Solvent - (100-230° C @ 1.6 Torr)			77.49			77.49
	Heavy Oil - (230-255°C @ 1.6 Torr)			7.00			7.00
	SRL						
	Coal (MAF)		22.86				22.86
	Ash		3.92				3.92
	Water		15.11	0.16			15.27
	Phenol						
	TOTAL	17.13	41.89	90.54			149.56
Elemental	Carbon	6.85	15.95	79.36			102.16
	Hydrogen	1.16	2.83	7.18			11.17
	Nitrogen		0.21	0.16			0.37
	Sulfur		0.30	1.66			1.96
	Oxygen (by diff)	9.12	18.68	2.18			29.98
	Ash		3.92				3.92
	TOTAL	17.13	41.89	90.54			149.56

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

MATERIAL OUT

lbs/hour

Temperature: 749°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 306

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.15	0.08				0.01
	Carbon Monoxide - CO	8.33	0.67				0.08
	Carbon Dioxide - CO_2	11.43	1.97				0.46
	Hydrogen Sulfide - H_2S	0.29	0.07				
	Methane - CH_4	0.84	0.08				0.01
	Ethane - C_2H_6	0.29	0.06				0.02
	Propane - C_3H_8	0.14	0.05				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3	0.02		0.01			
	Light Oil - (0-100° C @ 1.6 Torr)			0.26		3.53	
	Solvent - (100-230°C @ 1.6 Torr)			0.25		1.06	
	Heavy Oil - (230-255°C @ 1.6 Torr)			0.03			
	SRL						
	Coal (MAF)						
	Ash						
	Water			11.01		1.73	
	Phenol						
	TOTAL	22.49	2.98	11.56	Negl	6.32	0.60
Elemental	Carbon	7.67	0.97	0.45		4.02	0.20
	Hydrogen	1.46	0.12	1.27		0.65	0.02
	Nitrogen	0.01	0.01	0.01		0.03	
	Sulfur	0.27	0.07	0.01		0.05	
	Oxygen (by diff)	13.08	1.81	9.82		1.57	0.38
	Ash						
	TOTAL	22.49	2.98	11.56	Negl.	6.32	0.60

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

MATERIAL OUT

lbs/hour

Temperature: 749°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 306

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-2 Btms		Total Out
SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.24
Carbon Monoxide - CO						9.08
Carbon Dioxide - CO_2						13.86
Hydrogen Sulfide - H_2S						0.36
Methane - CH_4						0.93
Ethane - C_2H_6						0.37
Propane - C_3H_8						0.21
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						0.03
Light Oil - (0-100° C @ 1.6 Torr)	0.06		4.44	1.50		9.79
Solvent - (100-230°C @ 1.6 Torr)	0.14		53.69	22.94		78.08
Heavy Oil - (230-255°C @ 1.6 Torr)	0.01		5.62	0.88		6.54
SRL		10.15				10.15
Coal (MAF)		2.44				2.44
Ash		3.18				3.18
Water	0.47		0.09			13.30
Phenol						
TOTAL	0.68	15.77	63.84	25.32		149.56

Elemental

Carbon	0.18	10.72	55.21	22.28		101.70
Hydrogen	0.07	0.71	5.20	2.21		11.71
Nitrogen		0.14	0.17	0.07		0.44
Sulfur		0.14	1.05	0.32		1.91
Oxygen (by diff)	0.43	0.88	2.21	0.44		30.62
Ash		3.18				3.18
TOTAL	0.68	15.77	63.84	25.32		149.56

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

WEIGHT PERCENT

SAMPLE DESCRIPTION	Lignite	F-1 Btms	Makeup Solvent	F-3 Btms	Feed Solvent	S-8 Oil
SAMPLE POINT	Sx-1	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative						
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2						
Hydrogen Sulfide – H_2S						
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)						
Light Oils – (0-100° C @ 1.6 Torr)			5.01	5.93	6.51	73.40
Solvent – (100-230° C @ 1.6 Torr)			84.50	90.60	85.58	22.05
Heavy Oil – (230-255° C @ 1.6 Torr)			10.20	3.47	7.73	
SRL		64.36				
Coal (MAF)	54.56	15.47				
Ash	9.36	20.17				
Water	36.08		0.29		0.18	4.55
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)		80.62				
Melting Point °F		319				
Specific Gravity 60/60			1.038	1.007	1.043	
Viscosity, cp			57.4	17.5	40.42	
Elemental						
Carbon	38.09	68.00	87.58	88.00	87.65	83.73
Hydrogen	6.75	4.51	8.18	8.73	7.93	9.98
Nitrogen	0.50	0.86	0.12	0.27	0.18	0.53
Sulfur	0.71	0.90	2.00	1.27	1.83	1.14
Oxygen (by diff)	44.59	5.56	2.12	1.73	2.41	4.62
Ash	9.36	20.17				
TOTAL	100	100	100	100	100	100
Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water
	SAMPLE POINT	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Quantitative	Hydrogen – H_2			5.12	6.79		
	Carbon Monoxide – CO			37.05	93.21		
	Carbon Dioxide – CO_2			50.83			
	Hydrogen Sulfide – H_2S			1.28			
	Methane – CH_4			3.73			
	Ethane – C_2H_6			1.31			
	Propane – C_3H_8			0.61			
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)			0.07			0.10
	Light Oils – (0-100° C @ 1.6 Torr)		55.81			47.83	
	Solvent – (100-230° C @ 1.6 Torr)		16.76			47.37	
	Heavy Oil – (230-255° C @ 1.6 Torr)					4.81	
	SRL						
	Coal (MAF)						
	Ash						
	Water	100	27.43				99.90
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon		63.66	34.09	39.95	84.89	
	Hydrogen	11.11	10.25	6.51	6.79	8.76	11.12
	Nitrogen		0.40	0.06		0.22	0.08
	Sulfur		0.87	1.20		1.36	
	Oxygen (by diff)	88.89	24.82	58.14	53.26	4.77	88.80
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Total	S-4A Ovhd	J-1 Dish.	Cold Trap	Recycle Solvent	
	SAMPLE POINT	Sx-23	Sx-30	Sx-32	Sx-33	Sx-39	
Quantitative	Hydrogen – H_2		2.60	1.49			
	Carbon Monoxide – CO		22.33	13.87			
	Carbon Dioxide – CO_2		65.98	76.77			
	Hydrogen Sulfide – H_2S		2.29				
	Methane – CH_4		2.74	2.48			
	Ethane – C_2H_6		2.05	2.65			
	Propane – C_3H_8		1.74	2.74			
	Butane – C_4H_{10}						
	Nitrogen – N_2		0.17				
	Ammonia – NH_3 (PPM)	0.10	0.10				
	Light Oils – (0-100° C @ 1.6 Torr)	2.21			8.48	6.96	
	Solvent – (100-230° C @ 1.6 Torr)	2.19			21.08	84.10	
	Heavy Oil – (230-255° C @ 1.6 Torr)	0.22			1.69	8.80	
	SRL						
	Coal (MAF)						
	Ash						
	Water	95.28			68.75	0.14	
	Phenol						
	TOTAL	100	100	100	100	100	
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60					1.048	
	Viscosity, cp					43.30	

Elemental	Carbon	3.92	32.68	33.10	26.51	86.48	
	Hydrogen	11.01	4.16	3.14	10.26	8.15	
	Nitrogen	0.09	0.25		0.10	0.27	
	Sulfur	0.06	2.16		0.52	1.64	
	Oxygen (by diff)	84.92	60.75	63.76	62.61	3.46	
	Ash						
	TOTAL	100	100	100	100	100	
	Number of Sample Avg.	2	2	2	2	2	

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	47.66	50.50	32.89	22.62		
Carbon Monoxide – CO	24.64	49.50	20.16	15.06		
Carbon Dioxide – CO_2	21.51		37.90	53.03		
Hydrogen Sulfide – H_2S	0.70		1.70			
Methane – CH_4	4.34		4.32	4.72		
Ethane – C_2H_6	0.81		1.73	2.68		
Propane – C_3H_8	0.26		1.00	1.89		
Butane – C_4H_{10}						
Nitrogen – N_2			0.15			
Ammonia – NH_3 (PPM)	0.08		0.15			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230° C @ 1.6 Torr)						
Heavy Oil – (230-255° C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Mole Wt (Calc)	18.62	14.87	25.27	30.39		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2		

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: M-44D
DATE: 6/24/77
TIME: 0230-1430

SAMPLE DESCRIPTION	F-1 Btms	Makeup Solv	LEC Btms	Feed Solv.	Cold trap Oil
SAMPLE POINT	Sx-2	Sx-8	Sx-12	Sx-14	Sx-33
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5	5	
VOLUME PERCENT / TEMPERATURE, °C — IBP		70.2	105.0	80.0	
5%		121.0	117.5	108.5	
10%		142.6	120.0	121.0	
20%		185.2	127.0	150.8	
30%		188.8	140.0	169.8	
40%		191.0	143.0	178.0	
50%		196.2	157.0	185.2	
60%		203.0	172.3	191.6	
70%		212.0	181.0	199.0	
80%		230.0	188.6	207.3	
90%		248.6	201.0	239.6	
95%		260.0	218.0	260.0	
DRY PT.					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR					747
VOLUME PERCENT / TEMPERATURE, °C — IBP					86
5%					98
10%					100
20%					101
30%					102
40%					103
50%					105
60%					256
70%					310
80%					336
90%					348
95%					-
DRY PT.					350
ASPHALTENE TEST					
WT % ASH	20.17				
WT % UNCONVERTED COAL	15.47				
WT % PRE-ASPHALTENES	20.63				
WT % ASPHALTENES	24.44				
WT % MALTENES & DIST. OIL	19.29				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		16.1	11.3	13.4	
210° F		8.8	9.1	8.9	
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)		0.29		0.18	68.75
INFRARED RATIO					
SP. GRAV. 60/60 F		1.038	1.008	1.043	

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION, USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: M-33D
DATE: 6/24/77
TIME: 0230-1430

SAMPLE DESCRIPTION	S-7 Btms	S-4A Btms			
SAMPLE POINT	Sx-34/39	Sx-37			
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5				
IBP	72.6				
5%	111.6				
10%	128.2				
20%	155.3				
30%	172.6				
40%	181.6				
50%	186.6				
60%	193.2				
70%	200.4				
80%	211.2				
90%	236.4				
95%	260.0				
DRY PT.					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR		749			
IBP		80			
5%		127			
10%		172			
20%		204			
30%		221			
40%		231			
50%		239			
60%		251			
70%		281			
80%		315			
90%		338			
95%		-			
DRY PT.		342			
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F	14.3				
210° F	8.8				
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)	0.14				
INFRARED RATIO					
SP. GRAV. 60/60 F	1.048	0.953			

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION, USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

MATERIAL OUT

Temperature: 749°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 306

lbs/hour

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.11	0.07				0.01
	Carbon Monoxide - CO	8.04	0.64				0.08
	Carbon Dioxide - CO_2	11.04	1.89				0.44
	Hydrogen Sulfide - H_2S	0.28	0.07				
	Methane - CH_4	0.81	0.08				0.01
	Ethane - C_2H_6	0.28	0.06				0.02
	Propane - C_3H_8	0.13	0.05				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3	0.02	0.01	0.01			
	Light Oil - (0-100° C @ 1.6 Torr)			0.25		3.41	
	Solvent - (100-230° C @ 1.6 Torr)			0.24		1.02	
	Heavy Oil - (230-255° C @ 1.6 Torr)			0.03			
	SRL						
	Coal (MAF)						
	Ash						
	Water			10.63		1.67	
	Phenol						
	TOTAL	21.71	2.87	11.16	Negl.	6.10	0.58
Elemental	Carbon	7.40	0.94	0.44		3.88	0.19
	Hydrogen	1.42	0.12	1.23		0.63	0.02
	Nitrogen	0.01	0.01	0.01		0.02	
	Sulfur	0.26	0.06			0.05	
	Oxygen (by diff)	12.62	1.74	9.48		1.52	0.37
	Ash						
	TOTAL	21.71	2.87	11.16	Negl.	6.10	0.58

PROJECT LIGNITE

MEASURED MATERIAL BALANCE

Updated: 12/19/77

Run No: M-33D
Date: 6/24/77
Time: 0230-1430

MATERIAL OUT

lbs/hour

Temperature: 749°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 306

	STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms		Total Out
	SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Quantitative	Hydrogen - H_2						1.19
	Carbon Monoxide - CO						8.76
	Carbon Dioxide - CO_2						13.37
	Hydrogen Sulfide - H_2S						0.35
	Methane - CH_4						0.90
	Ethane - C_2H_6						0.36
	Propane - C_3H_8						0.20
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						0.04
	Light Oil - (0-100° C @ 1.6 Torr)	0.06		4.44	1.50		9.66
	Solvent - (100-230° C @ 1.6 Torr)	0.14		53.69	22.94		78.03
	Heavy Oil - (230-255°C @ 1.6 Torr)	0.01		5.62	0.88		6.54
	SRL		9.80				9.80
	Coal (MAF)		2.35				2.35
	Ash		3.07				3.07
	Water	0.45		0.09			12.84
	Phenol						
	TOTAL	0.66	15.22	63.84	25.32		147.46
Elemental	Carbon	0.18	10.35	55.21	22.28		100.87
	Hydrogen	0.07	0.69	5.20	2.21		11.59
	Nitrogen	-	0.13	0.17	0.07		0.42
	Sulfur	-	0.14	1.05	0.32		1.88
	Oxygen (by diff)	0.41	0.84	2.21	0.44		29.63
	Ash		3.07				3.07
	TOTAL	0.66	15.22	63.84	25.32		147.46

Appendix C

Process Development Unit Run L-1
July 10 - August 6, 1977

Run L-1 was the first in a series of three runs, each to involve 28 days of continuous operation. The purpose of the run was to test plant operability for extended periods of coal processing and to determine the effects of solvent recycle on liquefaction yields. In addition, the solid-liquids separation unit was intermittently on-stream in an effort to produce a substantial quantity of low-ash solvent refined lignite.

Nominal run conditions were those thought to be optimum for minimizing gas and maximizing SRL yields when processing lignite mined near Zap, North Dakota. The maximum reaction temperature in the liquefaction reactor was nominally controlled at 820-840°F with the reactor operating at 2500 psig pressure. Coal and solvent charge rates to the Process Development Unit were equivalent to those used for the unit's design i.e. 50 lbs/hr coal feed - 93 lbs/hr solvent feed. One reactor volume, about 1.4 cubic feet, was used throughout the run and all recoverable organic liquids boiling above 300°F were recycled. The gas charge rate averaged about 9.4 standard cubic feet per pound of raw coal fed and the gas consisted of equal parts hydrogen and carbon monoxide. All product gases were measured, sampled, and oxidized. The product deashing section of the PDU was operated at 300 psig and 450°F using toluene as the deashing solvent. The solvent to charge slurry ratio was nominally four to one by volume.

Operating difficulties during Run L-1, exclusive of those attributeable to wear and tear of process machinery, fall into three broad categories: (1) F-1 vacuum bottoms withdrawal; (2) Solids buildup in the liquefaction reactor and process lines and (3) Solvent recovery.

Problems with the vacuum bottoms withdrawal system were basically two - product solidification and buildup. Solidification of product within the vacuum flash drum leg occurred on two separate occasions and was caused by non-uniform heat tracing in the vicinity of the vacuum lockout valves in one case and by heat tracing element burn out in the second. Product solidification within the vacuum flash vessel leg was relatively easy to avoid by careful temperature monitoring and control, provided the conversion of coal to pyridine soluble material was sufficiently high so that the vacuum bottoms melting point remained below 450°F.

The second problem with the vacuum flash tower and with the bottoms withdrawal system in particular was solids buildup

on the walls of the bottoms drawoff leg and the vessel proper. This buildup seems to result via two mechanisms. First, localized coking with the coked material acting as an initiator for further buildup, and, second, adhesion to the walls of a very thick, sandy like material which is relatively high in ash and unconverted coal. This material may result when solids are burped from the liquefaction reactor and then carried through the system, flowing relatively easily when diluted with hot process solvent but becoming very viscous when the solvent is removed. This material characteristically exhibits a melting point in excess of 500°F. These high melting point solids may also result when solids accumulations in the liquefaction reactor is sufficient to decrease residence time and suppress conversion.

This leads to the second major problem in extended unit operations; that is, solids buildup in the liquefaction reactor and associated high pressure piping.

During Run L-1, coal processing operations were temporarily interrupted when the high pressure tubing between dissolver R-1B and the high pressure flash separator S-1 plugged. Prior to this incident, and after approximately 76 hours of coal feed to the dissolver, the pressure within the reactor began increasing slowly. The pressure drop measured between the dissolver outlet and the high pressure flash separator increased to between 300 and 400 psig indicating material buildup in the 5/16 inch ID tubing connecting these two vessels. While coal feed was cut out,efforts to clear the line by flushing with solvent proved ineffective, so coal processing was resumed and continued for approximately another 85 hours, after which time the line plugged and operations were switched to the standby reactor R-1A. Reactor R-1A was used for the remainder of the run and afterwards was disassembled and cleaned. Disassembly revealed that reactor R-1A was also partially plugged with the plug thickness varying up to perhaps 2-inches at places in the 3-5/8-inch ID vessel. This decrease in volume, with the corresponding decrease in residence time, may be responsible for the lower temperature gradients resulting from lower conversions, which correspondingly produced the higher melting point vacuum bottoms seen near the end of the run. The air cooler tubing from the top of reactor R-1A to separator S-1 was found to have uniform deposits about 1/16-inch in thickness, reducing the internal diameter from 5/16-inch to 3/16-inch. The deposits were initially black, but became light tan or white upon heating, without a noticeable decrease in volume. A rough analysis of the deposits after heating, conducted by the Grand Forks Energy Research Center with an electron micro-probe, indicated the approximate distribution of the major components. This analysis with the major constituents calculated as oxides and normalized to 100 percent, is compared with a typical X-ray fluorescence analysis of the

Zap lignite ash in the table below:

	Tubing Deposits	Zap Lignite Ash
Na_2O	11.9	6.7
MgO	21.8	6.8
CaO	16.7	26.7
Fe_2O_3	8.2	10.0
Al_2O_3	31.8	10.5
SiO_2	2.9	20.2
SO_3	6.7	17.2
Other	-	1.9

An analysis by X-ray diffraction of the tubing deposits indicated the presence of magnesium oxide, but no calcium carbonate. There are obvious differences between the compositions of lignite ash and the tubing deposits, but no firm conclusions as to the cause of fouling have been reached. Reactor R-1A was used intermittently throughout Run L-1 without cleaning the product cooling line. During its use, coal was processed for approximately 204 hours as compared to 161 hours of coal processing before dissolver R-1B plugged.

The third major problem associated with extended PDU operations is solvent recovery. Data from Run L-1 indicate that on the average about 4 percent more organic liquid is generated than charged; but throughout the run an average of only 90 percent was actually recovered and recycled. The 14 percent oil loss occurred mainly in three areas. First, some of the solvent remains with the F-1 vacuum bottoms. A good vacuum bottoms product with a melting point around 350°F contains roughly 9.8 weight percent solvent. This translated into percent of charge solvent amounts to 2.7 percent when the charge solvent to feed coal ratio is 1.86.

The second area of solvent loss is the separation system for waste water and S-4A light oil streams. On the average, the waste water stream contained about 11.4 weight percent oil during Run L-1. Efficiency of the gravimetric separation system varied substantially throughout the run. In some cases only trace amounts of oil were present in the waste water while at other times this stream contained as much as 25 or 30 percent oil. The oil lost in this way amounted to 1.9 percent of the charge solvent. Solvent losses of this nature can be easily remedied in a larger scale plant by incorporating a relatively larger settling or separation volume to provide a longer settling time.

The third area of solvent loss was with the light ends column. Because of the column's small size, heat losses in the area of the top flange and light oil draw off port would at times cause excessive condensation of oil vapor resulting in the column flooding. In this state, the distillation column overhead

contained substantial quantities of recycleable oil. The problem was worsened by water in the feed to the distillation column which results in solvent range oil going overhead because of steam distillation.

During Run L-1 nine data periods, each of a nominal 12 hours duration, were completed and quantitative material balances made. In addition elemental balances were made for two of the nine yield periods and are included in their respective workups. All nine material balance workups, including sample analyses, ASTM D-86 and D-1160 distillation data and average run conditions, are attached.

Material balance closures varied from 98.1 percent in data period L-1D to 101.3 percent in yield period L-1H. In all nine cases, the outgoing product streams were normalized to provide 100 percent recovery. In addition, in yield period L-1E where elemental balances were available, a forced carbon balance was made by adjusting the oil-water ratio of the waste water stream; and in yield periods L-1J and L-1K, for which only poor samples of the V-8 bottoms were available, the V-8 bottoms compositions were calculated by making material balances around the deashing unit assuming an ash loss equal to that of the average ash loss of the L-1 yield periods made without the deashing unit on stream.

A comparison of the nine material balance periods after adjustment is shown on the following page. Also included in the comparison is a tenth column showing the average of all the L-1 data periods.

Conversion of MAF lignite to gas, oil and SRL varied from 88 to 99.2 weight percent with the overall average being 92.2 percent. During the early yield periods of Run L-1, the pyridine soluble material content of the F-1 vacuum bottoms appeared unusually high and the pyridine extraction and ash tests were repeated in triplicate on each sample. Essentially the same results were obtained, confirming the initial tests. It is not known why such high (above 93%) MAF lignite conversions were obtained in some of the data periods, but it is felt that those yield periods where conversions were above 93% should not be viewed as representative of expected results in the solvent refining of lignite.

Net gas yields were within the range anticipated for the reaction conditions employed. They varied from 27 to 40 percent with the average close to 31 weight percent of the MAF lignite charged. The average net hydrocarbon liquid yield averaged about 66 weight percent of the MAF lignite fed and was typical of previous results obtained at similar conditions. The breakdown of the hydrocarbon liquid yield into its distillable oil and SRL components was 20 and 80 percent, respectively.

Table 1

Process Development Unit Run L-1

Yield Period	L-1B	L-1C	L-1D	L-1E	L-1F	L-1H	L-1I	L-1J	L-1K	L-1 Average
Reactor in Use	R-1B	R-1B	R-1B	R-1B	R-1A	R-1A	R-1A	R-1A	R-1A	-
SLS System in Use	No	No	No	No	Yes	No	No	Yes	Yes	-
LHSV	1.38	1.44	1.41	1.46	1.44	1.43	1.41	1.40	1.42	1.42
GHSV	330	342	318	304	323	328	328	341	336	328
Solvent/MAF Coal Ratio	3.16	3.02	2.96	3.03	3.00	2.89	2.82	2.87	2.91	2.96
H_2/CO Mol Ratio	1.16	1.13	1.11	1.11	1.16	1.19	1.11	1.11	1.12	1.13
Temperature, °F										
Preheater Outlet, E-1	717	715	718	721	715	736	741	754	757	730
Reactor 3 ft	757	757	745	742	770	745	746	755	758	753
Reactor 7 ft	797	798	798	794	811	761	762	772	774	785
Reactor 11 ft	806	806	782	782	804	770	764	771	773	784
Reactor 15 ft	827	829	824	822	828	823	824	815	804	822
Max. Reaction	827	829	824	822	828	823	824	815	804	822
Vacuum Flash Ovhd	526	526	530	528	507	505	504	508	504	515
Dissolver Pressure, psig	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
Solvent Recycle, %										
Actual	89.7	95.0	93.4	91.4	86.8	93.3	93.2	83.5	86.4	90.3
Possible	107.3	108.0	103.0	105.2	101.4	101.4	102.1	103.7	107.6	104.0
Possible (Ex Light Oil)	100.5	103.9	-	99.3	-	-	-	97.2	101.4	-
Yield, Wt % MAF Lignite										
Net Gas	36.8	28.2	33.3	31.0	40.3	27.1	30.0	28.5	26.9	31.3
Net Liquid	74.0	73.0	62.6	71.6	56.1	65.0	65.0	61.8	65.8	66.1
(Dist. Oil)	(23.0)	(24.2)	(9.0)	(15.7)	(4.1)	(3.9)	(5.9)	(10.5)	(22.2)	(13.2)
(SRL)	(51.0)	(48.8)	(53.6)	(55.9)	(52.0)	(61.1)	(59.1)	(51.3)	(43.6)	(52.9)
Net Water & Ash	-11.6	-8.5	-3.2	-5.8	-5.3	-4.1	-4.4	-0.9	-3.4	-5.2
Unconverted Coal	0.8	7.3	7.3	3.2	8.9	12.0	9.4	10.6	10.8	7.8
Overall Material Balance, %	100.2	100.2	98.1	99.6	99.5	101.3	101.0	98.6	99.3	99.8
Number of solvent passes thru Liquefaction Reactor by middle of yield period. (Estimated)	1.1	2.1	8.8	9.8	9.5	1.9	2.9	6.7	8.4	-

Actual solvent recovery for recycle averaged about 90 percent for the nine data periods, but because of various operating and equipment problems during the run the longest period of operations without fresh solvent addition was 120 hours or about 24 turnovers for the solvent inventory. Overall, the calculated maximum possible solvent available for recovery, which includes all organic liquids, averaged 104 percent which compares well with that obtained from previous runs.

Of the nine data periods, three were completed with the deashing system on stream. During these yield periods, the ash content of the F-1 vacuum bottoms varied from 0.9 to 6.4 weight percent while the unconverted coal content varied from 0.3 to 2.9 weight percent. For comparison, the ash content of undeashed F-1 vacuum bottoms would range between 10 and 12 weight percent and the unconverted coal content would be about 9-1/2 percent, for an MAF lignite conversion of about 92 percent with a feed lignite containing about 6 percent ash and 33 percent moisture.

Consumption of reducing gases on a hydrogen equivalent basis averaged 2.0 weight percent of the MAF coal charged or 2.3 standard cubic feet of gas per pound raw coal fed.

The two prime objectives of Run L-1 were (1) to demonstrate and to define the problems of long term plant operations and (2) to determine the effects of extended solvent recycle on liquefaction yields. In these respects Run L-1 was only partly successful. Results from the run indicate that the general problems of long term plant operations are (A) solids buildup in the reactors which eventually lead to low conversions and plugging; (B) erosion and some corrosion; and (C) equipment malfunctions.

The effects of extended solvent reuse are only sketchily known from the data at hand. To illustrate, the number of solvent passes thru the liquefaction reactor has been estimated for each of the nine data periods and listed at the bottom of Table 1. There does not appear to be a discernable relationship between the net yields and the number of solvent cycles. This is perhaps because only oil boiling above 350°F was recycled. From the distillation data obtained during this run, it appears that approximately 0.5 percent more liquefaction solvent, i.e. 450-850°F boiling range material, was made than was charged. This is consistent with the general trend of previous similar runs where the yield of 450-850°F material was sometimes slightly more and sometimes slightly less than that charged.

In summary, Run L-1 was scheduled for 672 hours of continuous operation with 652 hours devoted to coal processing. In practice, from the time coal was first introduced to the time coal was last shut off 615-1/2 hours of operating time were logged during which coal was actually charged for 460-1/2 hours or about

75 percent of the actual operating time. The total amount of lignite processed was 22,800 pounds at an average feed rate of 49-1/2 pounds per hour.

Make-up solvent was added at various times throughout the run, either because operating difficulties resulted in the loss of solvent, or because of the failure to recover enough of the solvent range material. The longest period of operation without make-up solvent addition was 120 hours. Thus one of the primary purposes of the run, to demonstrate long continued operation without make-up solvent addition, was not entirely successful. However, the 120 hours of operation without solvent addition represented approximately 24 turnovers of the solvent inventory. During this period the solvent inventory decreased by 1093 pounds for an average loss of 9.1 lbs/hr, including that in samples. A large part of the loss represented the failure to recover all of the recoverable solvent in the streams from the oil-water separator and in the F-1 vacuum bottoms. There was no significant effect on liquefaction during solvent recycle as the original starting solvent was being replaced by coal derived material.

A chronological log of Run L-1 follows to provide additional details of the operations and difficulties of the Process Development Unit.

1. Run Hours 0 to 89.

After the usual start-up difficulties coal was charged at 0500 hours of the second day of operation. The unit was allowed to line out for 45 hours, at which time yield period L-1A was initiated. However, the yield period was terminated after only three hours because of plugging in the bottoms draw-off leg of vacuum flash column F-1. The leg was cleared without interrupting the coal feed, but a considerable amount of recycle solvent was lost, and the solvent system was replenished with fresh solvent. After 9 hours of lined out operation another yield period operation was initiated.

2. Run Hours 89 to 113.

Two yield periods of 12 hours duration each were run back to back. The run conditions were as follows:

	Specified
Pressure, psig	2500
Max. Dissolver Temperature, ^{o}F	820 to 830
Solvent to Raw Coal Ratio	1.8:1
Slurry Flow Rate, lbs/hr.	140
LHSV	1.4
GHSV	330

3. Run Hours 113 to 289.5

After the yield period L-1C the plant was run for several days to test longer term operability. During the fifth day of operation the F-1 bottom draw-off leg plugged again, this time as the result of a burned out heat tape which allowed part of the leg to cool down to 280°F. The heat tape was replaced and the solidified SRL was cleared from the leg.

During this period, the compressors experienced some minor malfunctions as a result of worn check valves. Other minor problems involved the trim of the high pressure letdown valves and packing in valves and pumps.

On the afternoon of the seventh day of operation, with an outside temperature of 96°F, the safety relief disc blew out on a carbon dioxide extinguisher on the upper catwalk near the dissolvers heads. The sound of the explosion and the dense fumes were interpreted as a vessel or line failure at the top of the dissolvers and the emergency shutdown procedure was implemented. The carbon dioxide extinguisher at this high temperature location has been replaced by a dry powder extinguisher.

The emergency shut down caused the plugging of numerous lines including preheater coil E-1 and dissolver R-1B. Hence PDU operations were suspended and startup solvent was prepared by distilling Raw FS-120 carbon black feedstock until the coil in E-1 could be removed and replaced.

The liquefaction section was started up again, this time with dissolver R-1A in service. After this start-up, there were numerous problems with wire-drawn valves around the dissolvers and with partial plugging of the line between S-1 and S-3. Therefore the operations were again interrupted to repair these valves and clean the lines.

At 2000 hours on the tenth day of operations the plant was again started up, this time with dissolver R-1B in operations, and coal was charged at 0600 hours on the eleventh day. After 19-1/2 hours lining out, yield period operations were started.

4. Run Hours 289.5 to 313.5

Yield periods L-1D and L-1E were 12 hours each and were run back to back. These yield periods were successfully completed with only a few minor problems under the same nominal operating conditions as had been used for L-1B and L-1C. Again only the liquefaction section was in operation.

5. Run Hours 313.5 to 453

After completion of yield period L-1E, preparations were made for the startup of the solid-liquid separation section or deashing section. However, after 32 hours, the pressure in

dissolver R-1B began to increase slowly. The pressure behavior indicated that there was probably some material build up in the 5/16" Incoloy line between dissolver R-1B and separator S-1. The pressure drop between these two vessels increased to 300-400 psig. This line could not be cleared with solvent flushing. Finally, after about 85 hours of pressure drop build-up, the line became plugged and operations were switched to dissolver R-1A. Thus far the deashing unit had been used only sparingly. After the warm up of dissolver R-1A, both the liquefaction and separation units were started up in series. After lining out for 39 hours on coal, yield period operations were initiated.

6. Run Hours 453 to 473

Yield period L-1F was the first attempted with both the liquefaction and the separation sections in operation simultaneously. During this yield period both distilled solvent and toluene were added to the respective charge tanks A-5A and A-1A in order to enable the solvent pumps to keep suction. The only other problem encountered during L-1F yield period was with deashing settler V-8. The solids dumping valves developed a leak which was easily remedied.

Yield period L-1G was started back to back with L-1F. About seven hours into the yield period problems were experienced with the slurry charge pump. A bleed valve in the slurry system which was opened to flush the pump released some of the dissolver contents and resulted in sudden depressurization of the dissolver R-1A. This upset resulted in plugging of various parts of the system and the yield period was terminated.

7. Run Hours 473 to 529.5

After lines and reactors were cleared and the slurry pump repaired, operations were resumed still using dissolver R-1A. Coal was charged at 0400 hours of the 21st day, and the liquefaction section only was lined out for 21-1/2 hours before starting yield period operations.

8. Run Hours 529.5 to 553.5

Yield periods L-1H and L-1I were run back to back and successfully completed. Both were made at the same nominal conditions as the previous yield periods.

9. Run Hours 553.5 to 58.

After completing two yield periods with liquefaction section operation only, the deashing section was started up. Because of depletion of the recycle liquefaction solvent, additional recycle solvent was added. The added solvent was that which had remained after Run M-33 and had been stored for such

contingency. After 27-1/2 hours of switching in and lining out the deashing unit, yield period operations were again initiated.

10. Run Hours 581 to 605

Yield periods L-1J and L-1K were made with both liquefaction and separation sections in operation simultaneously. They were successfully completed with little difficulty.

11. Run Hours 605 to 644.5

Following yield periods L-1J and K, some changes were made in the operation of the deashing system which seemed to give improved results. However, operation of this section was terminated when the gasket in the solids withdrawal valve failed, allowing toluene and SRL to spray out.

After 30 hours more on coal for the liquefaction section, another yield period operation was started. However, yield period L-1L was terminated because of plugging problems in the flash drum F-1. During this period the temperature rise through the dissolver had decreased, indicating less reaction, perhaps because of lower residence time because of build up of solids in the reactor or on the reactor wall.

Operations were continued for a time after the termination of L-1L, but the problems with the vacuum bottoms became so acute that shut down procedures were initiated after 644.5 hours of the scheduled 660 hours of the run before shut down. The last sample taken of the vacuum bottoms had a melting point higher than the 500°F maximum range of the gradient bar melting point apparatus.

12. Recapitulation

Run L-1 was the first of the three scheduled long runs of four weeks duration. Overall, it was fairly successful, as indicated by the summary table following:

Total Time Scheduled	672 hours
Operating Time on Coal Scheduled	652 hours
Actual Operating Time*	615.5 hours
Actual Time on Coal during Operating Time	460.5 hours
Time on Coal as percent of	
Actual Operating Time	74.8%
Scheduled Operating Time	70.8%
Total Scheduled Time	68.5%

*From time coal first introduced to time coal last shut off. During actual time on coal 22,800 pounds of lignite was processed at an average feed rate of 49.5 pounds per hour.

RUN CONDITIONS

RUN NO. L-1B

DATE MADE 7/13-14/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 725
- INLET 265
- OUTLET 717

DISSOLVERS
- R-1A (1)
- (2)
- (3)
- (4)
- R-1B (1) 757
- (2) 797
- (3) 806
- (4) 827

REACTOR PRODUCT SEPARATORS
- S-1 618
- S-2 77
- S-3 477
- S-4A 89
- S-4B 88

PREHEATER E-11
- DOWTHERM 672
- INLET 440
- OUTLET 646

VACUUM FLASH F-1
- OVERHEAD VAPOR 526
- UPPER WALL 598
- LOWER WALL 588
- DOWNCOMER 493
- CONDENSATE ACCUMULATOR, S-7 92

PREHEATER E-13
- DOWTHERM 596
- INLET 89
- OUTLET 504

LIGHT ENDS COLUMN, F-2
- REBOILER 464
- LOWER SECTION 560
- FEED SECTION 464
- OVERHEAD 185
- S-8 88
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2
2500

SEPARATOR S-3
300

SEPARATORS S-4A and S-4B
60

VACUUM FLASH, F-1
15 Torr

LIGHT ENDS COLUMN, F-2
0

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

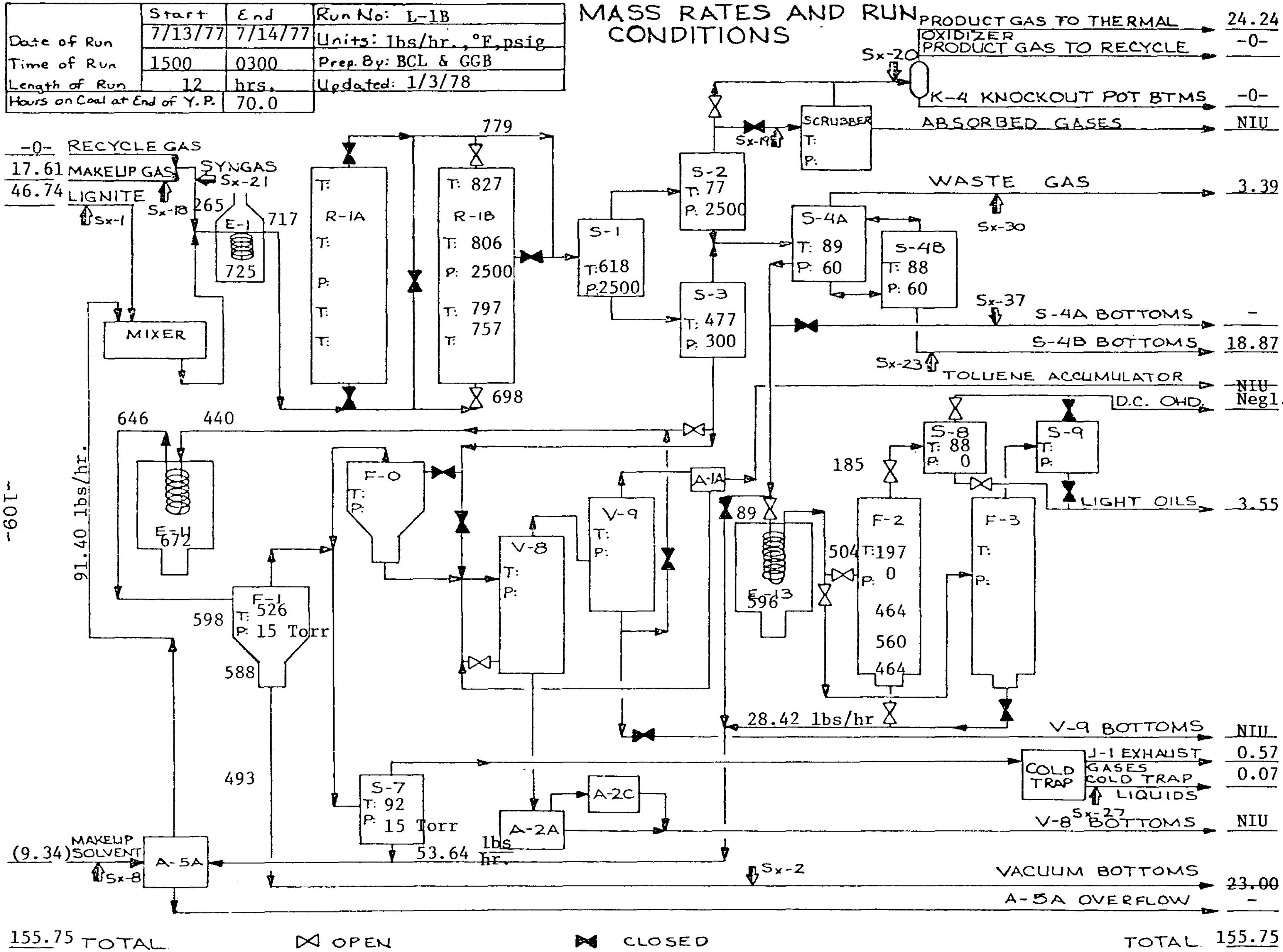
VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU

MASS RATES AND RUN CONDITIONS

	Start	End	
Date of Run	7/13/77	7/14/77	Run No: L-1B
Time of Run	1500	0300	Units: lbs/hr., °F, psig
Length of Run	12	hrs.	Prep. By: BCL & GGB
Hours on Coal at End of Y.P.	70.0		Updated: 1/3/78



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

SUMMARY
lbs/hour

Temperature: 717°F
Pressure: 2500 psig
LHSV: 1.38
GHSV: 330

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Lignite	
SAMPLE POINT						
Hydrogen - H_2	1.32	1.15	-0.17			
Carbon Monoxide - CO	16.11	9.18	-6.93			
Carbon Dioxide - CO_2		15.17	15.17			
Hydrogen Sulfide - H_2S		0.21	0.21			
Methane - CH_4		1.38	1.38			
Ethane - C_2H_6		0.61	0.61	10.61	36.76	
Propane - C_3H_8		0.29	0.29			
Butane - C_4H_{10}						
Nitrogen - N_2	0.18	0.19	0.01			
Ammonia - NH_3		0.04	0.04			
Light Oil - (0-100° C @ 1.6 Torr)	4.80	11.02	6.22			
Solvent - (100-230°C @ 1.6 Torr)	82.62	84.26	1.64	21.37	74.05	
Heavy Oil - (230-255°C @1.6 Torr)	3.75	2.53	-1.22			
SRL		14.73	14.73			
Coal (MAF)	28.86	0.23	-28.63		-99.20	
Ash	2.90	2.63	-0.27		-0.94	
Water	15.21	12.13	-3.08		-10.67	
Phenol						
TOTAL	155.75	155.75	-0-			

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED & ADJUSTED MATERIAL BALANCE
Revised: 1/3/78

MATERIAL IN

Run No: L-1B
Date: 7/13-14/78
Time: 1500-0300

Temperature: 717°F
Pressure: 2500 psig
LHSV: 1.38
GHSV: 330

lbs/hour

Quantitative

STREAM DESCRIPTION	Feed Gas	Lignite	Feed Solvent			Total In
SAMPLE POINT	Sx-21	Sx-1	Sx-14			
Hydrogen - H_2	1.32					1.32
Carbon Monoxide - CO	16.11					16.11
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2	0.18					0.18
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)			4.80			4.80
Solvent - (100-230° C @ 1.6 Torr)			82.62			82.62
Heavy Oil - (230-255° C @ 1.6 Torr)			3.75			3.75
SRL						
Cool (MAF)		28.86				28.86
Ash		2.90				2.90
Water		14.98	0.23			15.21
Phenol						
TOTAL	17.61	46.74	91.40			155.75

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

MATERIAL OUT

lbs/hour

Temperature: 717°F
Pressure: 2500 psig
LHSV: 1.38
GHSV: 330

Quantitative

STREAM DESCRIPTION	Product Gas	S-4A Overhead	S-4B Btms	S-8 Overhead	S-8 Btms	J-1 Exhaust
SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Hydrogen - H_2	1.09	0.06				
Carbon Monoxide - CO	8.70	0.44				0.04
Carbon Dioxide - CO_2	12.27	2.46				0.44
Hydrogen Sulfide - H_2S	0.15	0.06				
Methane - CH_4	1.22	0.14				0.02
Ethane - C_2H_6	0.47	0.11				0.03
Propane - C_3H_8	0.16	0.09				0.04
Butane - C_4H_{10}						
Nitrogen - N_2	0.17	0.02				
Ammonia - NH_3	0.01	0.01	0.02			
Light Oil - (0-100° C @ 1.6 Torr)			4.44		3.49	
Solvent - (100-230° C @ 1.6 Torr)			1.99		0.06	
Heavy Oil - (230-255° C @ 1.6 Torr)			0.55			
SRL						
Coal (MAF)						
Ash						
Water			11.87			
Phenol						
TOTAL	24.24	3.39	18.87	Negl.	3.55	0.57

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJEC: LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

MATERIAL OUT

lbs/hour

Temperature: 717°F
Pressure: 2500 psig
LHSV: 1.38
GHSV: 330

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-2 Btms		Total Out
SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.15
Carbon Monoxide - CO						9.18
Carbon Dioxide - CO_2						15.17
Hydrogen Sulfide - H_2S						0.21
Methane - CH_4						1.38
Ethane - C_2H_6						0.61
Propane - C_3H_8						0.29
Butane - C_4H_{10}						
Nitrogen - N_2						0.19
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.07		3.02			11.02
Solvent - (100-230°C @ 1.6 Torr)		5.41	49.01	27.79		84.26
Heavy Oil - (230-255°C @1.6 Torr)			1.35	0.63		2.53
SRL		14.73				14.73
Coal (MAF)		0.23				0.23
Ash		2.63				2.63
Water			0.26			12.13
Phenol						
TOTAL	0.07	23.00	53.64	28.42		155.75

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	Makeup Solvent	F-2 Btms	Feed Solvent	S-8 Oil
	SAMPLE POINT	Sx-1	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			3.73		5.25	98.40
	Solvent – (100-230°C @ 1.6 Torr)		23.50	89.50	97.80	90.40	1.60
	Heavy Oil – (230-255°C @ 1.6 Torr)			6.70	2.20	4.10	
	SRL		64.05				
	Coal (MAF)	61.74	1.01				
	Ash	6.20	11.44				
	Water	32.06		0.07		0.25	
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		98.86				
	Melting Point °F		244				
	Specific Gravity 60/60			1.040	1.052	1.047	
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water
	SAMPLE POINT	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Quantitative	Hydrogen – H_2			4.51	7.51		
	Carbon Monoxide – CO			35.87	91.50		
	Carbon Dioxide – CO_2			50.62			
	Hydrogen Sulfide – H_2S			0.61			
	Methane – CH_4			5.04			
	Ethane – C_2H_6			1.92			
	Propane – C_3H_8			0.68			
	Butane – C_4H_{10}						
	Nitrogen – N_2			0.72	0.99		
	Ammonia – NH_3 (PPM)			0.03			0.21
	Light Oils – (0-100° C @ 1.6 Torr)		98.40			62.82	
	Solvent – (100-230°C @ 1.6 Torr)		1.60			28.10	
	Heavy Oil – (230-255°C @1.6 Torr)					7.80	
	SRL						
	Coal (MAF)						
	Ash						
	Water	100				1.28	99.79
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60					0.958	
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	–	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Total	S-4A Ovhd	J-1 Disch.	Cold Trap	Recycle Solvent	
Quantitative	SAMPLE POINT	Sx-23	Sx-30	Sx-32	*Sx-33	Sx-39	
	Hydrogen – H_2		1.73	0.92			
	Carbon Monoxide – CO		13.11	7.50			
	Carbon Dioxide – CO_2		72.71	76.76			
	Hydrogen Sulfide – H_2S		1.66				
	Methane – CH_4		4.14	3.54			
	Ethane – C_2H_6		3.30	4.57			
	Propane – C_3H_8		2.54	6.71			
	Butane – C_4H_{10}						
	Nitrogen – N_2		0.63				
	Ammonia – NH_3 (PPM)	0.13	0.18				
	Light Oils – (0-100° C @ 1.6 Torr)	23.52			99.92	5.62	
	Solvent – (100-230°C @ 1.6 Torr)	10.52				91.37	
	Heavy Oil – (230-255°C @1.6 Torr)	2.92				2.52	
	SRL						
	Coal (MAF)						
	Ash						
	Water	62.91			0.08	0.49	
	Phenol						
	TOTAL	100	100	100	100	100	
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60					1.052	
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	-	2	

*Insufficient sample for distillation. Assumed to be light oil and water.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

MOLE PERCENT

	SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
	SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Quantitative	Hydrogen – H_2	43.99	53.20	24.75	15.39		
	Carbon Monoxide – CO	24.99	46.30	13.40	8.92		
	Carbon Dioxide – CO_2	22.44		47.30	58.15		
	Hydrogen Sulfide – H_2S	0.35		1.40			
	Methane – CH_4	6.15		7.40	7.38		
	Ethane – C_2H_6	1.25		3.15	5.08		
	Propane – C_3H_8	0.30		1.65	5.08		
	Butane – C_4H_{10}						
	Nitrogen – N_2	0.50	0.50	0.65			
	Ammonia – NH_3 (PPM)	0.03		0.30			
	Light Oils – (0-100° C @ 1.6 Torr)						
	Solvent – (100-230°C @ 1.6 Torr)						
	Heavy Oil – (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water						
	Phenol						
	TOTAL	100	100	100	100		
	Calc Mole Wt.	19.51	14.17	28.62	33.33		
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2		

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1B
DATE: 7/13-14/77
TIME: 1500-0300

SAMPLE DESCRIPTION	Makeup Solv	F-2 Btms	Feed Solv.	S-8 Oil	S-4B Oil
SAMPLE POINT	Sx-8	Sx-12	Sx-14	Sx-16	Sx-23
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5	5	5		
IBP	73.5	143	43.4		
5%	134	152	117		
10%	164	157	145		
20%	187	162.5	175.6		
30%	193	169	187.2		
40%	198	174	193.5		
50%	203	180	198.6		
60%	208	184	205		
70%	218	191	212.2		
80%	226	196	223		
90%	240	204	244.3		
95%	252.5	221	260		
DRY PT.	260	231	260		
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR				745	742
IBP				59	91
5%				65	92
10%				68	169
20%				72	169
30%				76	220
40%				80	249
50%				84	277
60%				89	302
70%				94	328
80%				101	328
90%				212	328
95%					328
DRY PT.				212	356
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F	15.7	14.5	14.8		
210° F	9.2	9.0	8.9		
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)	0.07		0.25		1.28
INFRARED RATIO					
SP. GRAV. 60/60 F	1.040	1.052	1.047		0.959

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES - BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES - N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION, USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1B
DATE: 7/13-14/77
TIME: 1500-0300

SAMPLE DESCRIPTION	S-7 Btms				
SAMPLE POINT	Sx-39				
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5				
IBP	60.4				
5%	113.5				
10%	137.2				
20%	170.2				
30%	183.8				
40%	189.6				
50%	197.0				
60%	199.3				
70%	208.2				
80%	216.5				
90%	239.6				
95%	260.				
DRY PT.					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR					
IBP					
5%					
10%					
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
95%					
DRY PT.					
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F	14.9				
210° F	9.2				
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)	0.49				
INFRARED RATIO					
SP. GRAV. 60/60 F	1.052				

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION. USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

MATERIAL OUT

Temperature: 717°F
Pressure: 2500 psig
LHSV: 1.38
GHSV: 330

lbs/hour

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.10	0.06				
	Carbon Monoxide - CO	8.73	0.44				0.04
	Carbon Dioxide - CO_2	12.31	2.47				0.44
	Hydrogen Sulfide - H_2S	0.15	0.06				
	Methane - CH_4	1.23	0.14				0.02
	Ethane - C_2H_6	0.47	0.11				0.03
	Propane - C_3H_8	0.16	0.09				0.04
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.17	0.02				
	Ammonia - NH_3	0.01	0.01	0.02			
	Light Oil - (0-100°C @ 1.6 Torr)			4.46		3.50	
	Solvent - (100-230°C @ 1.6 Torr)			1.99		0.06	
	Heavy Oil - (230-255°C @ 1.6 Torr)			0.55			
	SRL						
	Coal (MAF)						
	Ash						
	Water			11.92			
	Phenol						
	TOTAL	24.33	3.40	18.94	Negl.	3.56	0.57

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/3/78

Run No: L-1B
Date: 7/13-14/77
Time: 1500-0300

MATERIAL OUT

Temperature: 717°F
Pressure: 2500 psig
LHSV: 1.38
GHSV: 330

lbs/hour

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-2 Btms		Total Out
SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.16
Carbon Monoxide - CO						9.21
Carbon Dioxide - CO_2						15.22
Hydrogen Sulfide - H_2S						0.21
Methane - CH_4						1.39
Ethane - C_2H_6						0.61
Propane - C_3H_8						0.29
Butane - C_4H_{10}						
Nitrogen - N_2						0.19
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.07		3.02			11.05
Solvent - (100-230° C @ 1.6 Torr)		5.43	49.01	27.79		84.28
Heavy Oil - (230-255°C @ 1.6 Torr)			1.35	0.63		2.53
SRL		14.78				14.78
Cool (MAF)		0.23				0.23
Ash		2.64				2.64
Water			0.26			12.18
Phenol						
TOTAL	0.07	23.08	53.64	28.42		156.01

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

RUN CONDITIONS

RUN NO. L-1C
DATE MADE 7/14/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 726
- INLET 260
- OUTLET 715

DISSOLVERS
- R-1A (1) ____
- (2) ____
- (3) ____
- (4) ____
- R-1B (1) 757
- (2) 798
- (3) 806
- (4) 829

REACTOR PRODUCT SEPARATORS
- S-1 622
- S-2 79
- S-3 474
- S-4A 83
- S-4B 79

PREHEATER E-11
- DOWTHERM 672
- INLET 435
- OUTLET 647

VACUUM FLASH F-1
- OVERHEAD VAPOR 526
- UPPER WALL 600
- LOWER WALL 583
- DOWNCOMER 491
- CONDENSATE ACCUMULATOR, S-7 87

PREHEATER E-13
- DOWTHERM 596
- INLET 79
- OUTLET 558

LIGHT ENDS COLUMN, F-2
- REBOILER 471
- LOWER SECTION 575
- FEED SECTION 500
- OVERHEAD 185
- S-8 86
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION ____
- FEED SECTION ____
- OVERHEAD ____

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION ____
- FEED SECTION ____
- OVERHEAD ____

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS ____

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2) ____
- (3) ____

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD ____

PRESSURE, psig

SEPARATORS S-1 and S-2
2500

SEPARATOR S-3
300

SEPARATORS S-4A and S-4B
61

VACUUM FLASH, F-1
14 Torr

LIGHT ENDS COLUMN, F-2
0

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

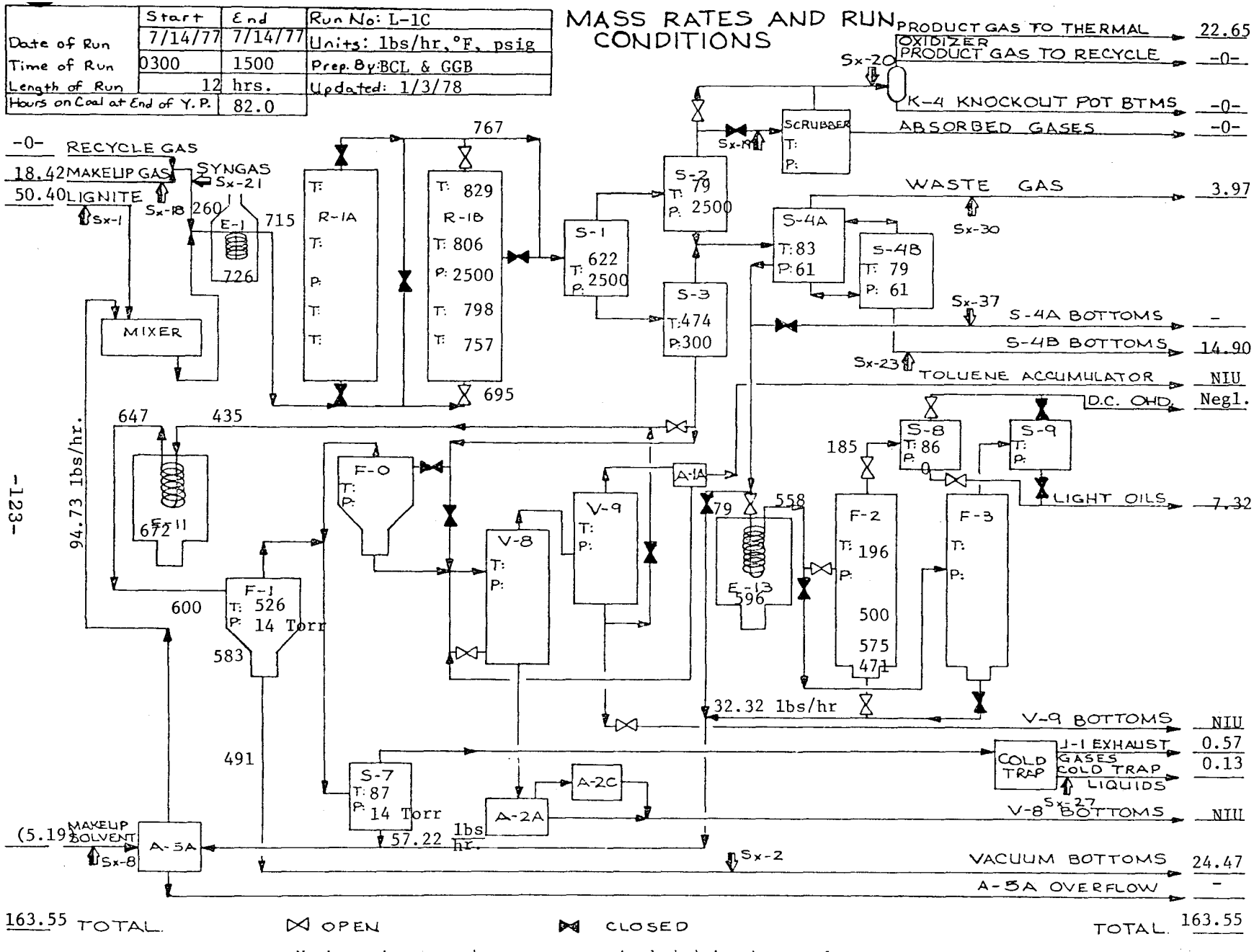
VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU

	Start	End	Run No: L-1C
Date of Run	7/14/77	7/14/77	Units: lbs/hr, °F, psig
Time of Run	0300	1500	Prep. By: BCL & GGB
Length of Run	12	hrs.	Updated: 1/3/78
Hours on Coal at End of Y.P.	82.0		

MASS RATES AND RUN CONDITIONS



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

SUMMARY

lbs/hour

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 342

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Lignite	
SAMPLE POINT						
Hydrogen - H_2	1.36	1.24	-0.12			
Carbon Monoxide - CO	16.88	9.97	-6.91			
Carbon Dioxide - CO_2		13.53	13.53			
Hydrogen Sulfide - H_2S		0.21	0.21			
Methane - CH_4		1.06	1.06	8.79	28.17	
Ethane - C_2H_6		0.49	0.49			
Propane - C_3H_8		0.50	0.50			
Butane - C_4H_{10}						
Nitrogen - N_2	0.18	0.17	-0.01			
Ammonia - NH_3		0.04	0.04			
Light Oil - (0-100° C @ 1.6 Torr)	7.64	11.79	4.15			
Solvent - (100-230°C @ 1.6 Torr)	83.66	87.53	3.87	22.77	72.98	
Heavy Oil - (230-255°C @ 1.6 Torr)	2.81	2.35	-0.46			
SRL		15.21	15.21			
Coal (MAF)	31.20	2.28	-28.92		-92.69	
Ash	3.00	2.70	-0.30		-0.96	
Water	16.82	14.48	-2.34		-7.50	
Phenol						
TOTAL	163.55	163.55	-0-			

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED & ADJUSTED MATERIAL BALANCE
Revised: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

MATERIAL IN

lbs/hour

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 342

Quantitative

STREAM DESCRIPTION	Feed Gas	Lignite	Feed Solvent			Total In
SAMPLE POINT	Sx-21	Sx-1	Sx-14			
Hydrogen - H_2	1.36					1.36
Carbon Monoxide - CO	16.88					16.88
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2	0.18					0.18
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)			7.64			7.64
Solvent - (100-230° C @ 1.6 Torr)			83.66			83.66
Heavy Oil - (230-255°C @ 1.6 Torr)			2.81			2.81
SRL						
Coal (MAF)		31.20				31.20
Ash		3.00				3.00
Water		16.20	0.62			16.82
Phenol						
TOTAL	18.42	50.40	94.73			163.55

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Normalized

Revised: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

MATERIAL OUT

lbs/hour

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 342

Quantitative

STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Hydrogen - H_2	1.14	0.09				0.01
Carbon Monoxide - CO	9.17	0.73				0.07
Carbon Dioxide - CO_2	10.37	2.73				0.43
Hydrogen Sulfide - H_2S	0.14	0.07				
Methane - CH_4	0.93	0.12				0.01
Ethane - C_2H_6	0.37	0.10				0.02
Propane - C_3H_8	0.38	0.09				0.03
Butane - C_4H_{10}						
Nitrogen - N_2	0.14	0.03				
Ammonia - NH_3	0.01	0.01	0.02			
Light Oil - (0-100° C @ 1.6 Torr)			0.32		7.01	
Solvent - (100-230°C @ 1.6 Torr)			0.36			
Heavy Oil - (230-255°C @ 1.6 Torr)					0.21	
SRL						
Coal (MAF)						
Ash						
Water			14.20		0.10	
Phenol						
TOTAL	22.65	3.97	14.90	Negl.	7.32	0.57

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

MATERIAL OUT

lbs/hour

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 342

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms		Total Out
SAMPLE POINT	*Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.24
Carbon Monoxide - CO						9.97
Carbon Dioxide - CO_2						13.53
Hydrogen Sulfide - H_2S						0.21
Methane - CH_4						1.06
Ethane - C_2H_6						0.49
Propane - C_3H_8						0.50
Butane - C_4H_{10}						
Nitrogen - N_2						0.17
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.13		4.33			11.79
Solvent - (100-230°C @ 1.6 Torr)		4.28	51.14	31.75		87.53
Heavy Oil - (230-255°C @1.6 Torr)			1.57	0.57		2.35
SRL		15.21				15.21
Coal (MAF)		2.28				2.28
Ash		2.70				2.70
Water			0.18			14.48
Phenol						
TOTAL	0.13	24.47	57.22	32.32		163.55

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

*No sample available. Assumed to be 100% light oil

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

WEIGHT PERCENT

Quantitative

SAMPLE DESCRIPTION	Lignite	F-1 Btms	F-2 Btms	Feed Solvent	S-8 Btms	Product Gas
SAMPLE POINT	Sx-1	Sx-2	Sx-12	Sx-14	Sx-16	Sx-19
Hydrogen – H_2						5.05
Carbon Monoxide – CO						40.48
Carbon Dioxide – CO_2						45.78
Hydrogen Sulfide – H_2S						0.64
Methane – CH_4						4.11
Ethane – C_2H_6						1.62
Propane – C_3H_8						1.66
Butane – C_4H_{10}						
Nitrogen – N_2						0.61
Ammonia – NH_3 (PPM)						0.05
Light Oils – (0-100° C @ 1.6 Torr)				8.06	95.78	
Solvent – (100-230°C @ 1.6 Torr)		17.50	98.24	88.32	-	
Heavy Oil – (230-255°C @ 1.6 Torr)			1.76	2.97	2.90	
SRL		62.15				
Coal (MAF)	61.90	9.30				
Ash	5.96	11.05				
Water	32.14			0.65	1.32	
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)		89.55				
Melting Point °F		262				
Specific Gravity 60/60			1.031	1.053		
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	3	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Feed Gas	S-4B Oil	S-4B Water	S-4B Total	S-4A Ovhd	J-1 Disch.
Quantitative	SAMPLE POINT	Sx-21	Sx-23	Sx-23	Sx-23	Sx-30	Sx-32
	Hydrogen – H_2	7.39				2.27	1.07
	Carbon Monoxide – CO	91.63				18.37	11.82
	Carbon Dioxide – CO_2					68.75	75.97
	Hydrogen Sulfide – H_2S					1.67	
	Methane – CH_4					3.11	2.66
	Ethane – C_2H_6					2.54	3.28
	Propane – C_3H_8					2.32	5.20
	Butane – C_4H_{10}						
	Nitrogen – N_2	0.98				0.84	
	Ammonia – NH_3 (PPM)			0.13	0.12	0.13	
	Light Oils – (0-100° C @ 1.6 Torr)		46.90		2.16		
	Solvent – (100-230°C @ 1.6 Torr)		52.50		2.42		
	Heavy Oil – (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water		0.60	99.87	95.30		
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

WEIGHT PERCENT

Quantitative

SAMPLE DESCRIPTION	Recycle Solvent					
SAMPLE POINT	Sx-39					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2						
Hydrogen Sulfide – H_2S						
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)						
Light Oils – (0-100° C @ 1.6 Torr)	7.57					
Solvent – (100-230° C @ 1.6 Torr)	89.37					
Heavy Oil – (230-255° C @ 1.6 Torr)	2.75					
SRL						
Coal (MAF)						
Ash						
Water	0.31					
Phenol						
TOTAL	100					
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60	1.054					
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2					

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	46.75	52.75	30.05	17.29		
Carbon Monoxide – CO	26.75	46.75	17.40	13.73		
Carbon Dioxide – CO_2	19.25		41.45	56.17		
Hydrogen Sulfide – H_2S	0.35		1.30			
Methane – CH_4	4.75		5.15	5.40		
Ethane – C_2H_6	1.00		2.25	3.55		
Propane – C_3H_8	0.70		1.40	3.86		
Butane – C_4H_{10}						
Nitrogen – N_2	0.40	0.50	0.80			
Ammonia – NH_3 (PPM)	0.05		0.20			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Calc Mole Wt.	18.50	14.29	26.53	32.53		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2		

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1C
DATE: 7/14/77
TIME: 0300-1500

SAMPLE DESCRIPTION	LEC Btms	Feed Solv.	S-8 Oil	S-4B Oil	S-7 Btms
SAMPLE POINT	Sx-12	Sx-14	Sx-16	Sx-23	Sx-39
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5	5			5
VOLUME PERCENT / TEMPERATURE, °C — IBP	133.6	71.3			65
5%	153.8	103			105
10%	157.2	132.2			128.5
20%	161.7	164.7			157.5
30%	168.2	178.2			173
40%	174.8	187.4			181
50%	181	193.8			185
60%	186	198.6			193
70%	191	204.3			200
80%	198.2	218			208
90%	211.2	238.3			224
95%	229.5				240.5
DRY PT.	234.5	265			260
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR			742	746	
VOLUME PERCENT / TEMPERATURE, °C — IBP			68	70	
5%			80	108	
10%			80	151	
20%			157	202	
30%			182	220	
40%			197	250	
50%			209	280	
60%			222	305	
70%			235	335	
80%			247	355	
90%			259	363	
95%			260		
DRY PT.			263	363	
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F	13.1	15.1			15.0
210° F	8.8	8.9			8.9
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)		0.65	1.32	0.60	0.31
INFRARED RATIO		0.30			
SP. GRAV. 60/60 F	1.031	1.053			1.054

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION, USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

MATERIAL OUT

lbs/hour

Temperature: 715°F
Pressure: 2500 psig
LHSV 1.44
GHSV: 342

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.15	0.09				0.01
	Carbon Monoxide - CO	9.21	0.73				0.07
	Carbon Dioxide - CO_2	10.42	2.74				0.43
	Hydrogen Sulfide - H_2S	0.15	0.07				
	Methane - CH_4	0.93	0.13				0.01
	Ethane - C_2H_6	0.37	0.10				0.02
	Propane - C_3H_8	0.38	0.09				0.03
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.14	0.03				
	Ammonia - NH_3	0.01	0.01	0.02			
	Light Oil - (0-100° C @ 1.6 Torr)			0.32		7.04	
	Solvent - (100-230°C @ 1.6 Torr)			0.36			
	Heavy Oil - (230-255°C @1.6 Torr)					0.21	
	SRL						
	Coal (MAF)						
	Ash						
	Water			14.27		0.10	
	Phenol						
	TOTAL	22.76	3.99	14.97	Negl.	7.35	0.57

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/3/78

Run No: L-1C
Date: 7/14/77
Time: 0300-1500

MATERIAL OUT

lbs/hour

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 342

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-2 Btms		Total Out
SAMPLE POINT	*Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.25
Carbon Monoxide - CO						10.01
Carbon Dioxide - CO_2						13.59
Hydrogen Sulfide - H_2S						0.22
Methane - CH_4						1.07
Ethane - C_2H_6						0.49
Propane - C_3H_8						0.50
Butane - C_4H_{10}						
Nitrogen - N_2						0.17
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.13		4.33			11.82
Solvent - (100-230° C @ 1.6 Torr)		4.30	51.14	31.75		87.55
Heavy Oil - (230-255°C @ 1.6 Torr)			1.57	0.57		2.35
SRL		15.28				15.28
Coal (MAF)		2.29				2.29
Ash		2.71				2.71
Water			0.18			14.55
Phenol						
TOTAL	0.13	24.58	57.22	32.32		163.89

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

*No sample available. Assumed to be 100% light oil.

RUN CONDITIONS

RUN NO. L-1D
DATE MADE 7/22/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 733
- INLET 312
- OUTLET 718

DISSOLVERS
- R-1A (1) —
- (2) —
- (3) —
- (4) —
- R-1B (1) 745
- (2) 798
- (3) 782
- (4) 824

REACTOR PRODUCT SEPARATORS
- S-1 600
- S-2 77
- S-3 486
- S-4A 82
- S-4B 78

PREHEATER E-11
- DOWTHERM 677
- INLET 438
- OUTLET 650

VACUUM FLASH F-1
- OVERHEAD VAPOR 530
- UPPER WALL 600
- LOWER WALL 581
- DOWNCOMER 378
- CONDENSATE ACCUMULATOR, S-7 88

PREHEATER E-13
- DOWTHERM 597
- INLET 82
- OUTLET 558

LIGHT ENDS COLUMN, F-2
- REBOILER 459
- LOWER SECTION 549
- FEED SECTION 474
- OVERHEAD 200
- S-8 86
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION —
- FEED SECTION —
- OVERHEAD —

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION —
- FEED SECTION —
- OVERHEAD —

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS —

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2) —
- (3) —

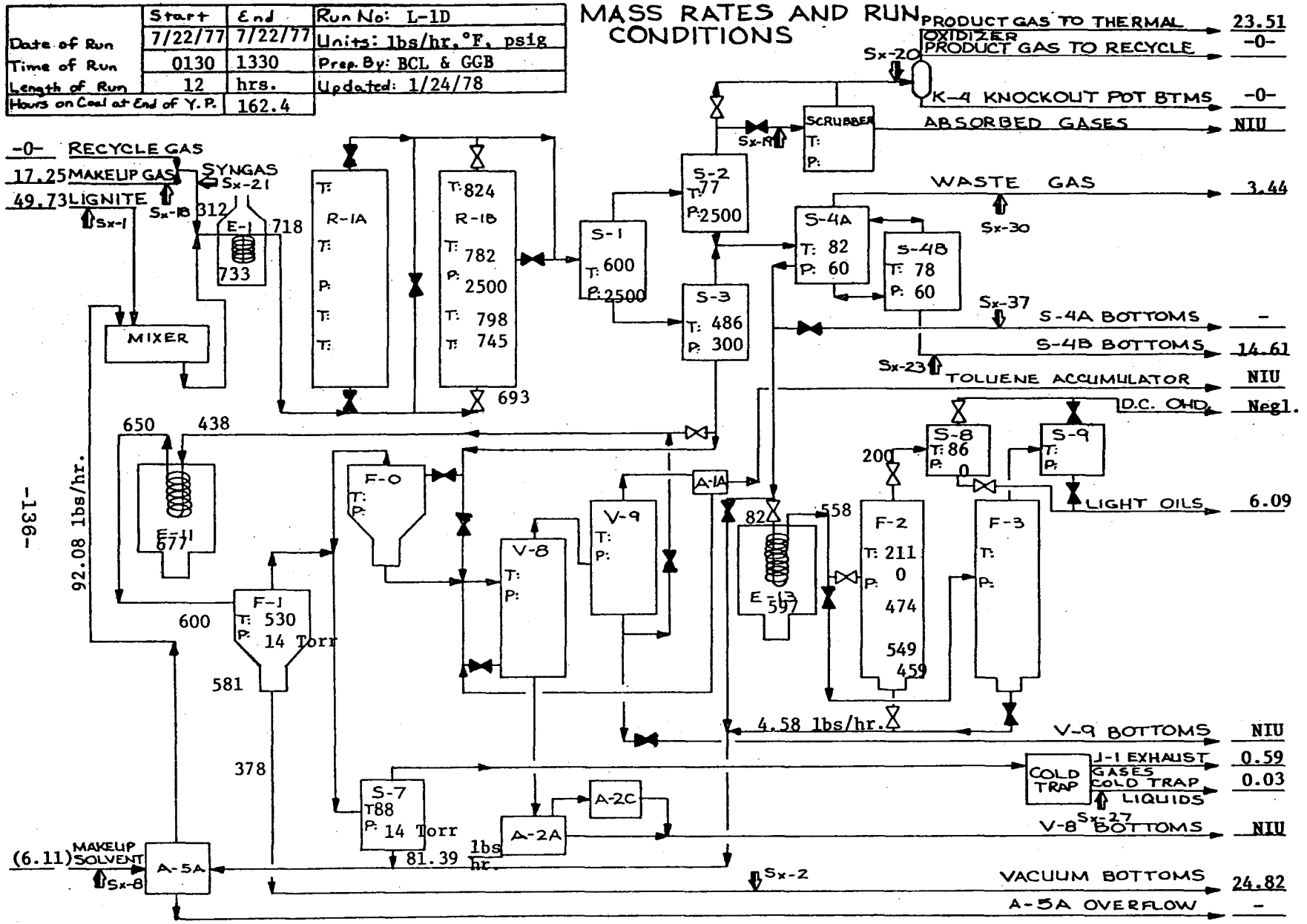
RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD —

PRESSURE, psig

- SEPARATORS S-1 and S-2: 2500
- SEPARATOR S-3: 300
- SEPARATORS S-4A and S-4B: 60
- VACUUM FLASH, F-1: 14 Torr
- LIGHT ENDS COLUMN, F-2: 0
- SOLVENT COLUMN, F-3: NIU
- HEAVY ENDS COLUMN, F-4: NIU
- VACUUM FLASH, F-0: NIU
- SETTLING TOWER, V-8: NIU
- RECOVERY TOWER, V-7: NIU

	Start	End	Run No: L-1D
Date of Run	7/22/77	7/22/77	Units: lbs/hr, °F, psig
Time of Run	0130	1330	Prep. By: BCL & GGB
Length of Run	12	hrs.	Updated: 1/24/78
Hours on Coal at End of Y.P.	162.4		

MASS RATES AND RUN CONDITIONS



159.06 TOTAL ⋈ OPEN ⋈ CLOSED TOTAL 159.06

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/24/78

SUMMARY

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

Temperature: 718°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 318

lbs/hour

	Stream Description	Total In	Total Out	Net Yield		Wt % MAF Coal	
Quantitative	Sample Point						
	Hydrogen - H_2	1.26	1.06	-0.20			
	Carbon Monoxide - CO	15.81	8.18	-7.63			
	Carbon Dioxide - CO_2		15.80	15.80			
	Hydrogen Sulfide - H_2S		0.16	0.16			
	Methane - CH_4		1.30	1.30	10.31	33.29	
	Ethane - C_2H_6		0.57	0.57			
	Propane - C_3H_8		0.29	0.29			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.18	0.16	-0.02			
	Ammonia - NH_3		0.04	0.04			
	Distillable Oil (IBP-255°C @1.6 Torr)	91.79	94.58	2.79	19.39	62.61	
	SRL		16.60	16.60			
	Coal (MAF)	30.97	2.25	-28.72		-92.74	
	Ash	3.18	3.16	-0.02		-0.06	
	Water	15.87	14.91	-0.96		-3.10	
	Phenol						
	Total	159.06	159.06				
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
MEASURED & ADJUSTED MATERIAL BALANCE
Revised: 1/24/78

MATERIAL IN

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

Temperature: 718°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 318

lbs/hour

	Stream Description	Feed Gas	Lignite	Feed Solvent			Total In
	Sample Point	Sx-21	Sx-1	Sx-14			
Quantitative	Hydrogen - H_2	1.26					1.26
	Carbon Monoxide - CO	15.81					15.81
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.18					0.18
	Ammonia - NH_3						
	Distillable Oil (IBP-255°C @1.6 Torr)			91.79			91.79
	SRL						
	Coal (MAF)		30.97				30.97
	Ash		3.18				3.18
	Water		15.58	0.29			15.87
	Phenol						
	Total	17.25	49.73	92.08			159.06

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/24/78

MATERIAL OUT

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

Temperature: 718°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 318

lbs/hour

	Stream Description	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
Quantitative	Sample Point	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
	Hydrogen - H_2	0.99	0.07				
	Carbon Monoxide - CO	7.62	0.50				0.06
	Carbon Dioxide - CO_2	12.89	2.44				0.47
	Hydrogen Sulfide - H_2S	0.10	0.06				
	Methane - CH_4	1.15	0.13				0.02
	Ethane - C_2H_6	0.45	0.10				0.02
	Propane - C_3H_8	0.18	0.09				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.13	0.03				
	Ammonia - NH_3		0.02	0.02			
	Distillable Oil (IBP-255°C @1.6 Torr)			0.04		6.02	
	SRL						
	Coal (MAF)						
	Ash						
	Water			14.55		0.07	
	Phenol						
	Total	23.51	3.44	14.61	Negl.	6.09	0.59

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/24/78

MATERIAL OUT

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

Temperature: 718°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 318

lbs/hour

	Stream Description	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-2 Btms		Total Out
	Sample Point	Sx-33	Sx-2	Sx-39	Sx-12		
Quantitative	Hydrogen - H_2						1.06
	Carbon Monoxide - CO						8.18
	Carbon Dioxide - CO_2						15.80
	Hydrogen Sulfide - H_2S						0.16
	Methane - CH_4						1.30
	Ethane - C_2H_6						0.57
	Propane - C_3H_8						0.29
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.16
	Ammonia - NH_3						0.04
	Distillable Oil (IBP-255°C @1.6 Torr)	0.02	2.81	81.11	4.58		94.58
	SRL		16.60				16.60
	Coal (MAF)		2.25				2.25
	Ash		3.16				3.16
	Water	0.01		0.28			14.91
	Phenol						
	Total	0.03	24.82	81.39	4.58		159.06

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

WEIGHT PERCENT

	Sample Description	Lignite	F-1 Btms	Makeup Solvent	LEC Btms	Feed Solvent	S-8 Oil
	Sample Point	Sx-1	*Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3 (PPM)						
	Distillable Oil (IBP-255°C @1.6 Torr)		11.35	99.93	100	99.69	98.91
	SRL		66.87				
	Coal (MAF)	62.27	9.06				
	Ash	6.40	12.72				
	Water	31.33		0.07		0.31	1.09
	Total	100	100	100	100	100	100
	P.S. (Ash-free		89.62				
	Melting Point		338				
	Specific Gravity 60/60			1.040	1.028	1.042	
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	2	2	2	2	2	2

*Distillable oil calculated by following equation =
Wt % Distillable Oil = -0.1273 (F-1 Btms Melting Point) + 54.38
See attached graph.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

WEIGHT PERCENT

	Sample Description	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water
Quantitative	Sample Point	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
	Hydrogen - H_2			4.24	7.28		
	Carbon Monoxide - CO			32.40	91.65		
	Carbon Dioxide - CO_2			54.82			
	Hydrogen Sulfide - H_2S			0.42			
	Methane - CH_4			4.88			
	Ethane - C_2H_6			1.93			
	Propane - C_3H_8			0.76			
	Butane - C_4H_{10}						
	Nitrogen - N_2			0.55	1.07		
	Ammonia - NH_3 (PPM)						0.14
	Distillable Oil (IBP-255°C @1.6 Torr)		98.91			100	
	SRL						
	Coal (MAF)						
	Ash						
	Water	100	1.09				99.86
	Total	100	100	100	100	100	100
	P.S. (Ash-free						
	Melting Point						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	2		2	2	-	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

WEIGHT PERCENT

	Sample Description	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	Recycle Solvent	
	Sample Point	Sx-23	Sx-30	Sx-32	Sx-33	Sx-39	
Quantitative	Hydrogen - H_2		1.99	0.90			
	Carbon Monoxide - CO		14.56	9.86			
	Carbon Dioxide - CO_2		71.05	80.21			
	Hydrogen Sulfide - H_2S		1.67				
	Methane - CH_4		3.88	2.80			
	Ethane - C_2H_6		2.80	2.99			
	Propane - C_3H_8		2.64	3.24			
	Butane - C_4H_{10}						
	Nitrogen - N_2		0.82				
	Ammonia - NH_3 (PPM)	0.14	0.59				
	Distillable Oil (IBP-255°C @1.6 Torr)	0.30			56.22	99.65	
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.56			43.78	0.35	
	Total	100	100	100	100	100	
	P.S. (Ash-free						
	Melting Point						
	Specific Gravity 60/60					1.054	
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	2	2	2	2		

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

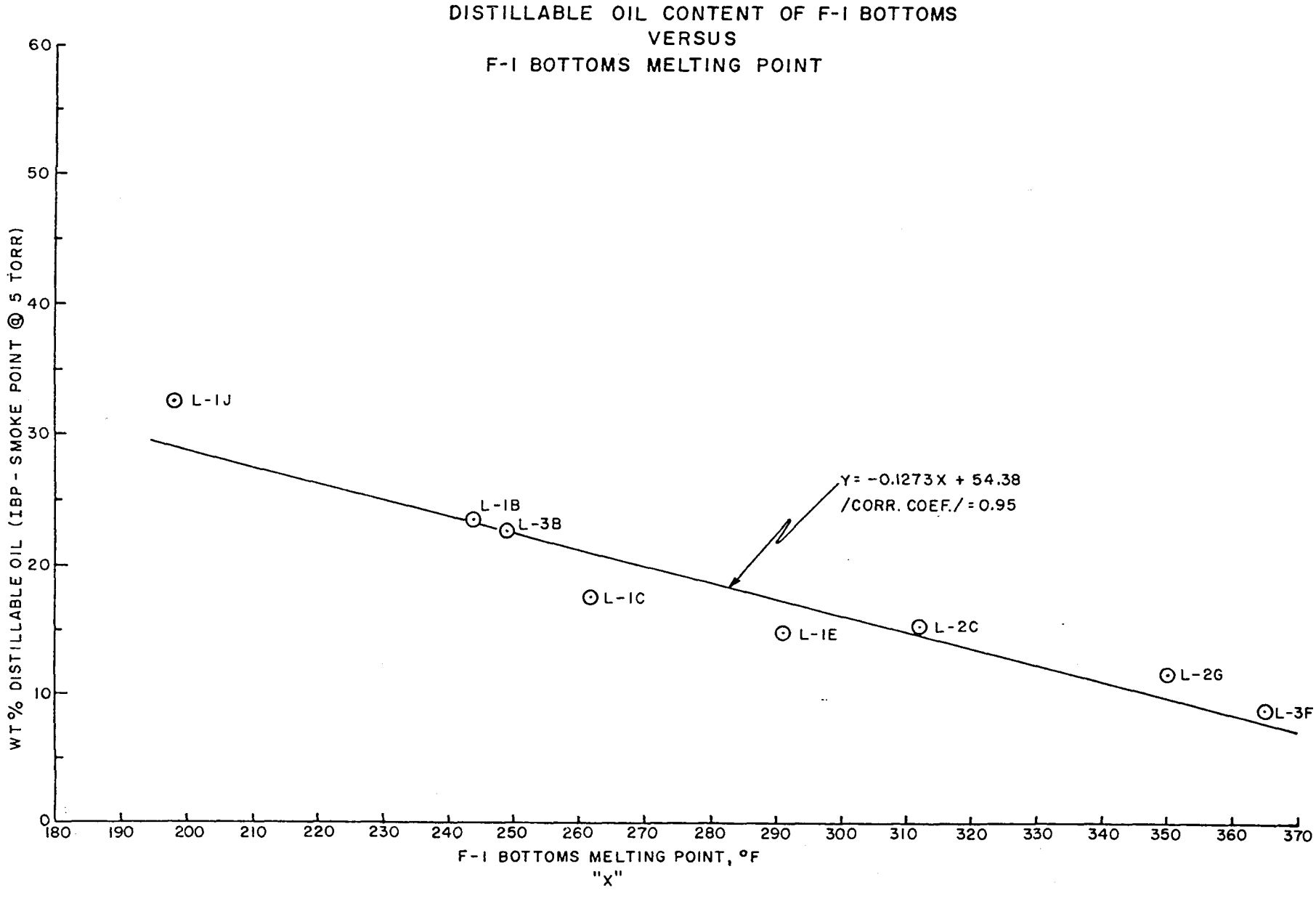
MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	42.91	52.35	27.37	15.06		
Carbon Monoxide – CO	23.41	47.10	14.29	11.85		
Carbon Dioxide – CO_2	25.20		44.36	61.36		
Hydrogen Sulfide – H_2S	0.25		1.35			
Methane – CH_4	6.17		6.67	5.90		
Ethane – C_2H_6	1.30		2.56	3.35		
Propane – C_3H_8	0.35		1.65	2.48		
Butane – C_4H_{10}						
Nitrogen – N_2	0.40	0.55	0.80			
Ammonia – NH_3 (PPM)	0.01		0.95			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Calc. Mole Wt.	20.23	14.39	27.47	33.66		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2		


DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT
WT% DISTILLABLE OIL (IBP - SMOKE POINT @ 5 TORR)
"Y"
F-1 BOTTOMS MELTING POINT, °F
"X"
Y = -0.1273X + 54.38
/CORR. COEF./ = 0.95
L-1J
L-1B
L-3B
L-1C
L-1E
L-2C
L-2G
L-3F
0
10
20
30
40
50
60
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/24/78

MATERIAL OUT

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

Temperature: 718°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 318

lbs/hour

	Stream Description	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
Quantitative	Sample Point	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
	Hydrogen - H_2	0.96	0.07				
	Carbon Monoxide - CO	7.30	0.48				0.06
	Carbon Dioxide - CO_2	12.36	2.34				0.44
	Hydrogen Sulfide - H_2S	0.09	0.05				
	Methane - CH_4	1.10	0.13				0.02
	Ethane - C_2H_6	0.44	0.09				0.02
	Propane - C_3H_8	0.17	0.09				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.12	0.03				
	Ammonia - NH_3		0.02	0.02			
	Distillable Oil (IBP-255°C @1.6 Torr)			0.04		5.78	
	SRL						
	Coal (MAF)						
	Ash						
	Water			13.95		0.06	
	Phenol						
	Total	22.54	3.30	14.01	Negl.	5.84	0.56

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE

MEASURED MATERIAL BALANCE
Revised: 1/24/78

MATERIAL OUT

Run No: L-1D
Date: 7/22/77
Time: 0130-1330

Temperature: 718°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 318

lbs/hour

	Stream Description	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms		Total Out
	Sample Point	Sx-33	Sx-2	Sx-39	Sx-12		
Quantitative	Hydrogen - H_2						1.03
	Carbon Monoxide - CO						7.84
	Carbon Dioxide - CO_2						15.14
	Hydrogen Sulfide - H_2S						0.14
	Methane - CH_4						1.25
	Ethane - C_2H_6						0.55
	Propane - C_3H_8						0.28
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.15
	Ammonia - NH_3						0.04
	Distillable Oil (IBP-255°C @1.6 Torr)	0.02	2.70	81.11	4.58		94.23
	SRL		15.91				15.91
	Coal (MAF)		2.16				2.16
	Ash		3.03				3.03
	Water	0.01		0.28			14.30
	Phenol						
	Total	0.03	23.80	81.39	4.58		156.05

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

RUN CONDITIONS

RUN NO. L-1E
DATE MADE 7/22-23/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 738
- INLET 309
- OUTLET 721

DISSOLVERS
- R-1A (1) _____
- (2) _____
- (3) _____
- (4) _____
- R-1B (1) 742
- (2) 794
- (3) 782
- (4) 822

REACTOR PRODUCT SEPARATORS
- S-1 586
- S-2 79
- S-3 485
- S-4A 90
- S-4B 88

PREHEATER E-11
- DOWTHERM 676
- INLET 438
- OUTLET 655

VACUUM FLASH F-1
- OVERHEAD VAPOR 528
- UPPER WALL 604
- LOWER WALL 585
- DOWNCOMER 461
- CONDENSATE ACCUMULATOR, S-7 94

PREHEATER E-13
- DOWTHERM 595
- INLET 90
- OUTLET 539

LIGHT ENDS COLUMN, F-2
- REBOILER 461
- LOWER SECTION 561
- FEED SECTION 474
- OVERHEAD 220
- S-8 93
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION _____
- FEED SECTION _____
- OVERHEAD _____

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION _____
- FEED SECTION _____
- OVERHEAD _____

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS _____

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2) _____
- (3) _____

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD _____

PRESSURE, psig

SEPARATORS S-1 and S-2
2500

SEPARATOR S-3
308

SEPARATORS S-4A and S-4B
60

VACUUM FLASH, F-1
15 Torr

LIGHT ENDS COLUMN, F-2
0

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

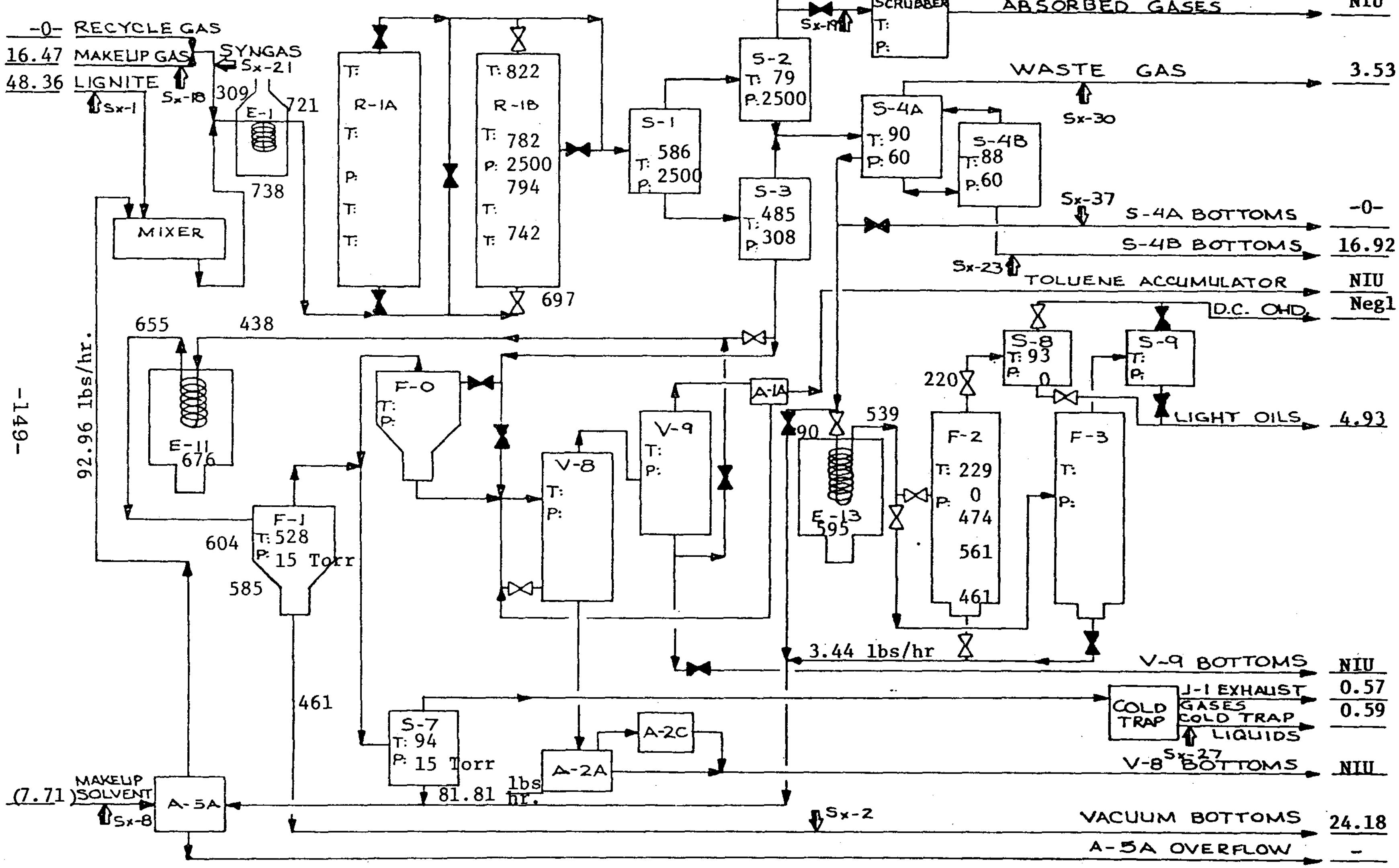
VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU

MASS RATES AND RUN CONDITIONS

	Start	End	Run No: L-1E
Date of Run	7/22/77	7/23/77	Units: lbs/hr, °F, psig
Time of Run	1330	0130	Prep. By: GGB & BCL
Length of Run	12	hrs.	Updated: 7/25/77
Hours on Coal at End of Y. P.	174.4		



157.79 TOTAL ⋈ OPEN ⧓ CLOSED TOTAL 157.79

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with Forced Carbon Balance by Adjusting S-4B oil/H_2O ratio
Revised: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

SUMMARY

lbs/hour

Temperature: 721°F
Pressure: 2500 psig
LHSV: 1.46
GHSV: 304

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Lignite	
SAMPLE POINT						
Hydrogen - H_2	1.20	1.04	-0.16			
Carbon Monoxide - CO	15.06	6.95	-8.11			
Carbon Dioxide - CO_2		15.49	15.49			
Hydrogen Sulfide - H_2S		0.17	0.17			
Methane - CH_4		1.21	1.21	9.47	30.98	
Ethane - C_2H_6		0.54	0.54			
Propane - C_3H_8		0.33	0.33			
Butane - C_4H_{10}						
Nitrogen - N_2	0.21	0.17	-0.04			
Ammonia - NH_3		0.04	0.04			
Light Oil - (0-100° C @ 1.6 Torr)	6.72	12.14	5.42			
Solvent - (100-230° C @ 1.6 Torr)	80.97	81.76	0.79	21.89	71.60	
Heavy Oil - (230-255°C @ 1.6 Torr)	4.93	3.52	-1.41			
SRL		17.09	17.09			
Coal (MAF)	30.57	0.99	-29.58		-96.76	
Ash	2.72	2.56	-0.16		-0.52	
Water	15.41	13.79	-1.62		-5.30	
Phenol						
TOTAL	157.79	157.79	-0-			

Elemental

Carbon	108.66	108.66	-0-			
Hydrogen	11.66	11.72	0.06			
Nitrogen	0.71	0.66	-0.05			
Sulfur	1.74	1.97	0.23			
Oxygen (by diff)	32.30	32.22	-0.08			
Ash	2.72	2.56	-0.16			
TOTAL	157.79	157.79	-0-			

PROJECT LIGNITE
MEASURED & ADJUSTED MATERIAL BALANCE
Revised: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

MATERIAL IN

lbs/hour

Temperature: 721°F
Pressure: 2500 psig
LHSV: 1.46
GHSV: 304

Quantitative

STREAM DESCRIPTION	Feed Gas	Lignite	Feed Solvent			Total In
SAMPLE POINT	Sx-21	Sx-1	Sx-14			
Hydrogen - H_2	1.20					1.20
Carbon Monoxide - CO	15.06					15.06
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2	0.21					0.21
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)			6.72			6.72
Solvent - (100-230°C @ 1.6 Torr)			80.97			80.97
Heavy Oil - (230-255°C @ 1.6 Torr)			4.93			4.93
SRL						
Coal (MAF)		30.57				30.57
Ash		2.72				2.72
Water		15.07	0.34			15.41
Phenol						
TOTAL	16.47	48.36	92.96			157.79

Elemental

Carbon	6.45	21.40	80.81			108.66
Hydrogen	1.20	3.17	7.29			11.66
Nitrogen	0.21	0.30	0.20			0.71
Sulfur		0.25	1.49			1.74
Oxygen (by diff)	8.61	20.52	3.17			32.30
Ash		2.72				2.72
TOTAL	16.47	48.36	92.96			157.79

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Normalized with Forced Carbon Balance by Adjusting S-4B Oil/H_2O Ratio

Revised: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

MATERIAL OUT

lbs/hour

Temperature: 721°F
Pressure: 2500 psig
LHSV: 1.46
GHSV: 304

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	SAMPLE POINT	Sx-19	Sx-30	calc.	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	0.97	0.06				0.01
	Carbon Monoxide - CO	6.49	0.40				0.06
	Carbon Dioxide - CO_2	12.36	2.68				0.45
	Hydrogen Sulfide - H_2S	0.11	0.06				
	Methane - CH_4	1.09	0.11				0.01
	Ethane - C_2H_6	0.42	0.10				0.02
	Propane - C_3H_8	0.22	0.09				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.15	0.02				
	Ammonia - NH_3	0.01	0.01	0.02			
	Light Oil - (0-100° C @ 1.6 Torr)			1.75		4.53	
	Solvent - (100-230° C @ 1.6 Torr)			1.84		0.13	
	Heavy Oil - (230-255°C @ 1.6 Torr)			0.21		0.21	
	SRL						
	Coal (MAF)						
	Ash						
	Water			13.10		0.06	
	Phenol						
	TOTAL	21.82	3.53	16.92	Negl.	4.93	0.57
Elemental	Carbon	7.49	1.13	3.20		3.87	0.19
	Hydrogen	1.38	0.14	1.81		0.50	0.01
	Nitrogen	0.16	0.03	0.02		0.01	
	Sulfur	0.10	0.05	0.04		0.02	
	Oxygen (by diff)	12.69	2.18	11.85		0.53	0.37
	Ash						
	TOTAL	21.82	3.53	16.92	Negl.	4.93	0.57

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Normalized with Forced Carbon Balance by Adjusting S-4B Oil/H_2O Ratio.

Revised: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

MATERIAL OUT

lbs/hour

Temperature: 721°F
Pressure: 2500 psig
LHSV: 1.46
GHSV: 304

	STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-2 Btms		Total Out
	SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Quantitative	Hydrogen - H_2						1.04
	Carbon Monoxide - CO						6.95
	Carbon Dioxide - CO_2						15.49
	Hydrogen Sulfide - H_2S						0.17
	Methane - CH_4						1.21
	Ethane - C_2H_6						0.54
	Propane - C_3H_8						0.33
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.17
	Ammonia - NH_3						0.04
	Light Oil - (0-100° C @ 1.6 Torr)	0.12		5.74			12.14
	Solvent - (100-230°C @ 1.6 Torr)	0.40	3.54	72.48	3.37		81.76
	Heavy Oil - (230-255°C @ 1.6 Torr)			3.03	0.07		3.52
	SRL		17.09				17.09
	Coal (MAF)		0.99				0.99
	Ash		2.56				2.56
	Water	0.07		0.56			13.79
	Phenol						
	TOTAL	0.59	24.18	81.81	3.44		157.79
Elemental	Carbon	0.45	18.91	70.38	3.04		108.66
	Hydrogen	0.05	1.22	6.32	0.29		11.72
	Nitrogen		0.24	0.19	0.01		0.66
	Sulfur	0.01	0.23	1.46	0.06		1.97
	Oxygen (by diff)	0.08	1.02	3.46	0.04		32.22
	Ash		2.56				2.56
	TOTAL	0.59	24.18	81.81	3.44		157.79

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Feed Coal	F-1 Btms	Makeup Solvent	F-2 Btms	Feed Solvent	S-8 Oil
	SAMPLE POINT	Sx-1	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			3.73		7.23	91.86
	Solvent – (100-230° C @ 1.6 Torr)		14.62	89.50	98.00	87.10	2.60
	Heavy Oil – (230-255° C @ 1.6 Torr)			6.70	2.00	5.30	4.30
	SRL		70.70				
	Coal (MAF)	63.22	4.10				
	Ash	5.62	10.58				
	Water	31.16		0.07		0.37	1.24
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		95.42				
	Melting Point °F		290				
	Specific Gravity 60/60			1.040	1.032	1.054	
	Viscosity, cp						
Elemental	Carbon	44.25	78.20	87.39	88.49	86.93	78.57
	Hydrogen	6.55	5.04	8.16	8.29	7.84	10.17
	Nitrogen	0.63	1.00	0.10	0.23	0.22	0.27
	Sulfur	0.51	0.96	2.28	1.79	1.60	0.32
	Oxygen (by diff)	42.44	4.22	2.07	1.20	3.41	10.67
	Ash	5.62	10.58				
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water
	SAMPLE POINT	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Quantitative	Hydrogen – H_2			4.44	7.28		
	Carbon Monoxide – CO			29.73	91.46		
	Carbon Dioxide – CO_2			56.63			
	Hydrogen Sulfide – H_2S			0.51			
	Methane – CH_4			5.01			
	Ethane – C_2H_6			1.95			
	Propane – C_3H_8			0.99			
	Butane – C_4H_{10}						
	Nitrogen – N_2			0.70	1.26		
	Ammonia – NH_3 (PPM)			0.04			0.12
	Light Oils – (0-100° C @ 1.6 Torr)		91.86			45.37	
	Solvent – (100-230°C @ 1.6 Torr)		2.60			47.50	
	Heavy Oil – (230-255°C @1.6 Torr)		4.30			5.50	
	SRL						
	Coal (MAF)						
	Ash						
	Water	100	1.24			1.63	99.88
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon		78.57	34.31	39.20	82.77	
	Hydrogen	11.11	10.17	6.30	7.28	9.13	11.12
	Nitrogen		0.27	0.73	1.26	0.25	0.10
	Sulfur		0.32	0.48		1.00	
	Oxygen (by diff)	88.89	10.67	58.18	52.26	6.85	88.78
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Total	S-4A Ovhd	J-1 Disch.	Cold Trap	S-4A Oil	S-4A Water
Quantitative	SAMPLE POINT	Sx-23	Sx-30	Sx-32	Sx-33	Sx-37	Sx-37
	Hydrogen – H_2		1.85	0.83			
	Carbon Monoxide – CO		11.32	10.77			
	Carbon Dioxide – CO_2	SEE CALCULATED S-4B COMPOSITION	75.86	79.76			
	Hydrogen Sulfide – H_2S		1.60				
	Methane – CH_4		3.10	2.27			
	Ethane – C_2H_6		2.72	3.03			
	Propane – C_3H_8		2.53	3.34			
	Butane – C_4H_{10}						
	Nitrogen – N_2		0.63				
	Ammonia – NH_3 (PPM)	0.10	0.39				0.20
	Light Oils – (0-100° C @ 1.6 Torr)	5.90			19.88	52.85	
	Solvent – (100-230°C @ 1.6 Torr)	6.18			68.31	42.98	
	Heavy Oil – (230-255°C @1.6 Torr)	0.71				3.30	
	SRL						
	Coal (MAF)						
	Ash						
	Water	87.11			11.81	0.87	99.80
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60					0.975	
	Viscosity, cp						
Elemental	Carbon	10.76	32.11	33.22	76.93	83.29	
	Hydrogen	10.86	3.79	2.62	8.51	9.55	11.13
	Nitrogen	0.12	0.95		0.40	0.23	0.16
	Sulfur	0.13	1.51		0.98	0.90	
	Oxygen (by diff)	78.13	61.64	64.16	13.18	6.03	88.71
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	5	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Total	Recycle Solvent		S-4B Btms		
	SAMPLE POINT	Sx-37	Sx-39		Calc.		
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)				0.09		
	Light Oils – (0-100° C @ 1.6 Torr)	52.59	7.02		10.38		
	Solvent – (100-230°C @ 1.6 Torr)	42.77	88.60		10.86		
	Heavy Oil – (230-255°C @ 1.6 Torr)	3.28	3.70		1.26		
	SRL						
	Coal (MAF)						
	Ash						
	Water	1.36	0.68		77.41		
	Phenol						
	TOTAL	100	100		100		
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60		1.052				
	Viscosity, cp						
Elemental	Carbon	82.87	86.03		18.93		
	Hydrogen	9.56	7.73		10.67		
	Nitrogen	0.23	0.23		0.14		
	Sulfur	0.90	1.78		0.23		
	Oxygen (by diff)	6.44	4.23		70.03		
	Ash						
	TOTAL	100	100		100		
	Number of Sample Avg.	2	2		-		

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-013[illegible]

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	44.27	52.35	26.50	14.16		
Carbon Monoxide – CO	21.19	47.00	11.60	13.12		
Carbon Dioxide – CO_2	25.69		49.45	61.84		
Hydrogen Sulfide – H_2S	0.30		1.35			
Methane – CH_4	6.25		5.55	4.84		
Ethane – C_2H_6	1.30		2.60	3.45		
Propane – C_3H_8	0.45		1.65	2.59		
Butane – C_4H_{10}						
Nitrogen – N_2	0.50	0.65	0.65			
Ammonia – NH_3 (PPM)	0.05		0.65			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Calc. Mole Wt.	19.96	14.39	28.68	34.12		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2		

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1E
DATE: 7/22-23/77
TIME: 1330-0130

SAMPLE DESCRIPTION	F-1 Btms	Makeup Solv	LEC Btms	Feed Solv.	S-8 Oil
SAMPLE POINT	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5	5	
IBP		73.5	150	67	
5%		134	155.5	106	
10%		164	161.5	133	
20%		187	165.5	165	
30%		193	172.0	180	
40%		198	179.0	187	
50%		203	182.6	193	
60%		208	187.4	198	
70%		218	193.2	205	
80%		226	197.5	212	
90%		240	210.0	228	
95%		252.5	229.5	249	
DRY PT.		260	233.2	260	
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR					742
IBP					67
5%					79
10%					84
20%					158
30%					186
40%					200
50%					210
60%					223
70%					235
80%					246
90%					260
95%					290
DRY PT.					290
ASPHALTENE TEST					
WT % ASH	10.58				
WT % UNCONVERTED COAL	4.10				
WT % PRE-ASPHALTENES	37.68				
WT % ASPHALTENES	20.44				
WT % MALTENES & DIST. OIL	27.20				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		15.7	13.0	14.0	
210° F		9.2	8.5	8.7	
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)		0.07	0.09	0.37	1.24
INFRARED RATIO			0.35	0.28	
SP. GRAV. 60/60 F		1.040	1.032	1.054	

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION. USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1E
DATE: 7/22-23/77
TIME: 1330-0130

SAMPLE DESCRIPTION	S-4B Oil	S-4A Oil	Recycle Solv.		
SAMPLE POINT	Sx-23	Sx-37	Sx-39		
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR			5		
VOLUME PERCENT / TEMPERATURE, °C — IBP			68		
5%			105		
10%			131		
20%			164		
30%			178		
40%			186		
50%			194		
60%			198		
70%			204		
80%			210		
90%			226		
95%			247		
DRY PT.			263		
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	747	752			
VOLUME PERCENT / TEMPERATURE, °C — IBP	84	79			
5%	147.5	182			
10%	182	192			
20%	205	216			
30%	228.5	254			
40%	258	280			
50%	284	290			
60%	312	316			
70%	336	340			
80%	362	355			
90%		360			
95%					
DRY PT.	362	360			
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F			14.4		
210° F			8.5		
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)	1.63	0.87	0.68		
INFRARED RATIO			0.36		
SP. GRAV. 60/60 F		0.975	1.052		

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION, USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 12/22/77

MATERIAL OUT

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

Temperature: 721°F
Pressure: 2500 psig
LHSV: 1.46
GHSV: 304

lbs/hour

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	0.96	0.06				0.01
	Carbon Monoxide - CO	6.44	0.40				0.06
	Carbon Dioxide - CO_2	12.26	2.65				0.45
	Hydrogen Sulfide - H_2S	0.11	0.06				
	Methane - CH_4	1.09	0.11				0.01
	Ethane - C_2H_6	0.42	0.10				0.02
	Propane - C_3H_8	0.21	0.09				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.15	0.02				
	Ammonia - NH_3	0.01	0.01	0.02			
	Light Oil - (0-100° C @ 1.6 Torr)			0.99		4.49	
	Solvent - (100-230° C @ 1.6 Torr)			1.04		0.13	
	Heavy Oil - (230-255° C @ 1.6 Torr)			0.12		0.21	
	SRL						
	Coal (MAF)						
	Ash						
	Water			14.62		0.06	
	Phenol						
	TOTAL	21.65	3.50	16.79	Negl.	4.89	0.57
Elemental	Carbon	7.43	1.13	1.81		3.84	0.19
	Hydrogen	1.36	0.13	1.83		0.50	0.01
	Nitrogen	0.16	0.03	0.02		0.01	
	Sulfur	0.10	0.05	0.01		0.02	
	Oxygen (by diff)	12.60	2.16	13.12		0.52	0.37
	Ash						
	TOTAL	21.65	3.50	16.79	Negl.	4.89	0.57

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 12/22/77

Run No: L-1E
Date: 7/22-23/77
Time: 1330-0130

MATERIAL OUT

lbs/hour

Temperature: 721°F
Pressure: 2500 psig
LHSV: 1.46
GHSV: 304

Quantitative

STREAM DESCRIPTION	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms		Total Out
SAMPLE POINT	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.03
Carbon Monoxide - CO						6.90
Carbon Dioxide - CO_2						15.36
Hydrogen Sulfide - H_2S						0.17
Methane - CH_4						1.21
Ethane - C_2H_6						0.54
Propane - C_3H_8						0.32
Butane - C_4H_{10}						
Nitrogen - N_2						0.17
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)	0.11		5.74			11.33
Solvent - (100-230°C @ 1.6 Torr)	0.40	3.51	72.48	3.37		80.93
Heavy Oil - (230-255°C @1.6 Torr)			3.03	0.07		3.43
SRL		16.96				16.96
Coal (MAF)		0.98				0.98
Ash		2.54				2.54
Water	0.07		0.56			15.31
Phenol						
TOTAL	0.58	23.99	81.81	3.44		157.22

Elemental

Carbon	0.45	18.76	70.38	3.04		107.03
Hydrogen	0.05	1.21	6.32	0.29		11.70
Nitrogen	-	0.24	0.19	0.01		0.66
Sulfur	-	0.23	1.46	0.06		1.93
Oxygen (by diff)	0.08	1.01	3.46	0.04		33.36
Ash		2.54				2.54
TOTAL	0.58	23.99	81.81	3.44		157.22

RUN CONDITIONS

RUN NO. L-1F
DATE MADE 7/28-29/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 723
- INLET 305
- OUTLET 715

DISSOLVERS
- R-1A (1) 770
- (2) 811
- (3) 804
- (4) 828
- R-1B (1)
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 614
- S-2 80
- S-3 463
- S-4A 82
- S-4B 79

PREHEATER E-11
- DOWTHERM 677
- INLET 365
- OUTLET 650

VACUUM FLASH F-1
- OVERHEAD VAPOR 507
- UPPER WALL 627
- LOWER WALL 593
- DOWNCOMER 439
- CONDENSATE ACCUMULATOR, S-7 86

PREHEATER E-13
- DOWTHERM 596
- INLET 80
- OUTLET 565

LIGHT ENDS COLUMN, F-2
- REBOILER 406
- LOWER SECTION 526
- FEED SECTION 450
- OVERHEAD 213
- S-8 85
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD 440
- BOTTOMS 495

PRECIPITATION TOWER, V-8
- ZONE (1) 417
- (2) 418
- (3) 428

RECOVERY TOWER V-9
- REBOILER 493
- OVERHEAD 330

PRESSURE, psig

SEPARATORS S-1 and S-2
2500

SEPARATOR S-3
273

SEPARATORS S-4A and S-4B
60

VACUUM FLASH, F-1
14 Torr

LIGHT ENDS COLUMN, F-2
0

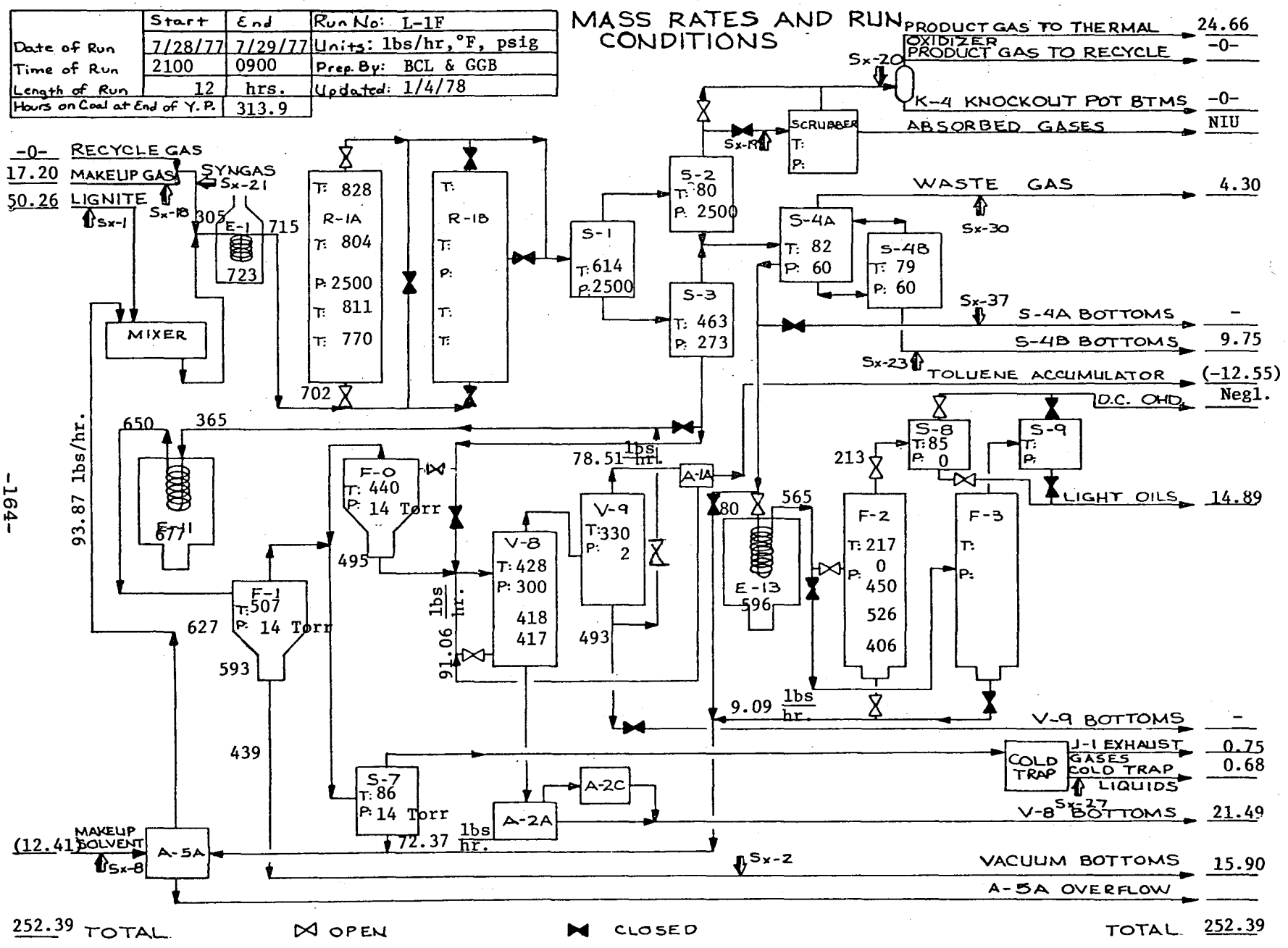
SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

VACUUM FLASH, F-0
14 Torr

SETTLING TOWER, V-8
300

RECOVERY TOWER, V-7
2



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Normalized

Revised: 1/4/78

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

SUMMARY

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 323

lbs/hour

	Stream Description	Total In	Total Out	Net Yield		Wt % MAF Coal	
Quantitative	Sample Point						
	Hydrogen - H_2	1.30	1.07	-0.23			
	Carbon Monoxide - CO	15.68	7.23	-8.45			
	Carbon Dioxide - CO_2		18.53	18.53			
	Hydrogen Sulfide - H_2S		0.18	0.18			
	Methane - CH_4		1.40	1.40			
	Ethane - C_2H_6		0.64	0.64	12.53	40.24	
	Propane - C_3H_8		0.48	0.48			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.22	0.16	-0.06			
	Ammonia - NH_3		0.04	0.04			
	Distillable Oil (IBP-255°C @1.6 Torr)	184.63	185.91	1.28	17.48	56.13	
	SRL		16.20	16.20			
	Coal (MAF)	31.14	2.78	-28.36		-91.07	
	Ash	3.38	3.24	-0.14		-0.45	
	Water	16.04	14.53	-1.51		-4.85	
	Phenol						
	Total	252.39	252.39	-0-			

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE

MEASURED & ADJUSTED MATERIAL BALANCE

Revised: 1/4/78

MATERIAL IN

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 323

lbs/hour

	Stream Description	Feed Gas	Lignite	Feed Solvent	Feed Toluene		Total In
Quantitative	Sample Point	Sx-21	Sx-1	Sx-14	Sx-40		
	Hydrogen - H_2	1.30					1.30
	Carbon Monoxide - CO	15.68					15.68
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.22					0.22
	Ammonia - NH_3						
	Distillable Oil (IBP-255°C @1.6 Torr)			93.57	91.06		184.63
	SRL						
	Coal (MAF)		31.14				31.14
	Ash		3.38				3.38
	Water		15.74	0.30			16.04
	Phenol						
	Total	17.20	50.26	93.87	91.06		252.39

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/4/78

MATERIAL OUT

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 323

lbs/hour

	Stream Description	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	Sample Point	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.00	0.06				0.01
	Carbon Monoxide - CO	6.74	0.44				0.05
	Carbon Dioxide - CO_2	14.63	3.29				0.61
	Hydrogen Sulfide - H_2S	0.12	0.06				
	Methane - CH_4	1.24	0.14				0.02
	Ethane - C_2H_6	0.50	0.12				0.02
	Propane - C_3H_8	0.29	0.15				0.04
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.13	0.03				
	Ammonia - NH_3	0.01	0.01	0.01		0.01	
	Distillable Oil (IBP-255°C @1.6 Torr)			0.34		10.04	
	SRL						
	Coal (MAF)						
	Ash						
	Water			9.40		4.84	
	Phenol						
	Total	24.66	4.30	9.75	Negl.	14.89	0.75

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/4/78

MATERIAL OUT

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 323

lbs/hour

	Stream Description	Cold Trap	V-8 Btms	F-1 Btms	V-9 Ovhd	←Recycle S-7 Btms	Solvent→ F-2 Btms
	Sample Point	Sx-33	Sx-27	Sx-2	Sx-28	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Distillable Oil (IBP-255°C @1.6 Torr)	0.60	11.42	3.75	78.51	72.16	9.09
	SRL		5.49	10.71			
	Coal (MAF)		2.36	0.42			
	Ash		2.22	1.02			
	Water	0.08				0.21	
	Phenol						
	Total	0.68	21.49	15.90	78.51	72.37	9.09

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Normalized

Revised: 1/4/78

MATERIAL OUT

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 323

lbs/hour

Quantitative	Stream Description						Total Out
	Sample Point						
	Hydrogen - H_2						1.07
	Carbon Monoxide - CO						7.23
	Carbon Dioxide - CO_2						18.53
	Hydrogen Sulfide - H_2S						0.18
	Methane - CH_4						1.40
	Ethane - C_2H_6						0.64
	Propane - C_3H_8						0.48
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.16
	Ammonia - NH_3						0.04
	Distillable Oil (IBP-255°C @1.6 Torr)						185.91
	SRL						16.20
	Coal (MAF)						2.78
	Ash						3.24
	Water						14.53
	Phenol						
	Total						252.39

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

WEIGHT PERCENT

	Sample Description	Lignite	F-1 Btms	Makeup Solvent	LEC Btms	Feed Solvent	S-8 Oil
	Sample Point	Sx-1	*Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3 (PPM)						
	Distillable Oil (IBP-255°C @1.6 Torr)		23.57	99.80	100	99.68	100
	SRL		67.33				
	Coal (MAF)	61.96	2.66				
	Ash	6.72	6.44				
	Water	31.32		0.20		0.32	
	Total	100	100	100	100	100	100
	P.S. (Ash-free		97.16				
	Melting Point		242				
	Specific Gravity 60/60			1.040	1.032	1.033	
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	2	2	2	2	2	2

*Distillable oil calculated by following equation:
Wt % Distillable Oil = -0.1273 (F-1 Btms Melting Point) + 54.38
See graph.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

WEIGHT PERCENT

	Sample Description	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water
	Sample Point	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Quantitative	Hydrogen - H_2			4.07	7.55		
	Carbon Monoxide - CO			27.32	91.16		
	Carbon Dioxide - CO_2			59.31			
	Hydrogen Sulfide - H_2S			0.49			
	Methane - CH_4			5.04			
	Ethane - C_2H_6			2.02			
	Propane - C_3H_8			1.16			
	Butane - C_4H_{10}						
	Nitrogen - N_2			0.54	1.29		
	Ammonia - NH_3 (PPM)	0.13	0.04	0.05			0.13
	Distillable Oil (IBP-255°C @1.6 Torr)		67.43			100	
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.87	32.53				99.87
	Total	100	100	100	100	100	100
	P.S. (Ash-free						
	Melting Point						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	2	2	2	2	-	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

WEIGHT PERCENT

	Sample Description	S-4B Total	V-8 Btms	V-9 Ovhd	S-4A Ovhd	J-1 Disch.	Cold Trap
Quantitative	Sample Point	Sx-23	*Sx-27	Sx-28	Sx-30	Sx-32	Sx-33
	Hydrogen - H_2				1.42	0.68	
	Carbon Monoxide - CO				10.24	6.22	
	Carbon Dioxide - CO_2				76.50	82.00	
	Hydrogen Sulfide - H_2S				1.44		
	Methane - CH_4				3.19	2.18	
	Ethane - C_2H_6				2.79	3.23	
	Propane - C_3H_8				3.59	5.69	
	Butane - C_4H_{10}						
	Nitrogen - N_2				0.69		
	Ammonia - NH_3 (PPM)	0.13			0.14		
	Distillable Oil (IBP-255°C @1.6 Torr)	3.43	53.14	100			88.19
	SRL		25.55				
	Coal (MAF)		10.98				
	Ash		10.33				
	Water	96.44					11.81
	Total	100	100	100	100	100	100
	P.S. (Ash-free						
	Melting Point						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	-	-	-	2	2	2

***Composition calculated by mass balance around area 03.**

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

WEIGHT PERCENT

Quantitative

Sample Description	Recycle Solvent	Deashing Solvent				
Sample Point	Sx-39	Sx-40				
Hydrogen - H_2						
Carbon Monoxide - CO						
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3 (PPM)						
Distillable Oil (IBP-255°C @1.6 Torr)	99.71	100				
SRL						
Coal (MAF)						
Ash						
Water	0.29					
Total	100	100				
P.S. (Ash-free						
Melting Point						
Specific Gravity 60/60	1.034					
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff.)						
Ash						
Total						
Number of Sample Avg.	-	-				

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

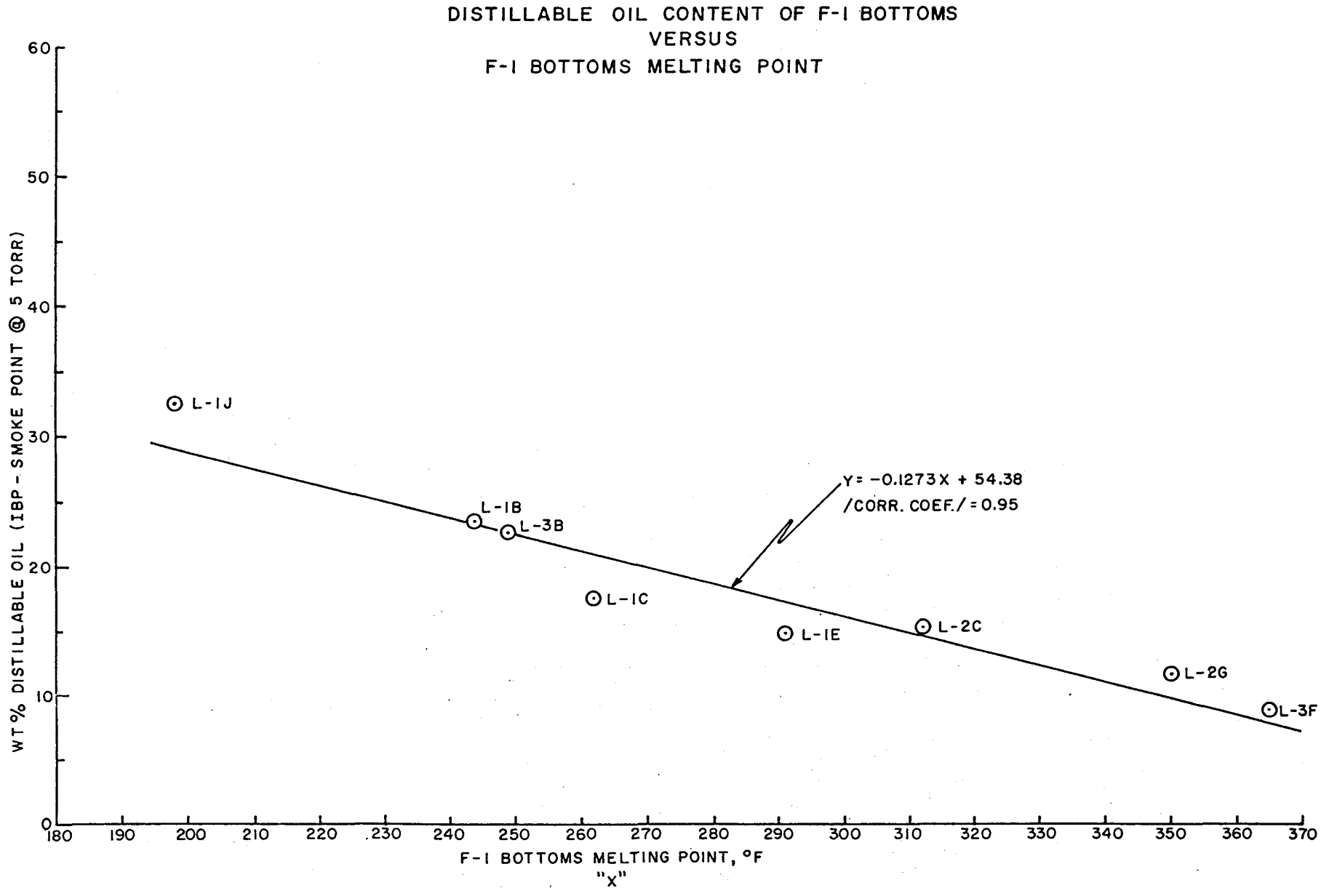
MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed GAs	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	42.39	53.35	21.80	12.19		
Carbon Monoxide – CO	20.30	46.00	11.20	7.94		
Carbon Dioxide – CO_2	28.05		53.25	66.55		
Hydrogen Sulfide – H_2S	0.30		1.30			
Methane – CH_4	6.55		6.10	4.86		
Ethane – C_2H_6	1.40		2.85	3.84		
Propane – C_3H_8	0.55		2.50	4.62		
Butane – C_4H_{10}						
Nitrogen – N_2	0.40	0.65	0.75			
Ammonia – NH_3 (PPM)	0.06		0.25			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Calc Mole Wt	20.81	14.13	30.63	35.71		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2		


DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT
WT% DISTILLABLE OIL (IBP - SMOKE POINT @ 5 TORR)
"Y"
F-1 BOTTOMS MELTING POINT, °F
"X"
Y = -0.1273X + 54.38
/CORR. COEF./ = 0.95
L-1J
L-1B
L-3B
L-1C
L-1E
L-2C
L-2G
L-3F
0
10
20
30
40
50
60
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/4/78

MATERIAL OUT

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

Temperature:715°F
Pressure:2500 psig
LHSV: 1.44
GHSV: 323

lbs/hour

	Stream Description	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	Sample Point	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	0.99	0.06				
	Carbon Monoxide - CO	6.65	0.43				0.05
	Carbon Dioxide - CO_2	14.44	3.24				0.61
	Hydrogen Sulfide - H_2S	0.12	0.06				
	Methane - CH_4	1.23	0.14				0.02
	Ethane - C_2H_6	0.49	0.12				0.02
	Propane - C_3H_8	0.28	0.15				0.04
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.13	0.03				
	Ammonia - NH_3	0.01	0.01	0.01		0.01	
	Distillable Oil (IBP-255°C @1.6 Torr)			0.33		9.91	
	SRL						
	Coal (MAF)						
	Ash						
	Water			9.28		4.78	
	Phenol						
	Total	24.34	4.24	9.62	Negl.	14.70	0.74
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE

MEASURED MATERIAL BALANCE

Revised: 1/4/78

MATERIAL OUT

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 323

lbs/hour

	Stream Description	Cold Trap	V-8 Btms	F-1 Btms	V-9 Ovhd	←Recycle S-7 Btms	Solvent→ F-2 Btms
Quantitative	Sample Point	Sx-33	Sx-27	Sx-2	Sx-28	Sx-39	Sx-12
	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Distillable Oil (IBP-255°C @1.6 Torr)	0.59	11.27	3.70	78.51	72.16	9.09
	SRL		5.42	10.56			
	Coal (MAF)		2.33	0.42			
	Ash		2.19	1.01			
	Water	0.08				0.21	
	Phenol						
	Total	0.67	21.21	15.69	78.51	72.37	9.09

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT IGNITE

MEASURED MATERIAL BALANCE

Revised: 1/4/78

MATERIAL OUT

Run No: L-1F
Date: 7/28/77
Time: 2100-0900

Temperature: 715°F
Pressure: 2500 psig
LHSV: 1.44
GHSV: 323

lbs/hour

Quantitative	Stream Description						Total Out
	Sample Point						
	Hydrogen - H_2						1.05
	Carbon Monoxide - CO						7.13
	Carbon Dioxide - CO_2						18.29
	Hydrogen Sulfide - H_2S						0.18
	Methane - CH_4						1.39
	Ethane - C_2H_6						0.63
	Propane - C_3H_8						0.47
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.16
	Ammonia - NH_3						0.04
	Distillable Oil (IBP-255°C @1.6 Torr)						185.56
	SRL						15.98
	Coal (MAF)						2.75
	Ash						3.20
	Water						14.35
	Phenol						
	Total						251.18

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

RUN CONDITIONS

RUN NO. L-1H
DATE MADE 8/1/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 758
- INLET 319
- OUTLET 736

DISSOLVERS
- R-1A (1) 745
- (2) 761
- (3) 770
- (4) 823
- R-1B (1)
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 622
- S-2 80
- S-3 467
- S-4A 80
- S-4B 74

PREHEATER E-11
- DOWTHERM 646
- INLET 432
- OUTLET 626

VACUUM FLASH F-1
- OVERHEAD VAPOR 505
- UPPER WALL 617
- LOWER WALL 610
- DOWNCOMER 434
- CONDENSATE ACCUMULATOR, S-7 83

PREHEATER E-13
- DOWTHERM 596
- INLET 75
- OUTLET 565

LIGHT ENDS COLUMN, F-2
- REBOILER 399
- LOWER SECTION 468
- FEED SECTION 416
- OVERHEAD 190
- S-8 79
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2
2500

SEPARATOR S-3
296

SEPARATORS S-4A and S-4B
60

VACUUM FLASH, F-1
14 Torr

LIGHT ENDS COLUMN, F-2
0

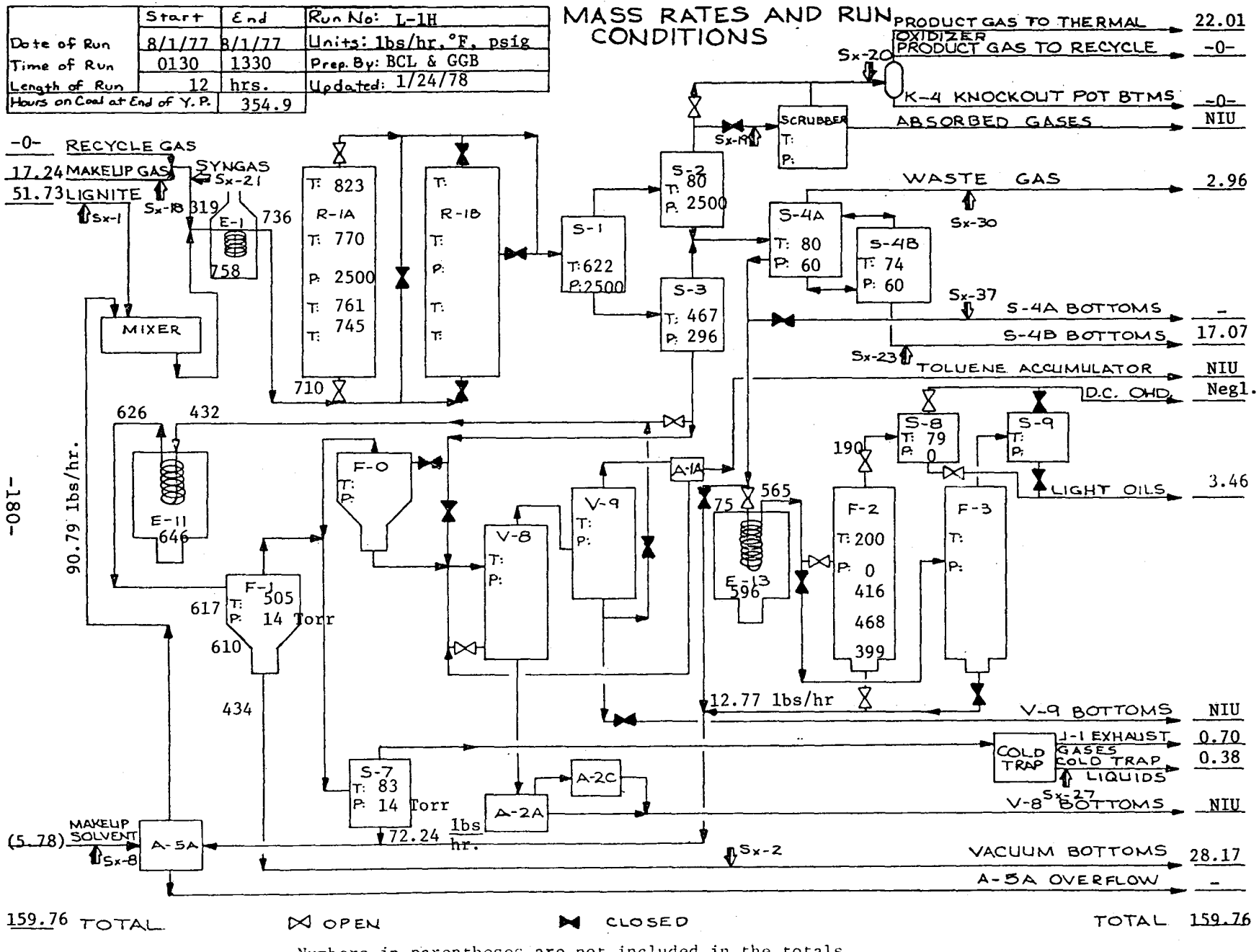
SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/24/78

SUMMARY

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

Temperature: 736°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 328

lbs/hour

	Stream Description	Total In	Total Out	Net Yield		Wt % MAF Coal	
Quantitative	Sample Point						
	Hydrogen - H_2	1.34	1.13	-0.21			
	Carbon Monoxide - CO	15.75	9.56	-6.19			
	Carbon Dioxide - CO_2		12.81	12.81			
	Hydrogen Sulfide - H_2S		0.17	0.17			
	Methane - CH_4		0.89	0.89			
	Ethane - C_2H_6		0.60	0.60	8.45	27.04	
	Propane - C_3H_8		0.35	0.35			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.15	0.15	-0-			
	Ammonia - NH_3		0.03	0.03			
	Distillable Oil (IBP-255°C @1.6 Torr)	90.36	91.58	1.22	20.31	64.99	
	SRL		19.09	19.09			
	Coal (MAF)	31.25	3.76	-27.49		-87.97	
	Ash	3.22	3.20	-0.02		-0.06	
	Water	17.69	16.44	-1.25		-4.00	
	Phenol						
	Total	159.76	159.76	-0-			

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE

MEASURED & ADJUSTED MATERIAL BALANCE

Revised: 1/24/78

MATERIAL IN

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

Temperature: 736°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 328

lbs/hour

	Stream Description	Feed Gas	Lignite	Feed Solvent			Total In
	Sample Point	Sx-21	Sx-1	Sx-14			
Quantitative	Hydrogen - H_2	1.34					1.34
	Carbon Monoxide - CO	15.75					15.75
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.15					0.15
	Ammonia - NH_3						
	Distillable Oil (IBP-255°C @1.6 Torr)			90.36			90.36
	SRL						
	Coal (MAF)		31.25				31.25
	Ash		3.22				3.22
	Water		17.26	0.43			17.69
	Phenol						
	Total	17.24	51.73	90.79			159.76

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/24/78

MATERIAL OUT

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

Temperature: 736°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 328

lbs/hour

	Stream Description	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	Sample Point	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.06	0.06				0.01
	Carbon Monoxide - CO	8.97	0.50				0.09
	Carbon Dioxide - CO_2	10.19	2.07				0.55
	Hydrogen Sulfide - H_2S	0.12	0.05				
	Methane - CH_4	0.81	0.07				0.01
	Ethane - C_2H_6	0.49	0.09				0.02
	Propane - C_3H_8	0.23	0.10				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.13	0.02				
	Ammonia - NH_3	0.01		0.02			
	Distillable Oil (IBP-255°C @1.6 Torr)			1.53		3.46	
	SRL						
	Coal (MAF)						
	Ash						
	Water			15.52			
	Phenol						
	Total	22.01	2.96	17.07	Negl.	3.46	0.70
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/24/78

MATERIAL OUT

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

Temperature: 736°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 328

lbs/hour

	Stream Description	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-2 Btms		Total Out
	Sample Point	Sx-33	Sx-2	Sx-39	Sx-12		
Quantitative	Hydrogen - H_2						1.13
	Carbon Monoxide - CO						9.56
	Carbon Dioxide - CO_2						12.81
	Hydrogen Sulfide - H_2S						0.17
	Methane - CH_4						0.89
	Ethane - C_2H_6						0.60
	Propane - C_3H_8						0.35
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.15
	Ammonia - NH_3						0.03
	Distillable Oil (IBP-255°C @1.6 Torr)	0.15	2.12	71.55	12.77		91.58
	SRL		19.09				19.09
	Coal (MAF)		3.76				3.76
	Ash		3.20				3.20
	Water	0.23		0.69			16.44
	Phenol						
	Total	0.38	28.17	72.24	12.77		159.76

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

WEIGHT PERCENT

	Sample Description	Lignite	F-1 Btms	Makeup Solvent	F-3 Btms	Feed Solvent	S-8 Oil
	Sample Point	Sx-1	*Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3 (PPM)						
	Distillable Oil (IBP-255°C @1.6 Torr)		7.53	99.80	100	99.53	100
	SRL		67.77				
	Coal (MAF)	60.41	13.34				
	Ash	6.23	11.36				
	Water	33.36		0.20		0.47	
	Total	100	100	100	100	100	100
	P.S. (Ash-free		84.95				
	Melting Point		368				
	Specific Gravity 60/60			1.040	1.006	1.039	
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	2	2	2	2	2	2

*Distillable oil calculated using the following equation:
Wt % Distillable oil = -0.1273 (F-1 Btms melting point) + 54.38.
See graph

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

WEIGHT PERCENT

	Sample Description	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water
	Sample Point	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Quantitative	Hydrogen - H_2			4.82	7.75		
	Carbon Monoxide - CO			40.77	91.35		
	Carbon Dioxide - CO_2			46.28			
	Hydrogen Sulfide - H_2S			0.54			
	Methane - CH_4			3.68			
	Ethane - C_2H_6			2.22			
	Propane - C_3H_8			1.05			
	Butane - C_4H_{10}						
	Nitrogen - N_2			0.59	0.90		
	Ammonia - NH_3 (PPM)			0.05			0.14
	Distillable Oil (IBP-255°C @1.6 Torr)		100			98.57	
	SRL						
	Coal (MAF)						
	Ash						
	Water	100				1.43	99.86
	Total	100	100	100	100	100	100
	P.S. (Ash-free						
	Melting Point						
	Specific Gravity 60/60						
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	-	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

WEIGHT PERCENT

	Sample Description	S-4B Total	S-4A Ovhd	J-1 Disch.	Cold Trap	Recycle Solvent	
	Sample Point	Sx-23	Sx-30	Sx-32	Sx-33	Sx-39	
Quantitative	Hydrogen - H_2		1.98	0.93			
	Carbon Monoxide - CO		17.08	12.32			
	Carbon Dioxide - CO_2		69.85	78.35			
	Hydrogen Sulfide - H_2S		1.59				
	Methane - CH_4		2.35	1.35			
	Ethane - C_2H_6		3.12	3.67			
	Propane - C_3H_8		3.31	3.38			
	Butane - C_4H_{10}						
	Nitrogen - N_2		0.60				
	Ammonia - NH_3 (PPM)	0.13	0.12				
	Distillable Oil (IBP-255°C @1.6 Torr)	8.96			40.70	99.04	
	SRL						
	Coal (MAF)						
	Ash						
	Water	90.91			59.30	0.96	
	Total	100	100	100	100	100	
	P.S. (Ash-free						
	Melting Point						
	Specific Gravity 60/60					1.042	
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	2	2	2	2	2	

PROJECT LIGNITE
SAMPLE ANALYSIS

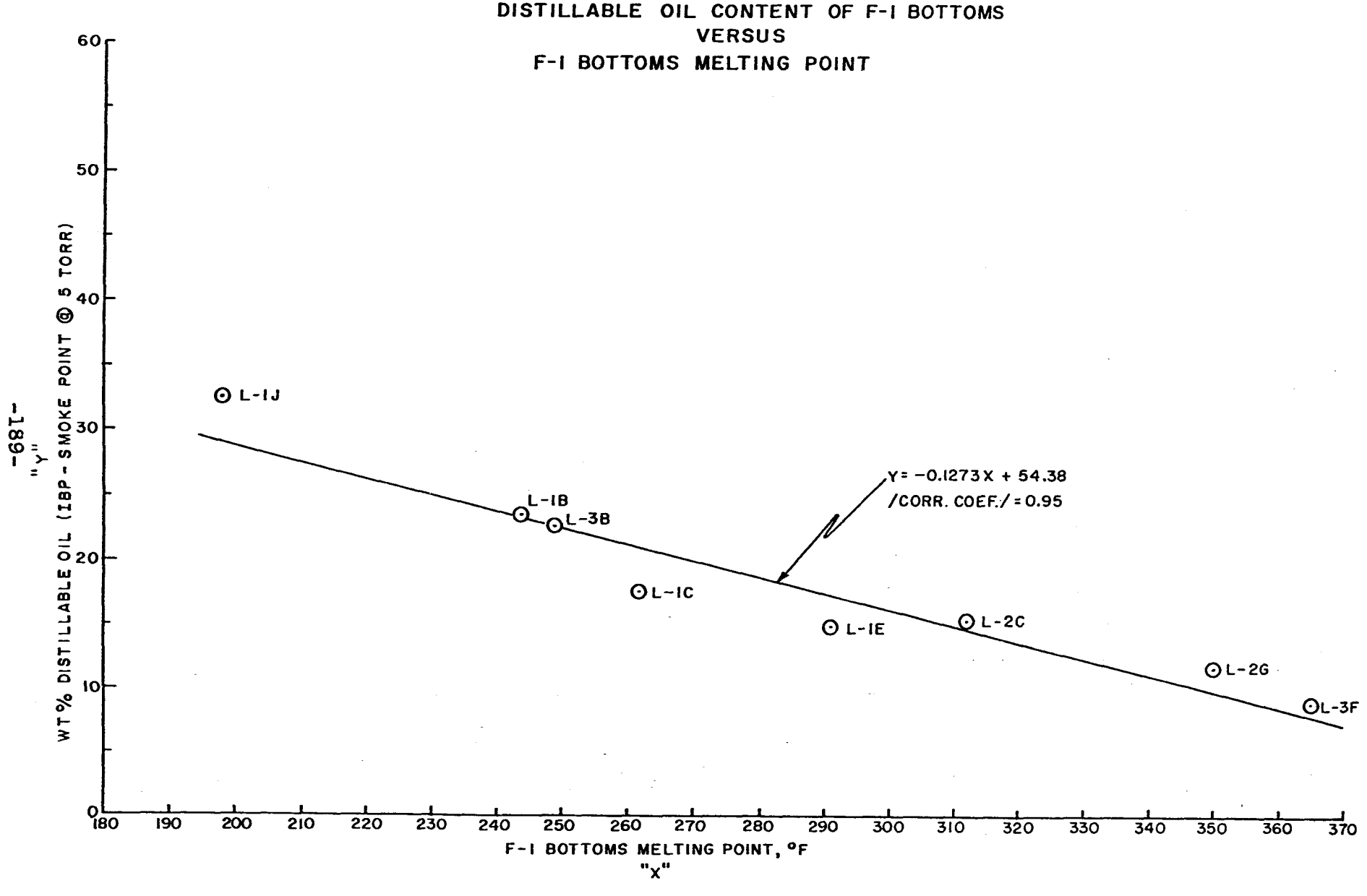
Updated: 1/4/78

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

MOLE PERCENT

	SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
	SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Quantitative	Hydrogen – H_2	45.62	54.05	27.55	15.66		
	Carbon Monoxide – CO	27.54	45.50	17.00	14.82		
	Carbon Dioxide – CO_2	19.89		44.25	59.97		
	Hydrogen Sulfide – H_2S	0.30		1.30			
	Methane – CH_4	4.35		4.10	2.84		
	Ethane – C_2H_6	1.40		2.90	4.12		
	Propane – C_3H_8	0.45		2.10	2.59		
	Butane – C_4H_{10}						
	Nitrogen – N_2	0.40	0.45	0.60			
	Ammonia – NH_3 (PPM)	0.05		0.20			
	Light Oils – (0-100° C @ 1.6 Torr)						
	Solvent – (100-230° C @ 1.6 Torr)						
	Heavy Oil – (230-255°C @1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water						
	Phenol						
	TOTAL	100	100	100	100		
	Calc Mole Wt.	18.91	13.95	27.88	33.68		
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2		


DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT
WT % DISTILLABLE OIL (IBP - SMOKE POINT @ 5 TORR)
"Y"
F-1 BOTTOMS MELTING POINT, °F
"X"
Y = -0.1273X + 54.38
/CORR. COEF./ = 0.95
L-1J
L-1B
L-3B
L-1C
L-1E
L-2C
L-2G
L-3F
0
10
20
30
40
50
60
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370

PROJECT LIGNITE

MEASURED MATERIAL BALANCE

Revised: 1/24/78

MATERIAL OUT

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

Temperature: 736°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 328

lbs/hour

	Stream Description	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	Sample Point	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.09	0.06				0.01
	Carbon Monoxide - CO	9.22	0.52				0.09
	Carbon Dioxide - CO_2	10.46	2.12				0.56
	Hydrogen Sulfide - H_2S	0.12	0.05				
	Methane - CH_4	0.83	0.07				0.01
	Ethane - C_2H_6	0.50	0.10				0.03
	Propane - C_3H_8	0.24	0.10				0.02
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.13	0.02				
	Ammonia - NH_3	0.01		0.02			
	Distillable Oil (IBP-255°C @1.6 Torr)			1.57		3.55	
	SRL						
	Coal (MAF)						
	Ash						
	Water			15.94			
	Phenol						
	Total	22.60	3.04	17.53	Negl.	3.55	0.72

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/24/78

MATERIAL OUT

Run No: L-1H
Date: 8/1/77
Time: 0130-1330

Temperature: 736°F
Pressure: 2500 psig
LHSV: 1.43
GHSV: 328

lbs/hour

Stream Description	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms		Total Out
Sample Point	Sx-33	Sx-2	Sx-39	Sx-12		
Hydrogen - H_2						1.16
Carbon Monoxide - CO						9.83
Carbon Dioxide - CO_2						13.14
Hydrogen Sulfide - H_2S						0.17
Methane - CH_4						0.91
Ethane - C_2H_6						0.63
Propane - C_3H_8						0.36
Butane - C_4H_{10}						
Nitrogen - N_2						0.15
Ammonia - NH_3						0.03
Distillable Oil (IBP-255°C @1.6 Torr)	0.16	2.18	71.55	12.77		91.78
SRL		19.60				19.60
Coal (MAF)		3.86				3.86
Ash		3.29				3.29
Water	0.23		0.69			16.86
Phenol						
Total	0.39	28.93	72.24	12.77		161.77

Quantitative

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
Total						

RUN CONDITIONS

RUN NO. L-1I

DATE MADE 8/1-2/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 760
- INLET 322
- OUTLET 741

DISSOLVERS
- R-1A (1) 746
- (2) 762
- (3) 764
- (4) 824
- R-1B (1)
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 617
- S-2 80
- S-3 465
- S-4A 83
- S-4B 60

PREHEATER E-11
- DOWTHERM 646
- INLET 433
- OUTLET 626

VACUUM FLASH F-1
- OVERHEAD VAPOR 504
- UPPER WALL 623
- LOWER WALL 611
- DOWNCOMER 436
- CONDENSATE ACCUMULATOR, S-7 85

PREHEATER E-13
- DOWTHERM 596
- INLET 78
- OUTLET 566

LIGHT ENDS COLUMN, F-2
- REBOILER 400
- LOWER SECTION 474
- FEED SECTION 425
- OVERHEAD 194
- S-8 81
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2: 2500

SEPARATOR S-3: 290

SEPARATORS S-4A and S-4B: 60

VACUUM FLASH, F-1: 14 Torr

LIGHT ENDS COLUMN, F-2: 0

SOLVENT COLUMN, F-3: NIU

HEAVY ENDS COLUMN, F-4: NIU

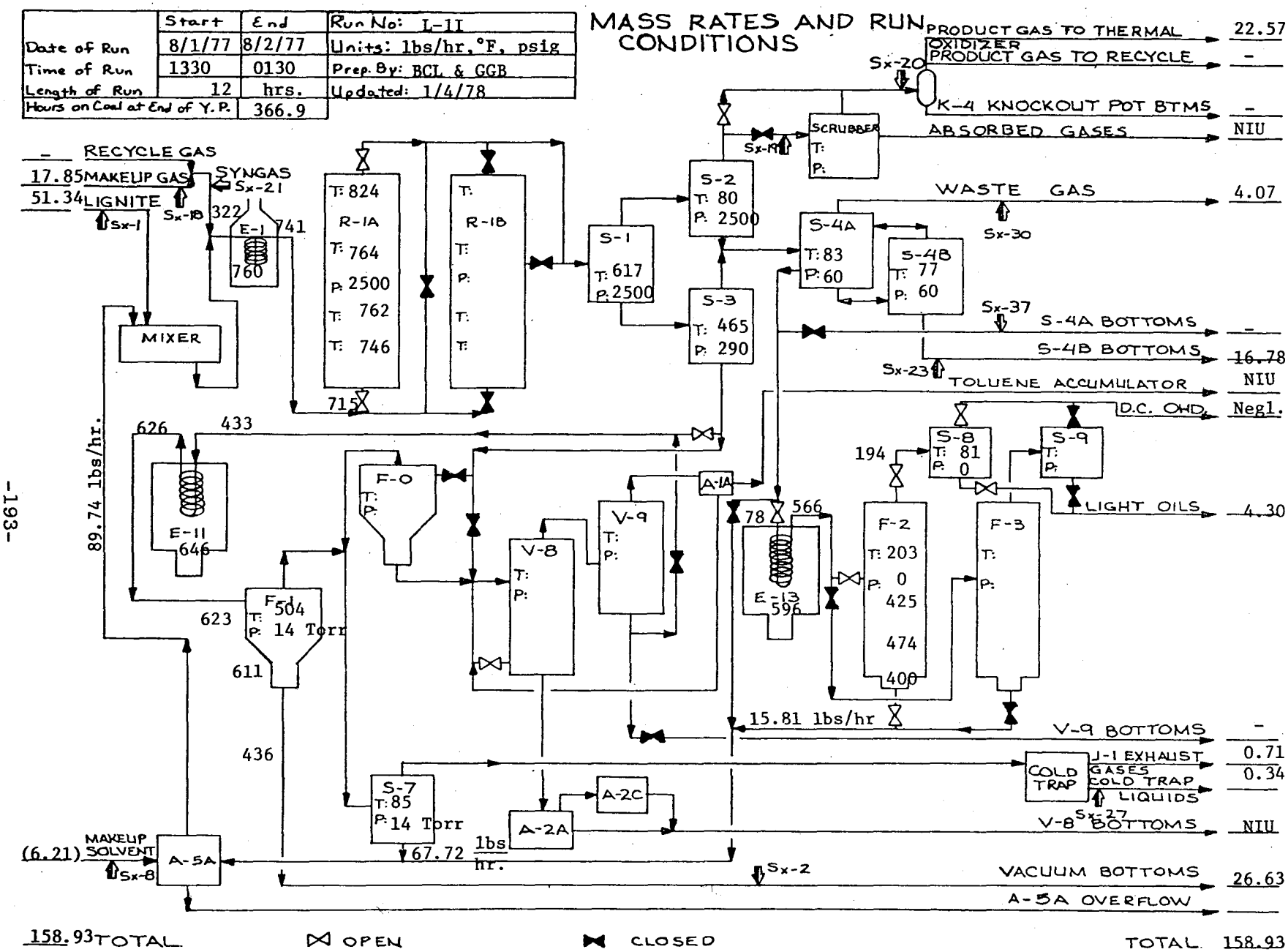
VACUUM FLASH, F-0: NIU

SETTLING TOWER, V-8: NIU

RECOVERY TOWER, V-7: NIU

	Start	End	Run No: L-11
Date of Run	8/1/77	8/2/77	Units: lbs/hr, °F, psig
Time of Run	1330	0130	Prep. By: BCL & GGB
Length of Run	12	hrs.	Updated: 1/4/78
Hours on Coal at End of Y.P.	366.9		

MASS RATES AND RUN CONDITIONS



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/4/78

SUMMARY

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 328

lbs/hour

Quantitative

Stream Description	Total In	Total Out	Net Yield		Wt.% MAF Coal	
Sample Point						
Hydrogen - H_2	1.29	1.15	-0.14			
Carbon Monoxide - CO	16.30	10.20	-6.10			
Carbon Dioxide - CO_2		13.49	13.49			
Hydrogen Sulfide - H_2S		0.20	0.20			
Methane - CH_4		0.90	0.90	9.52	30.03	
Ethane - C_2H_6		0.67	0.67			
Propane - C_3H_8		0.55	0.55			
Butane - C_4H_{10}						
Nitrogen - N_2	0.26	0.17	-0.09			
Ammonia - NH_3		0.04	0.04			
Distillable Oil (IBP-255°C @1.6 Torr)	89.30	91.18	1.88	20.60	64.99	
SRL		18.72	18.72			
Coal (MAF)	31.70	2.98	-28.72		-90.60	
Ash	3.11	2.86	-0.25		-0.79	
Water	16.97	15.82	-1.15		-3.63	
Phenol						
Total	158.93	158.93	-0-			

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
Total						

PROJECT LIGNITE
MEASURED & ADJUSTED MATERIAL BALANCE
Revised: 1/4/78

MATERIAL IN

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.41
GHSV:328

lbs/hour

Stream Description	Feed Gas	Lignite	Feed Solvent			Total In
Sample Point	Sx-21	Sx-1	Sx-14			
Hydrogen - H_2	1.29					1.29
Carbon Monoxide - CO	16.30					16.30
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2	0.26					0.26
Ammonia - NH_3						
Distillable Oil (IBP-255°C @1.6 Torr)			89.30			89.30
SRL						
Coal (MAF)		31.70				31.70
Ash		3.11				3.11
Water		16.53	0.44			16.97
Phenol						
Total	17.85	51.34	89.74			158.93

Quantitative

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
Total						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/4/78

MATERIAL OUT

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 328

lbs/hour

	Stream Description	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	Sample Point	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.07	0.07				0.01
	Carbon Monoxide - CO	9.41	0.70				0.09
	Carbon Dioxide - CO_2	10.20	2.75				0.54
	Hydrogen Sulfide - H_2S	0.12	0.08				
	Methane - CH_4	0.78	0.11				0.01
	Ethane - C_2H_6	0.51	0.14				0.02
	Propane - C_3H_8	0.34	0.17				0.04
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.13	0.04				
	Ammonia - NH_3	0.01	0.01	0.02			
	Distillable Oil (IBP-255°C @1.6 Torr)			1.47		4.30	
	SRL						
	Coal (MAF)						
	Ash						
	Water			15.29			
	Phenol						
	Total	22.57	4.07	16.78	Negl.	4.30	0.71

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized
Revised: 1/4/78

MATERIAL OUT

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 328

lbs/hour

	Stream Description	Cold Trap	F-1 Btms	← Recycle S-7 Btms	Solvent → F-2 Btms		Total Out
	Sample Point	Sx-33	Sx-2	Sx-39	Sx-12		
Quantitative	Hydrogen - H_2						1.15
	Carbon Monoxide - CO						10.20
	Carbon Dioxide - CO_2						13.49
	Hydrogen Sulfide - H_2S						0.20
	Methane - CH_4						0.90
	Ethane - C_2H_6						0.67
	Propane - C_3H_8						0.55
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.17
	Ammonia - NH_3						0.04
	Distillable Oil (IBP-255°C @1.6 Torr)	0.09	2.07	67.44	15.81		91.18
	SRL		18.72				18.72
	Coal (MAF)		2.98				2.98
	Ash		2.86				2.86
	Water	0.25		0.28			15.82
	Phenol						
	Total	0.34	26.63	67.72	15.81		158.93

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

WEIGHT PERCENT

	Sample Description	Lignite	F-1 Btms	Makeup Solvent	LEC Btms	Feed Solvent	S-8 Btms
Quantitative	Sample Point	Sx-1	*Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3 (PPM)						
	Distillable Oil (IBP-255°C @1.6 Torr)		7.79	99.80	100	99.51	100
	SRL		70.28				
	Coal (MAF)	61.75	11.19				
	Ash	6.06	10.74				
	Water	32.19		0.20		0.49	
	Total	100	100	100	100	100	100
	P.S. (Ash-free		87.46				
	Melting Point		366				
	Specific Gravity 60/60			1.040	1.017	1.039	
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.						

*Distillable oil calculated using following equation:
Wt % Distillable Oil = -0.1273 (F-1 Btms Melting Point) + 54.38
See Attached graph.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated:1/4/78

Run No: L-1I
Date: 8/1-2/77
Time: 1330- 0130

WEIGHT PERCENT

	Sample Description	Product Gas	Feed Gas	S-4B Oil	S-4B Water	S-4B Total	S-4A Ovhd
	Sample Point	Sx-19	Sx-21	Sx-23	Sx-23	Sx-23	Sx-30
Quantitative	Hydrogen - H_2	4.75	7.22				1.77
	Carbon Monoxide - CO	41.69	91.32				17.23
	Carbon Dioxide - CO_2	45.17					67.69
	Hydrogen Sulfide - H_2S	0.54					1.85
	Methane - CH_4	3.45					2.73
	Ethane - C_2H_6	2.28					3.59
	Propane - C_3H_8	1.50					4.10
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.59	1.46				0.89
	Ammonia - NH_3 (PPM)	0.03			0.15	0.14	0.15
	Distillable Oil (IBP-255°C @1.6 Torr)			99.46		8.73	
	SRL						
	Coal (MAF)						
	Ash						
	Water			0.54	99.85	91.13	
	Total	100	100	100	100	100	100
	P.S. (Ash-free						
	Melting Point						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff.)						
	Ash						
	Total						
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

WEIGHT PERCENT

Quantitative

Sample Description	J-1 Disch.	Cold Trap	Recycle Solvent			
Sample Point	Sx-32	Sx-33	Sx-39			
Hydrogen - H_2	0.74					
Carbon Monoxide - CO	13.16					
Carbon Dioxide - CO_2	75.17					
Hydrogen Sulfide - H_2S						
Methane - CH_4	1.56					
Ethane - C_2H_6	3.36					
Propane - C_3H_8	6.01					
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3 (PPM)						
Distillable Oil (IBP-255°C @1.6 Torr)		26.08	99.58			
SRL						
Coal (MAF)						
Ash						
Water		73.92	0.42			
Total	100	100	100			
P.S. (Ash-free						
Melting Point						
Specific Gravity 60/60			1.044			
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff.)						
Ash						
Total						
Number of Sample Avg.	2	3	2			

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

MOLE PERCENT

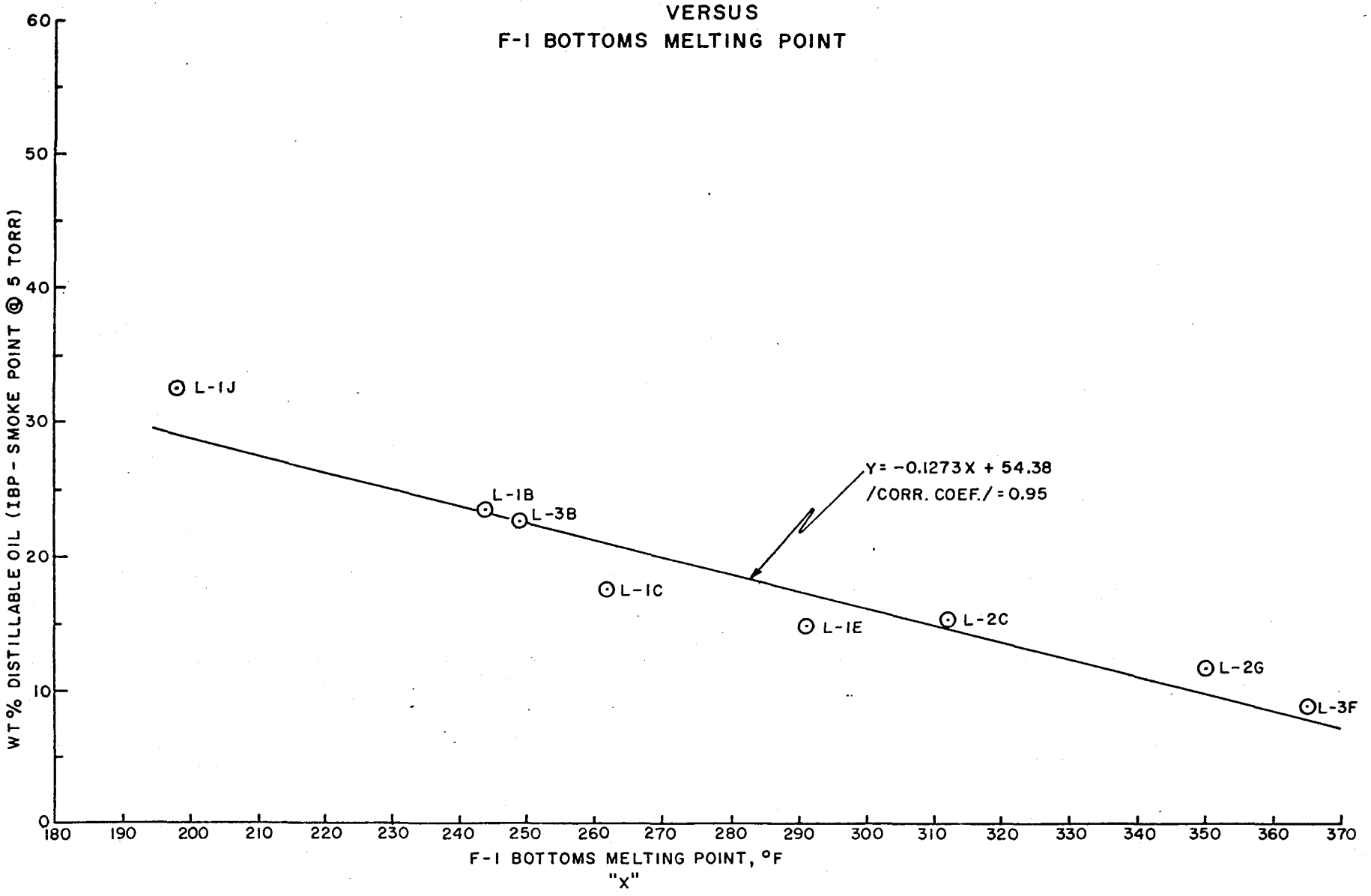
Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Exhaust		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	45.19	52.15	25.15	12.75		
Carbon Monoxide – CO	28.34	47.10	17.50	16.24		
Carbon Dioxide – CO_2	19.54		43.75	59.04		
Hydrogen Sulfide – H_2S	0.30		1.55			
Methane – CH_4	4.10		4.85	3.38		
Ethane – C_2H_6	1.45		3.40	3.87		
Propane – C_3H_8	0.65		2.65	4.72		
Butane – C_4H_{10}						
Nitrogen – N_2	0.40	0.75	0.90			
Ammonia – NH_3 (PPM)	0.03		0.25			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Calc Mole Wt	19.03	14.44	28.44	34.56		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2		

DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT



PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/4/78

MATERIAL OUT

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 328

lbs/hour

	Stream Description	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
Quantitative	Sample Point	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
	Hydrogen - H_2	1.09	0.07				0.01
	Carbon Monoxide - CO	9.60	0.71				0.10
	Carbon Dioxide - CO_2	10.40	2.81				0.54
	Hydrogen Sulfide - H_2S	0.12	0.08				
	Methane - CH_4	0.79	0.11				0.01
	Ethane - C_2H_6	0.53	0.15				0.02
	Propane - C_3H_8	0.35	0.17				0.04
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.14	0.04				
	Ammonia - NH_3	0.01	0.01	0.02			
	Distillable Oil (IBP-255°C @1.6 Torr)			1.50		4.39	
	SRL						
	Coal (MAF)						
	Ash						
	Water			15.61			
	Phenol						
	Total	23.03	4.15	17.13	Negl.	4.39	0.72

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/4/78

MATERIAL OUT

Run No: L-1I
Date: 8/1-2/77
Time: 1330-0130

Temperature: 741°F
Pressure: 2500 psig
LHSV: 1.41
GHSV: 328

lbs/hour

	Stream Description	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent → F-2 Btms		Total Out
	Sample Point	Sx-33	Sx-2	Sx-39	Sx-12		
Quantitative	Hydrogen - H_2						1.17
	Carbon Monoxide - CO						10.41
	Carbon Dioxide - CO_2						13.75
	Hydrogen Sulfide - H_2S						0.20
	Methane - CH_4						0.91
	Ethane - C_2H_6						0.70
	Propane - C_3H_8						0.56
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.18
	Ammonia - NH_3						0.04
	Distillable Oil (IBP-255°C @1.6 Torr)	0.09	2.12	67.44	15.81		91.35
	SRL		19.10				19.10
	Coal (MAF)		3.04				3.04
	Ash		2.92				2.92
	Water	0.26		0.28			16.15
	Phenol						
	Total	0.35	27.18	67.72	15.81		160.48
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	Total						

RUN CONDITIONS

RUN NO. L-1J
DATE MADE 8/3/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 773
- INLET 315
- OUTLET 754

DISSOLVERS
- R-1A (1) 755
- (2) 772
- (3) 771
- (4) 815
- R-1B (1)
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 610
- S-2 80
- S-3 463
- S-4A 83
- S-4B 76

PREHEATER E-11
- DOWTHERM 661
- INLET 367
- OUTLET 636

VACUUM FLASH F-1
- OVERHEAD VAPOR 508
- UPPER WALL 628
- LOWER WALL 638
- DOWNCOMER 466
- CONDENSATE ACCUMULATOR, S-7 85

PREHEATER E-13
- DOWTHERM 598
- INLET 80
- OUTLET 551

LIGHT ENDS COLUMN, F-2
- REBOILER 365
- LOWER SECTION 457
- FEED SECTION 438
- OVERHEAD 208
- S-8 86
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD 495
- BOTTOMS -

PRECIPITATION TOWER, V-8
- ZONE (1) 355
- (2) 380
- (3) 407

RECOVERY TOWER V-9
- REBOILER 470
- OVERHEAD 311

PRESSURE, psig

SEPARATORS S-1 and S-2
2500

SEPARATOR S-3
290

SEPARATORS S-4A and S-4B
61

VACUUM FLASH, F-1
14 Torr

LIGHT ENDS COLUMN, F-2
0

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

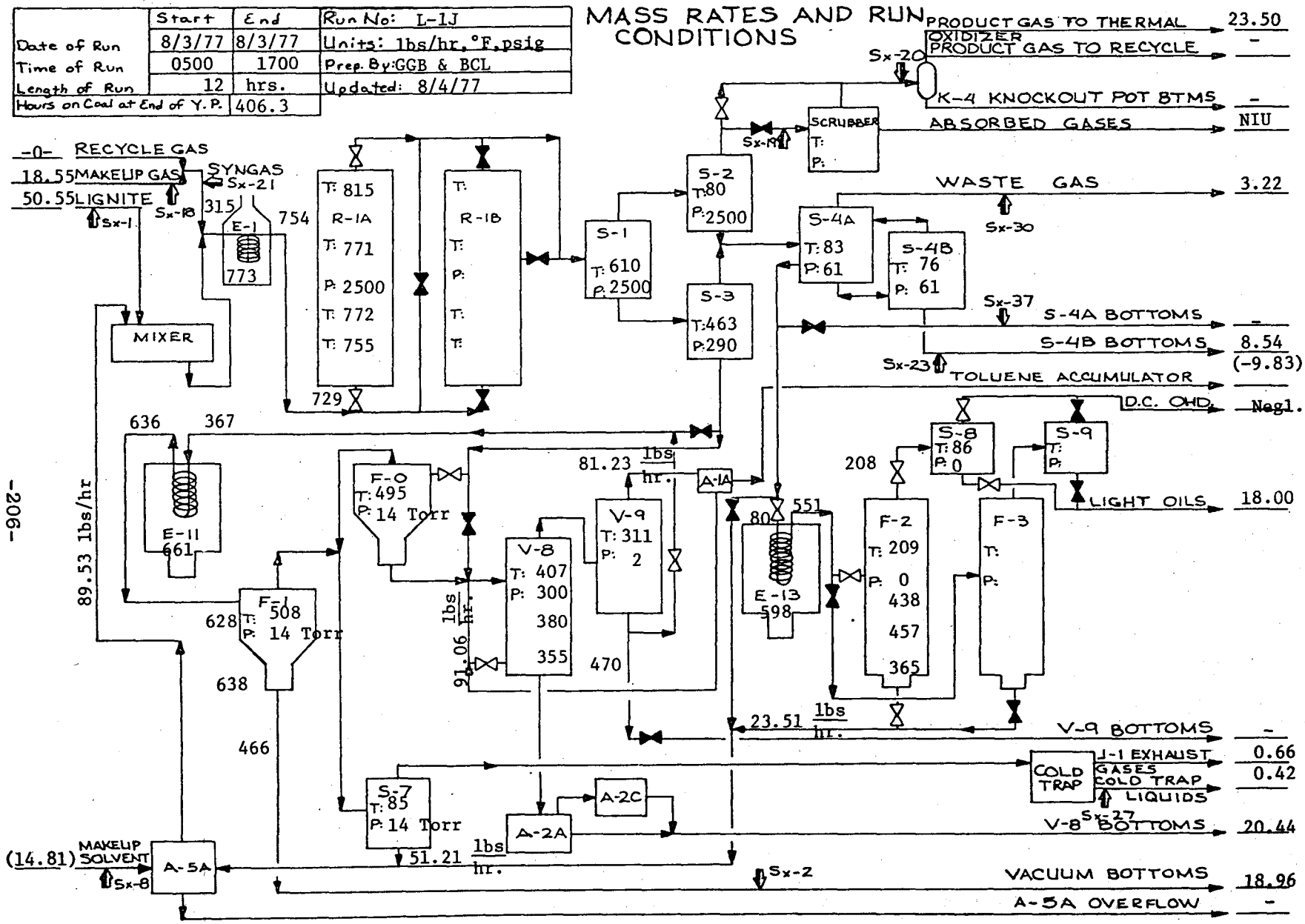
VACUUM FLASH, F-0
14 Torr

SETTLING TOWER, V-8
300

RECOVERY TOWER, V-7
2

	Start	End	Run No: L-1J
Date of Run	8/3/77	8/3/77	Units: lbs/hr, °F, psig
Time of Run	0500	1700	Prep. By: GGB & BCL
Length of Run	12	hrs.	Updated: 8/4/77
Hours on Coal at End of Y.P.	406.3		

MASS RATES AND RUN CONDITIONS



PRODUCT GAS TO THERMAL OXIDIZER	23.50
PRODUCT GAS TO RECYCLE	-
K-4 KNOCKOUT POT BTMS	-
ABSORBED GASES	NIU
WASTE GAS	3.22
S-4A BOTTOMS	-
S-4B BOTTOMS	8.54
	(-9.83)
TOLUENE ACCUMULATOR	-
D.C. OHD	Negl.
LIGHT OILS	18.00
V-9 BOTTOMS	-
J-1 EXHAUST GASES	0.66
COLD TRAP LIQUIDS	0.42
V-8 BOTTOMS	20.44
VACUUM BOTTOMS	18.96
A-5A OVERFLOW	-
249.69 TOTAL	TOTAL 249.69

⋈ OPEN ⋈ CLOSED

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with V-8 Btms Composition Calculated
Revised: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

SUMMARY

Temperature: 754°F
Pressure: 2500 psig
LHSV: 1.40
GHSV: 341

lbs/hour

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
SAMPLE POINT						
Hydrogen - H_2	1.34	1.29	-0.05			
Carbon Monoxide - CO	16.98	12.42	-4.56			
Carbon Dioxide - CO_2		11.83	11.83			
Hydrogen Sulfide - H_2S		0.22	0.22			
Methane - CH_4		0.66	0.66	8.84	28.46	
Ethane - C_2H_6		0.49	0.49			
Propane - C_3H_8		0.29	0.29			
Butane - C_4H_{10}						
Nitrogen - N_2	0.23	0.16	-0.07			
Ammonia - NH_3		0.03	0.03			
Light Oil - (0-100° C @ 1.6 Torr)	99.92	105.44	5.52			
Solvent - (100-230° C @ 1.6 Torr)	78.44	75.42	-3.02	19.19	61.78	
Heavy Oil - (230-255° C @ 1.6 Torr)	1.88	2.64	0.76			
SRL		15.93	15.93			
Coal (MAF)	31.06	3.29	-27.77		-89.40	
Ash	2.79	2.62	-0.17		-0.55	
Water	17.05	16.96	-0.09		-0.29	
Phenol						
TOTAL	249.69	249.69	-0-			

Elemental

Carbon	184.62	183.86	-0.76			
Hydrogen	19.55	20.18	0.63			
Nitrogen	0.78	0.64	-0.14			
Sulfur	1.64	1.59	-0.05			
Oxygen (by diff)	40.31	40.80	0.49			
Ash	2.79	2.62	-0.17			
TOTAL	249.69	249.69	-0-			

PROJECT LIGNITE
MEASURED & ADJUSTED MATERIAL BALANCE

Revised: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

MATERIAL IN

lbs/hour

Temperature: 754°F
Pressure: 2500 psig
LHSV: 1.40
GHSV: 341

Quantitative

STREAM DESCRIPTION	Feed Gas	Lignite	Liquef. Solvent	Deashing Solvent		Total In
SAMPLE POINT	Sx-21	Sx-1	Sx-14	Sx-40		
Hydrogen - H_2	1.34					1.34
Carbon Monoxide - CO	16.98					16.98
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2	0.23					0.23
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)			9.50	90.42		99.92
Solvent - (100-230° C @ 1.6 Torr)			77.80	0.64		78.44
Heavy Oil - (230-255°C @ 1.6 Torr)			1.88			1.88
SRL						
Coal (MAF)		31.06				31.06
Ash		2.79				2.79
Water		16.70	0.35			17.05
Phenol						
TOTAL	18.55	50.55	89.53	91.06		249.69

Elemental

Carbon	7.28	22.03	75.64	79.67		184.62
Hydrogen	1.34	3.41	6.72	8.08		19.55
Nitrogen	0.23	0.32	0.22	0.01		0.78
Sulfur		0.30	1.34			1.64
Oxygen (by diff)	9.70	21.70	5.61	3.30		40.31
Ash		2.79				2.79
TOTAL	18.55	50.55	89.53	91.06		249.69

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with the V-8 Btms Composition Calculated
Revised: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

MATERIAL OUT

lbs/hour

Temperature: 754°F
Pressure: 2500 psig
LHSV: 1.40
GHSV: 341

Quantitative

STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Hydrogen - H_2	1.22	0.06				0.01
Carbon Monoxide - CO	11.68	0.60				0.14
Carbon Dioxide - CO_2	9.26	2.16				0.41
Hydrogen Sulfide - H_2S	0.16	0.06				
Methane - CH_4	0.57	0.07				0.02
Ethane - C_2H_6	0.35	0.10				0.04
Propane - C_3H_8	0.12	0.13				0.04
Butane - C_4H_{10}						
Nitrogen - N_2	0.13	0.03				
Ammonia - NH_3	0.01	0.01	0.01			
Light Oil - (0-100° C @ 1.6 Torr)			0.32		9.02	
Solvent - (100-230° C @ 1.6 Torr)			0.26		0.22	
Heavy Oil - (230-255° C @ 1.6 Torr)			0.03		0.27	
SRL						
Coal (MAF)						
Ash						
Water			7.92		8.49	
Phenol						
TOTAL	23.50	3.22	8.54	Negl.	18.00	0.66

Elemental

Carbon	8.33	1.08	0.52		7.78	0.25
Hydrogen	1.47	0.13	0.94		1.92	0.03
Nitrogen	0.14	0.04	0.01		0.01	
Sulfur	0.15	0.06	0.01		0.03	
Oxygen (by diff)	13.41	1.91	7.06		8.26	0.38
Ash						
TOTAL	23.50	3.22	8.54	Negl.	18.00	0.66

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with V-8 Btms Composition Calculated
Revised: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

MATERIAL OUT

lbs/hour

Temperature: 754°F
Pressure: 2500 psig
LHSV: 1.40
GHSV: 341

	STREAM DESCRIPTION	Cold Trap	V-8 Btms	F-1 Btms	V-9 Ovhd	←Recycle S-7 Btms	Solvent→ F-2 Btms
Quantitative	SAMPLE POINT	Sx-33	Calc	Sx-2	Sx-28	Sx-39	Sx-12
	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	0.11	7.12		80.46	4.81	3.60
	Solvent - (100-230°C @ 1.6 Torr)	0.02	4.28	6.16	0.77	45.42	18.29
	Heavy Oil - (230-255°C @ 1.6 Torr)					0.72	1.62
	SRL		3.37	12.56			
	Coal (MAF)		3.23	0.06			
	Ash		2.44	0.18			
	Water	0.29				0.26	
	Phenol						
	TOTAL	0.42	20.44	18.96	81.23	51.21	23.51
Elemental	Carbon	0.11	15.28	15.86	70.40	43.58	20.67
	Hydrogen	0.04	1.32	1.09	7.16	4.13	1.95
	Nitrogen		0.07	0.16	0.01	0.13	0.07
	Sulfur		0.12	0.14	0.01	0.73	0.34
	Oxygen (by diff)	0.27	1.21	1.53	3.65	2.64	0.48
	Ash		2.44	0.18			
	TOTAL	0.42	20.44	18.96	81.23	51.21	23.51

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with V-8 Btms Composition Calculated
Revised: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

MATERIAL OUT

lbs/hour

Temperature: 754°F
Pressure: 2500 psig
LHSV: 1.40
GHSV: 341

	STREAM DESCRIPTION						Total Out
	SAMPLE POINT						
Quantitative	Hydrogen - H_2						1.29
	Carbon Monoxide - CO						12.42
	Carbon Dioxide - CO_2						11.83
	Hydrogen Sulfide - H_2S						0.22
	Methane - CH_4						0.66
	Ethane - C_2H_6						0.49
	Propane - C_3H_8						0.29
	Butane - C_4H_{10}						
	Nitrogen - N_2						0.16
	Ammonia - NH_3						0.03
	Light Oil - (0-100° C @ 1.6 Torr)						105.44
	Solvent - (100-230°C @ 1.6 Torr)						75.42
	Heavy Oil - (230-255°C @ 1.6 Torr)						2.64
	SRL						15.93
	Coal (MAF)						3.29
	Ash						2.62
	Water						16.96
	Phenol						
	TOTAL						249.86
Elemental	Carbon						183.86
	Hydrogen						20.18
	Nitrogen						0.64
	Sulfur						1.59
	Oxygen (by diff)						40.80
	Ash						2.62
	TOTAL						249.69

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Feed Coal	F-1 Btms	F-2 Btms	Feed Solvent	S-8 Oil	S-8 Water
	SAMPLE POINT	Sx-1	Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			15.30	10.61	94.38	
	Solvent – (100-230°C @ 1.6 Torr)		32.50	77.80	86.90	2.30	
	Heavy Oil – (230-255°C @1.6 Torr)			6.90	2.10	2.80	
	SRL		66.23				
	Coal (MAF)	61.44	0.33				
	Ash	5.52	0.94				
	Water	33.04			0.39	0.52	100
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		99.67				
	Melting Point °F		198				
	Specific Gravity 60/60			1.015	1.031		
	Viscosity, cp						
Elemental	Carbon	43.58	83.63	87.91	84.49	81.35	
	Hydrogen	6.74	5.77	8.28	7.50	10.33	11.11
	Nitrogen	0.63	0.84	0.29	0.24	0.08	
	Sulfur	0.60	0.74	1.47	1.50	0.31	
	Oxygen (by diff)	42.93	8.08	2.05	6.27	7.93	88.89
	Ash	5.52	0.94				
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water	S-4B Total
Quantitative	SAMPLE POINT	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23	Sx-23
	Hydrogen – H_2		5.21	7.22			
	Carbon Monoxide – CO		49.70	91.52			
	Carbon Dioxide – CO_2		39.41				
	Hydrogen Sulfide – H_2S		0.66				
	Methane – CH_4		2.44				
	Ethane – C_2H_6		1.49				
	Propane – C_3H_8		0.49				
	Butane – C_4H_{10}						
	Nitrogen – N_2		0.54	1.26			
	Ammonia – NH_3 (PPM)		0.06			0.13	0.12
	Light Oils – (0-100° C @ 1.6 Torr)	50.12			51.63		3.73
	Solvent – (100-230°C @ 1.6 Torr)	1.22			42.10		3.04
	Heavy Oil – (230-255°C @ 1.6 Torr)	1.49			5.60		0.40
	SRL						
	Coal (MAF)						
	Ash						
	Water	47.17			0.67	99.87	92.71
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon	43.21	35.47	39.22	84.26		6.08
	Hydrogen	10.70	6.26	7.22	9.42	11.12	11.00
	Nitrogen	0.04	0.59	1.26	0.20	0.11	0.12
	Sulfur	0.16	0.62		0.98		0.07
	Oxygen (by diff)	45.89	57.06	52.30	5.14	88.77	82.73
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

WEIGHT PERCENT

	SAMPLE DESCRIPTION	V-8 Btms	V-9 Ovhd	S-4A Ovhd	J-1 Disch	Cold Trap	S-4A Oil
	SAMPLE POINT	Sx-27	Sx-28	Sx-30	Sx-32	Sx-33	Sx-37
Quantitative	Hydrogen – H_2			1.92	1.92		
	Carbon Monoxide – CO			18.67	20.57		
	Carbon Dioxide – CO_2			67.13	62.12		
	Hydrogen Sulfide – H_2S			1.89			
	Methane – CH_4			2.21	3.34		
	Ethane – C_2H_6			3.17	5.40		
	Propane – C_3H_8			3.87	6.65		
	Butane – C_4H_{10}						
	Nitrogen – N_2			0.90			
	Ammonia – NH_3 (PPM)			0.24			
	Light Oils – (0-100° C @ 1.6 Torr)	46.23	99.05			26.50	52.34
	Solvent – (100-230°C @ 1.6 Torr)	26.29	0.95			5.50	30.70
	Heavy Oil – (230-255°C @ 1.6 Torr)						15.90
	SRL	14.03					
	Coal (MAF)	8.96					
	Ash	4.49					
	Water					68.00	1.06
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)	90.62					
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon	85.33	86.67	33.68	38.02	25.59	79.37
	Hydrogen	7.29	8.81	3.95	5.05	10.59	9.02
	Nitrogen	0.28	0.01	1.10		0.30	0.20
	Sulfur	0.99	0.01	1.78		0.25	0.79
	Oxygen (by diff)	1.62	4.50	59.49	56.93	63.27	10.62
	Ash	4.49					
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	1	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

WEIGHT PERCENT

SAMPLE DESCRIPTION	S-4A Water	S-4A Total	Recycle Solvent	Deashing Solvent		V-8 Btms
SAMPLE POINT	Sx-37	Sx-37	Sx-39	Sx-40		Calc.
Hydrogen - H_2						
Carbon Monoxide - CO						
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3 (PPM)	0.19	0.07				
Light Oils - (0-100° C @ 1.6 Torr)		32.92	9.40	99.30		34.83
Solvent - (100-230°C @ 1.6 Torr)		19.31	88.70	0.70		20.94
Heavy Oil - (230-255°C @1.6 Torr)		10.00	1.40			
SRL						16.49
Coal (MAF)						15.80
Ash						11.94
Water	99.81	37.70	0.50			
Phenol						
TOTAL	100	100	100	100		100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Carbon		49.92	85.11	87.49		74.75
Hydrogen	11.12	9.80	8.06	8.88		6.47
Nitrogen	0.16	0.19	0.26	0.01		0.35
Sulfur		0.50	1.42	-		0.57
Oxygen (by diff)	88.72	39.59	5.15	3.62		5.92
Ash						11.94
TOTAL	100	100	100	100		100
Number of Sample Avg.	2	2	2	2		-

Elemental

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

MOLE PERCENT

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	47.12	52.15	26.75	26.28		
Carbon Monoxide – CO	32.08	47.20	18.60	20.16		
Carbon Dioxide – CO_2	16.19		42.55	38.74		
Hydrogen Sulfide – H_2S	0.35		1.55			
Methane – CH_4	2.75		3.85	5.73		
Ethane – C_2H_6	0.90		2.95	4.94		
Propane – C_3H_8	0.20		2.45	4.15		
Butane – C_4H_{10}						
Nitrogen – N_2	0.35	0.65	0.90			
Ammonia – NH_3 (PPM)	0.06		0.40			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Calc. Mole Wt.	18.07	14.44	27.89	27.44		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	1		

Elemental

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1J
DATE: 8/3/77
TIME: 0500-1700

SAMPLE DESCRIPTION	F-1 Btms	LEC Btms	Feed Solv.	S-8 Oil	S-4B Oil
SAMPLE POINT	Sx-2	Sx-12	Sx-14	Sx-16	Sx-23
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5		
IBP		34	83		
5%		134	104		
10%		148	119		
20%		162	140		
30%		192	162		
40%		212	178		
50%		227	185		
60%		237.5	192		
70%		247	197.5		
80%		262	206		
90%			222		
95%			247		
DRY PT.			247		
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR				742	746
IBP				50	61
5%				72	114
10%				91	141
20%				105	196
30%				114	229
40%				119	250
50%				127	270
60%				140	290
70%				162	316
80%				197	333
90%				231	352
95%				275	
DRY PT.				280	354
ASPHALTENE TEST					
WT % ASH	0.94				
WT % UNCONVERTED COAL	0.33				
WT % PRE-ASPHALTENES	26.29				
WT % ASPHALTENES	41.86				
WT % MALTENES & DIST. OIL	30.58				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		13.2	12.1		
210° F		8.6	8.9		
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)			0.39	0.52	0.67
INFRARED RATIO			0.27		
SP. GRAV. 60/60 F		1.015	1.031		

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION. USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1J
DATE: 8/3/77
TIME: 0500-1700

SAMPLE DESCRIPTION	V-9 Ovhd	V-9 Btms	Cold Trap	S-4A Oil	S-7 Btms
SAMPLE POINT	Sx-28	Sx-29	Sx-33	Sx-37	Sx-39
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5			5
IBP		114.5			78
5%		165			106
10%		179			120
20%		192			141
30%		197			163
40%		200			176
50%		207			184
60%		220			190
70%		245			196
80%		260			203
90%					218
95%					238
DRY PT.					238
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	742		741	747	
IBP	109		87	76	
5%	112		87	91	
10%	112		96	141	
20%	112		105	193	
30%	112		110	227	
40%	112		114	247	
50%	113		118	270	
60%	113		126	284	
70%	113		128	311	
80%	113		146	327	
90%	113				
95%	114				
DRY PT.	168		152	362	
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					12.1
210° F					8.5
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)			68.00	1.06	0.50
INFRARED RATIO					0.37
SP. GRAV. 60/60 F				0.968	1.029

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION, USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1J
DATE: 8/3/77
TIME: 0500-1700

SAMPLE DESCRIPTION	Deashing Solv.				
SAMPLE POINT	Sx-40				
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR					
VOLUME PERCENT / TEMPERATURE, °C					
IBP					
5%					
10%					
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
95%					
DRY PT.					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	746				
VOLUME PERCENT / TEMPERATURE, °C					
IBP	112				
5%	112				
10%	112				
20%	112				
30%	112				
40%	112				
50%	112				
60%	112				
70%	112				
80%	112				
90%	113				
95%	113				
DRY PT.	183				
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)					
INFRARED RATIO					
SP. GRAV. 60/60 F					

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION, USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 12/30/77

MATERIAL OUT

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

Temperature: 754°F
Pressure: 2500 psig
LHSV: 1.40
GHSV: 341

lbs/hour

	STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
	SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Quantitative	Hydrogen - H_2	1.18	0.06				0.01
	Carbon Monoxide - CO	11.24	0.58				0.13
	Carbon Dioxide - CO_2	8.92	2.08				0.40
	Hydrogen Sulfide - H_2S	0.15	0.06				
	Methane - CH_4	0.55	0.07				0.02
	Ethane - C_2H_6	0.34	0.10				0.04
	Propane - C_3H_8	0.11	0.12				0.04
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.12	0.03				
	Ammonia - NH_3	0.01		0.01			
	Light Oil - (0-100° C @ 1.6 Torr)			0.31		8.68	
	Solvent - (100-230° C @ 1.6 Torr)			0.25		0.21	
	Heavy Oil - (230-255°C @ 1.6 Torr)			0.03		0.26	
	SRL						
	Coal (MAF)						
	Ash						
	Water			7.62		8.17	
	Phenol						
	TOTAL	22.62	3.10	8.22	Negl.	17.32	0.64
Elemental	Carbon	8.02	1.04	0.50		7.48	0.24
	Hydrogen	1.42	0.12	0.90		1.85	0.03
	Nitrogen	0.13	0.04	0.01		0.01	
	Sulfur	0.14	0.06	0.01		0.03	
	Oxygen (by diff)	12.91	1.84	6.80		7.95	0.37
	Ash						
	TOTAL	22.62	3.10	8.22	Negl.	17.32	0.64

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 12/30/77

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

MATERIAL OUT

lbs/hour

Temperature: 754°F
Pressure: 2500 psig
LHSV: 1.40
GHSV: 341

	STREAM DESCRIPTION	Cold Trap	V-8 Btms	F-1 Btms	V-9 Ovhd	←Recycle S-7 Btms	Solvent→ F-2 Btms
	SAMPLE POINT	Sx-33	Sx-27	Sx-2	Sx-28	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	0.11	9.10		80.46	4.81	3.60
	Solvent - (100-230°C @ 1.6 Torr)	0.02	5.17	5.93	0.77	45.42	18.29
	Heavy Oil - (230-255°C @1.6 Torr)					0.72	1.62
	SRL		2.76	12.09			
	Coal (MAF)		1.76	0.06			
	Ash		0.88	0.17			
	Water	0.27				0.26	
	Phenol						
	TOTAL	0.40	19.67	18.25	81.23	51.21	23.51
Elemental	Carbon	0.10	16.78	15.26	70.40	43.58	20.67
	Hydrogen	0.04	1.43	1.05	7.16	4.13	1.95
	Nitrogen		0.06	0.15	0.01	0.13	0.07
	Sulfur		0.20	0.14	0.01	0.73	0.34
	Oxygen (by diff)	0.26	0.32	1.48	3.65	2.64	0.48
	Ash		0.88	0.17			
	TOTAL	0.40	19.67	18.25	81.23	51.21	23.51

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 12/30/77

MATERIAL OUT

Run No: L-1J
Date: 8/3/77
Time: 0500-1700

lbs/hour

Temperature: 754°F
Pressure: 2500 psig
LHSV: 1.40
GHSV: 341

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.25
Carbon Monoxide - CO						11.95
Carbon Dioxide - CO_2						11.40
Hydrogen Sulfide - H_2S						0.21
Methane - CH_4						0.64
Ethane - C_2H_6						0.48
Propane - C_3H_8						0.27
Butane - C_4H_{10}						
Nitrogen - N_2						0.15
Ammonia - NH_3						0.02
Light Oil - (0-100° C @ 1.6 Torr)						107.07
Solvent - (100-230°C @ 1.6 Torr)						76.06
Heavy Oil - (230-255°C @ 1.6 Torr)						2.63
SRL						14.85
Coal (MAF)						1.82
Ash						1.05
Water						16.32
Phenol						
TOTAL						246.17

Elemental

Carbon						184.07
Hydrogen						20.08
Nitrogen						0.61
Sulfur						1.66
Oxygen (by diff)						38.70
Ash						1.05
TOTAL						246.17

RUN CONDITIONS

RUN NO. L-1K

DATE MADE 8/3-4/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 777
- INLET 307
- OUTLET 757

DISSOLVERS
- R-1A (1) 758
- (2) 774
- (3) 773
- (4) 804
- R-1B (1)
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 593
- S-2 79
- S-3 460
- S-4A 83
- S-4B 77

PREHEATER E-11
- DOWTHERM 667
- INLET 360
- OUTLET 641

VACUUM FLASH F-1
- OVERHEAD VAPOR 504
- UPPER WALL 626
- LOWER WALL 626
- DOWNCOMER 451
- CONDENSATE ACCUMULATOR, S-7 86

PREHEATER E-13
- DOWTHERM 597
- INLET 77
- OUTLET 567

LIGHT ENDS COLUMN, F-2
- REBOILER 395
- LOWER SECTION 470
- FEED SECTION 422
- OVERHEAD 183
- S-8 80
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD 492
- BOTTOMS -

PRECIPITATION TOWER, V-8
- ZONE (1) 342
- (2) 372
- (3) 398

RECOVERY TOWER V-9
- REBOILER 449
- OVERHEAD 312

PRESSURE, psig

SEPARATORS S-1 and S-2: 2500

SEPARATOR S-3: 297

SEPARATORS S-4A and S-4B: 60

VACUUM FLASH, F-1: 14 Torr

LIGHT ENDS COLUMN, F-2: 0

SOLVENT COLUMN, F-3: NIU

HEAVY ENDS COLUMN, F-4: NIU

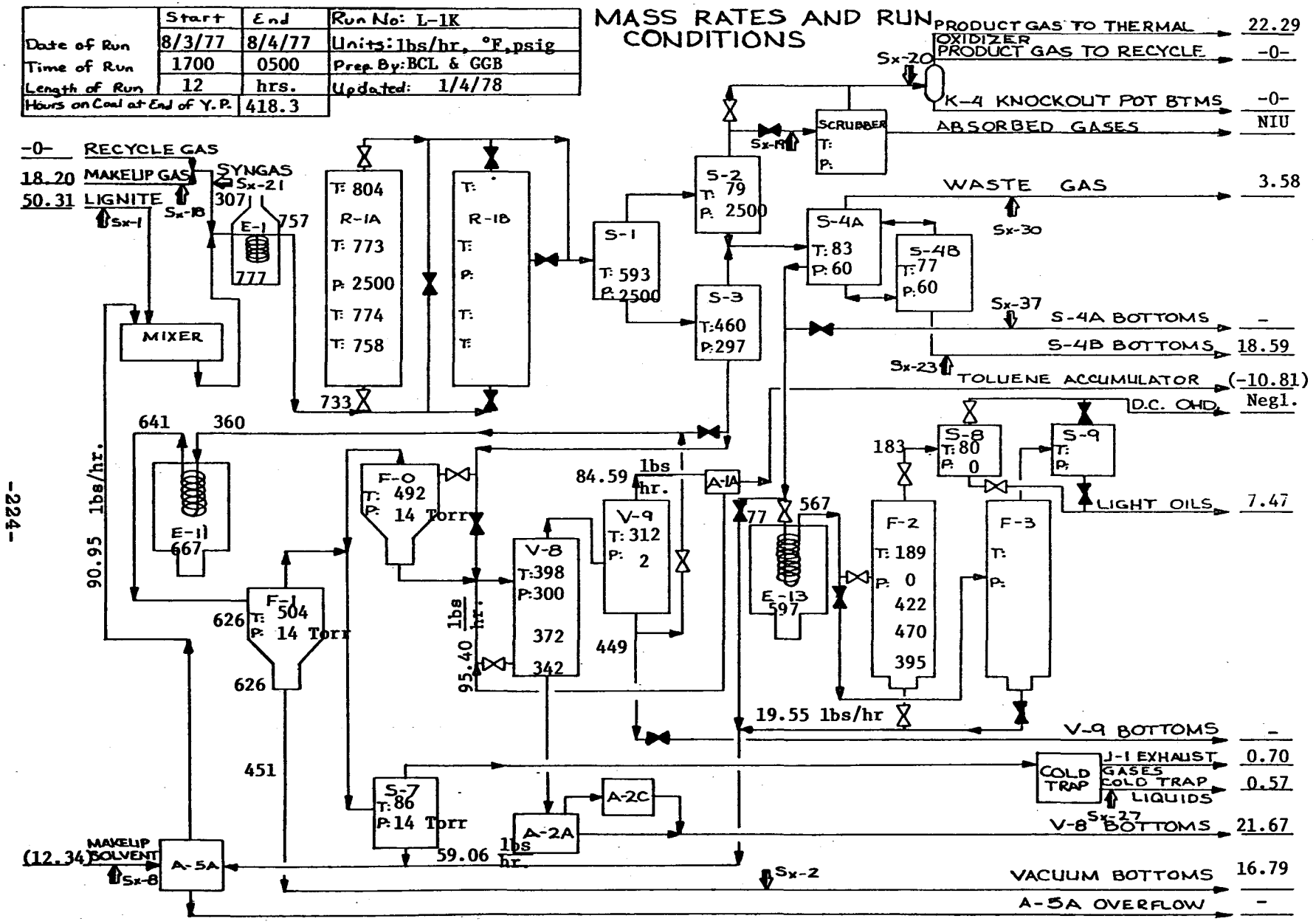
VACUUM FLASH, F-0: 14 Torr

SETTLING TOWER, V-8: 300

RECOVERY TOWER, V-7: 2

MASS RATES AND RUN CONDITIONS

	Start	End	Run No: L-1K
Date of Run	8/3/77	8/4/77	Units: lbs/hr, °F, psig
Time of Run	1700	0500	Prep By: BCL & GGB
Length of Run	12	hrs.	Updated: 1/4/78
Hours on Coal at End of Y.P.	418.3		



254.86 TOTAL ⋈ OPEN ⋈ CLOSED TOTAL 254.86

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with V-8 Btms Composition Calculated
Revised: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

SUMMARY

Temperature: 757°F
Pressure: 2500 psig
LHSV: 1.42
GHSV: 336

1bs/hour

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
Quantitative	SAMPLE POINT						
	Hydrogen - H_2	1.33	1.24	-0.09			
	Carbon Monoxide - CO	16.67	11.49	-5.18			
	Carbon Dioxide - CO_2		12.03	12.03			
	Hydrogen Sulfide - H_2S		0.14	0.14			
	Methane - CH_4		0.63	0.63	8.39	26.94	
	Ethane - C_2H_6		0.49	0.49			
	Propane - C_3H_8		0.36	0.36			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.20	0.15	-0.05			
	Ammonia - NH_3		0.06	0.06			
	Light Oil - (0-100° C @ 1.6 Torr)	111.44	117.31	5.87			
	Solvent - (100-230° C @ 1.6 Torr)	74.40	73.17	-1.23	20.50	65.81	
	Heavy Oil - (230-255° C @ 1.6 Torr)	0.18	2.47	2.29			
	SRL		13.57	13.57			
	Coal (MAF)	31.15	3.35	-27.80		-89.25	
	Ash	2.88	2.71	-0.17		-0.55	
	Water	16.61	15.69	-0.92		-2.95	
	Phenol						
	TOTAL	254.86	254.86	-0-			
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

MATERIAL IN

lbs/hour

Temperature: 757°F
Pressure: 2500 psig
LHSV: 1.42
GHSV: 336

Quantitative

STREAM DESCRIPTION	Feed Gas	Lignite	Feed Solvent	Deashing Solvent		Total In
SAMPLE POINT	Sx-21	Sx-1	Sx-14	Sx-40		
Hydrogen - H_2	1.33					1.33
Carbon Monoxide - CO	16.67					16.67
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2	0.20					0.20
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)			16.23	95.21		111.44
Solvent - (100-230° C @ 1.6 Torr)			74.21	0.19		74.40
Heavy Oil - (230-255°C @ 1.6 Torr)			0.18			0.18
SRL						
Coal (MAF)		31.15				31.15
Ash		2.88				2.88
Water		16.28	0.33			16.61
Phenol						
TOTAL	18.20	50.31	90.95	95.40		254.86

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with V-8 Btms Composition Calculated
Revised: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

MATERIAL OUT
lbs/hour

Temperature: 757°F
Pressure: 2500 psig
LHSV: 1.42
GHSV: 336

Quantitative

STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Hydrogen - H_2	1.14	0.09				0.01
Carbon Monoxide - CO	10.52	0.86				0.11
Carbon Dioxide - CO_2	9.29	2.25				0.49
Hydrogen Sulfide - H_2S	0.10	0.04				
Methane - CH_4	0.53	0.08				0.02
Ethane - C_2H_6	0.37	0.10				0.02
Propane - C_3H_8	0.19	0.12				0.05
Butane - C_4H_{10}						
Nitrogen - N_2	0.12	0.03				
Ammonia - NH_3	0.03	0.01	0.02			
Light Oil - (0-100° C @ 1.6 Torr)			2.13		7.41	
Solvent - (100-230°C @ 1.6 Torr)			1.10		0.06	
Heavy Oil - (230-255°C @ 1.6 Torr)			0.20			
SRL						
Coal (MAF)						
Ash						
Water			15.14			
Phenol						
TOTAL	22.29	3.58	18.59	Negl.	7.47	0.70

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with V-8 Btms Composition Calculated
Revised: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

MATERIAL OUT

lbs/hour

Temperature: 757°F
Pressure: 2500 psig
LHSV: 1.42
GHSV: 336

Quantitative

STREAM DESCRIPTION	Cold Trap	V-8 Btms	F-1 Btms	V-9 Ovhd	←Recycle S-7 Btms	Solvent→ F-2 Btms
SAMPLE POINT	Sx-33	Calc.	Sx-2	Sx-28	Sx-39	Sx-12
Hydrogen - H_2						
Carbon Monoxide - CO						
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)	0.31	8.51		83.87	10.25	4.83
Solvent - (100-230°C @ 1.6 Torr)	0.03	5.41	4.21	0.72	47.25	14.39
Heavy Oil - (230-255°C @1.6 Torr)		0.70			1.24	0.33
SRL		2.18	11.39			
Cool (MAF)		2.86	0.49			
Ash		2.01	0.70			
Water	0.23				0.32	
Phenol						
TOTAL	0.57	21.67	16.79	84.59	59.06	19.55

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Normalized with V-8 Btms Composition Calculated
Revised: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

MATERIAL OUT
lbs/hour

Temperature: 757°F
Pressure: 2500 psig
LHSV: 1.42
GHSV: 336

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.24
Carbon Monoxide - CO						11.49
Carbon Dioxide - CO_2						12.03
Hydrogen Sulfide - H_2S						0.14
Methane - CH_4						0.63
Ethane - C_2H_6						0.49
Propane - C_3H_8						0.36
Butane - C_4H_{10}						
Nitrogen - N_2						0.15
Ammonia - NH_3						0.06
Light Oil - (0-100°C @ 1.6 Torr)						117.31
Solvent - (100-230°C @ 1.6 Torr)						73.17
Heavy Oil - (230-255°C @ 1.6 Torr)						2.47
SRL						13.57
Coal (MAF)						3.35
Ash						2.71
Water						15.69
Phenol						
TOTAL						254.86

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	Makeup Solvent	F-3 Btms	Feed Solvent	S-8 Oil
	SAMPLE POINT	Sx-1	*Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3 (PPM)						
	Light Oils - (0-100° C @ 1.6 Torr)			3.74	24.70	17.84	99.20
	Solvent - (100-230°C @ 1.6 Torr)		25.10	92.42	73.60	81.60	0.80
	Heavy Oil - (230-255°C @1.6 Torr)			3.64	1.70	0.20	
	SRL		67.85				
	Coal (MAF)	61.92	2.91				
	Ash	5.72	4.14				
	Water	32.36		0.20		0.36	
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		96.96				
	Melting Point °F		230				
	Specific Gravity 60/60			1.040	1.007	1.030	
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	2

*Distillable oil calculated by following equation .
Wt% Distillable Oil = -0.1273 (F-1 Btms Melting Point) + 54.38. See graph.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

WEIGHT PERCENT

SAMPLE DESCRIPTION	S-8 Water	S-8 Total	Product Gas	Feed Gas	S-4B Oil	S-4B Water
SAMPLE POINT	Sx-16	Sx-16	Sx-19	Sx-21	Sx-23	Sx-23
Hydrogen – H_2			5.12	7.32		
Carbon Monoxide – CO			47.21	91.61		
Carbon Dioxide – CO_2			41.66			
Hydrogen Sulfide – H_2S			0.46			
Methane – CH_4			2.40			
Ethane – C_2H_6			1.64			
Propane – C_3H_8			0.84			
Butane – C_4H_{10}						
Nitrogen – N_2			0.53	1.07		
Ammonia – NH_3 (PPM)			0.14			0.14
Light Oils – (0-100° C @ 1.6 Torr)		99.20			61.04	
Solvent – (100-230°C @ 1.6 Torr)		0.80			31.70	
Heavy Oil – (230-255°C @ 1.6 Torr)					5.60	
SRL						
Coal (MAF)						
Ash						
Water	100				1.66	99.86
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	–	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Total	V-8 Btms	V-9 Ovhd	S-4A Ovhd	J-1 Disch.	Cold Trap
Quantitative	SAMPLE POINT	Sx-23	Sx-27	Sx-28	Sx-30	Sx-32	Sx-33
	Hydrogen – H_2				2.37	1.24	
	Carbon Monoxide – CO				24.00	16.20	
	Carbon Dioxide – CO_2				62.93	70.41	
	Hydrogen Sulfide – H_2S				1.25		
	Methane – CH_4				2.23	2.35	
	Ethane – C_2H_6				2.78	3.60	
	Propane – C_3H_8				3.48	6.20	
	Butane – C_4H_{10}						
	Nitrogen – N_2				0.70		
	Ammonia – NH_3 (PPM)	0.11			0.26		
	Light Oils – (0-100° C @ 1.6 Torr)	11.44	39.25	99.15			54.85
	Solvent – (100-230°C @ 1.6 Torr)	5.94	24.98	0.85			5.20
	Heavy Oil – (230-255°C @ 1.6 Torr)	1.05	3.24				
	SRL		11.56				
	Coal (MAF)		15.14				
	Ash		5.83				
	Water	81.46					39.95
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	1

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Oil	S-4A Water	S-4A Total	Recycle Solvent	Deashing Solvent	V-8 Btms
Quantitative	SAMPLE POINT	Sx-37	Sx-37	Sx-37	Sx-39	Sx-40	Calc.
	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)		0.16				
	Light Oils – (0-100° C @ 1.6 Torr)	69.00		68.46	17.35	99.80	39.25
	Solvent – (100-230° C @ 1.6 Torr)	29.20		28.97	80.00	0.20	24.98
	Heavy Oil – (230-255° C @ 1.6 Torr)	1.80		1.79	2.10		3.24
	SRL						10.07
	Coal (MAF)						13.18
	Ash						9.28
	Water		99.84	0.78	0.55		
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60				1.031		
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	-

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Product Gas	Feed Gas	S-4A Ovhd	J-1 Disch.		
SAMPLE POINT	Sx-19	Sx-21	Sx-30	Sx-32		
Hydrogen – H_2	46.90	52.50	30.73	19.29		
Carbon Monoxide – CO	30.90	46.95	22.19	18.05		
Carbon Dioxide – CO_2	17.35		37.03	49.93		
Hydrogen Sulfide – H_2S	0.25		0.95			
Methane – CH_4	2.75		3.60	4.59		
Ethane – C_2H_6	1.00		2.40	3.74		
Propane – C_3H_8	0.35		2.05	4.40		
Butane – C_4H_{10}						
Nitrogen – N_2	0.35	0.55	0.65			
Ammonia – NH_3 (PPM)	0.15		0.40			
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230° C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100		
Calc. Mole Wt.	18.33	14.35	25.89	31.20		
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2		

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1K
DATE: 8/3-4/77
TIME: 1700-0500

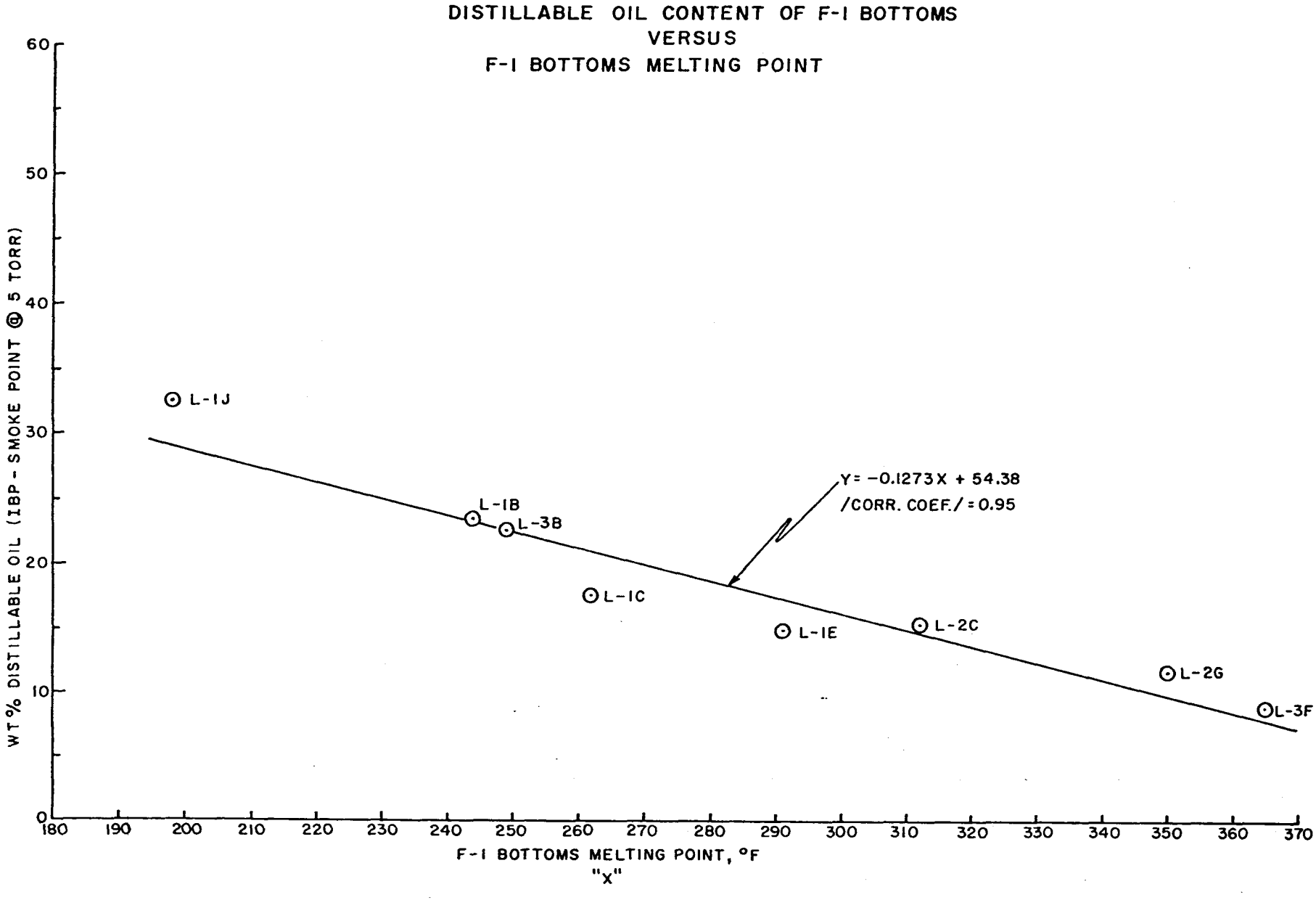
SAMPLE DESCRIPTION	LEC Btms	Feed Solv	S-8 Oil	S-4B Oil	V-9 Ovhd
SAMPLE POINT	Sx-12	Sx-14	Sx-16	Sx-23	Sx-28
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5	5			
IBP	104	78			
5%	108	93			
10%	111	106			
20%	118	130			
30%	126	152			
40%	136	167			
50%	149	177			
60%	165	183			
70%	176	189			
80%	185	196			
90%	196	206			
95%	207	212.5			
DRY PT.	211	230			
(VOLUME PERCENT — TEMPERATURE, °C)					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR			742	737	742
IBP			40	83	107
5%			89	101	112
10%			101	126	112
20%			116	201	112
30%			123	224	112
40%			138	245	112
50%			159	261	112
60%			188	272	113
70%			198	278	113
80%			207	312	113
90%			220		113
95%			226		115
DRY PT.			230	336	125
(VOLUME PERCENT — TEMPERATURE, °C)					
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F	10.8	11.4			
210° F	8.5	8.8			
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)		0.36	0.52	1.66	
INFRARED RATIO		0.29			
SP. GRAV. 60/60 F	1.007	1.030			

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION. USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-1K
DATE: 8/3-4/77
TIME: 1700-0500

SAMPLE DESCRIPTION	Cold Trap	S-4A Oil	S-7 Btms	Deash.Solv	
SAMPLE POINT	Sx-33	Sx-37	Sx-39	Sx-40	
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR			5		
IBP			78		
5%			88		
10%			100		
20%			127		
30%			146		
40%			163.5		
50%			176		
60%			183.5		
70%			188		
80%			195.5		
90%			213		
95%			226		
DRY PT.			227		
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	746	742		744	
IBP	91	84		106	
5%	101	107		109	
10%	106	139		110	
20%	113	198		111.5	
30%	113	218		111.5	
40%	115	229		112	
50%	116	239		112	
60%	119	256		112	
70%	124	278		112	
80%	142	315		112	
90%	162	346		112	
95%		357		112	
DRY PT.	167	360		176	
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F			11.5		
210° F			8.6		
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)			0.55		
INFRARED RATIO					
SP. GRAV. 60/60 F		0.969	1.031		

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION. USUALLY LESS THAN 5% FOR THE F-1 VACUUM BOTTOMS MATERIAL


DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT
WT % DISTILLABLE OIL (IBP - SMOKE POINT @ 5 TORR)
"Y"
F-1 BOTTOMS MELTING POINT, °F
"X"
Y = -0.1273X + 54.38
/CORR. COEF./ = 0.95
L-1J
L-1B
L-3B
L-1C
L-1E
L-2C
L-2G
L-3F
0
10
20
30
40
50
60
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/4/78

MATERIAL OUT

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

Temperature:757°F
Pressure: 2500 psig
LHSV: 1.42
GHSV: 336

lbs/hour

Quantitative

STREAM DESCRIPTION	Product Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd	S-8 Btms	J-1 Exhaust
SAMPLE POINT	Sx-19	Sx-30	Sx-23	Sx-44	Sx-16	Sx-32
Hydrogen - H_2	1.12	0.08				0.01
Carbon Monoxide - CO	10.33	0.85				0.11
Carbon Dioxide - CO_2	9.12	2.22				0.49
Hydrogen Sulfide - H_2S	0.10	0.04				
Methane - CH_4	0.52	0.08				0.02
Ethane - C_2H_6	0.36	0.10				0.02
Propane - C_3H_8	0.18	0.12				0.04
Butane - C_4H_{10}						
Nitrogen - N_2	0.12	0.02				
Ammonia - NH_3	0.03	0.01	0.02			
Light Oil - (0-100° C @ 1.6 Torr)			2.09		7.27	
Solvent - (100-230°C @ 1.6 Torr)			1.08		0.06	
Heavy Oil - (230-255°C @ 1.6 Torr)			0.19			
SRL						
Coal (MAF)						
Ash						
Water			14.87			
Phenol						
TOTAL	21.88	3.52	18.25	Negl.	7.33	0.69

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/4/78

MATERIAL OUT

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

Temperature: 757°F
Pressure: 2500 psig
LHSV: 1.42
GHSV: 336

lbs/hour

	STREAM DESCRIPTION	Cold Trap	V-8 Btms	F-1 Btms	V-9 Ovhd	←Recycle Solvent→ S-7 Btms	F-2 Btms
Quantitative	SAMPLE POINT	Sx-33	Sx-27	Sx-2	Sx-28	Sx-39	Sx-12
	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	0.31	8.35		83.87	10.25	4.83
	Solvent - (100-230°C @ 1.6 Torr)	0.03	5.32	4.14	0.72	47.25	14.39
	Heavy Oil - (230-255°C @ 1.6 Torr)		0.69			1.24	0.33
	SRL		2.46	11.18			
	Coal (MAF)		3.22	0.48			
	Ash		1.24	0.68			
	Water	0.22				0.32	
	Phenol						
	TOTAL	0.56	21.28	16.48	84.59	59.06	19.55
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 1/4/78

Run No: L-1K
Date: 8/3-4/77
Time: 1700-0500

MATERIAL OUT

lbs/hour

Temperature: 757°F
Pressure: 2500 psig
LHSV: 1.42
GHSV: 336

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.21
Carbon Monoxide - CO						11.29
Carbon Dioxide - CO_2						11.83
Hydrogen Sulfide - H_2S						0.14
Methane - CH_4						0.62
Ethane - C_2H_6						0.48
Propane - C_3H_8						0.34
Butane - C_4H_{10}						
Nitrogen - N_2						0.14
Ammonia - NH_3						0.06
Light Oil - (0-100° C @ 1.6 Torr)						116.97
Solvent - (100-230°C @ 1.6 Torr)						72.99
Heavy Oil - (230-255°C @ 1.6 Torr)						2.45
SRL						13.64
Coal (MAF)						3.70
Ash						1.92
Water						15.41
Phenol						
TOTAL						253.19

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

APPENDIX D

Process Development Unit Run L-2
August 21 - September 23, 1977

Run L-2 was the second of three runs scheduled for 672 hours of continuous operation. The objectives were (1) to evaluate long term plant operability with continuous liquefaction solvent recycle and (2) to determine the effects of off-gas clean-up and recycle on liquefaction yields.

Nominal run conditions were similar to those of previous Run L-1 and were 820-830°F maximum reaction temperature and 2500 psig dissolver operating pressure with liquid and gas hourly space velocities of 1.43 and 336, respectively. All recoverable organic distillates boiling above 350°F were recycled. The main product gas stream was caustic washed to remove carbon dioxide and hydrogen sulfide and then approximately three quarters was recycled and one quarter vented to the thermal oxidizer. One reactor volume, about 1.4 cubic feet, was used throughout the run.

Initially Run L-2 got off to a bad start because plugging in some lines that had not been replaced at the end of Run L-1 delayed PDU startup. Later, after coal processing had started, a solid state contactor in the electrical circuit servicing the heat tapes on the F-1 vacuum bottoms draw off leg failed closed, allowing the leg to overheat and coke the vacuum bottoms.

Operating difficulties initiated by the plugging of the vacuum flash tower bottoms outlet were compounded when the S-1 high pressure slurry letdown valves started leaking. These problems, coupled with other minor operating problems with the slurry charge pumps, consumed approximately the first 155 hours of the scheduled 672. To compensate, the run was extended an additional 144 hours for a total of 816 hours.

With the initial problems resolved, satisfactory startup was achieved on about the sixth day of operations. The unit operated at temperature for about thirty hours, then problems developed with the slurry charge pumps. The pumps worked well with solvent but not with coal slurry. This apparently resulted from an increase in the particle size distribution of the ground coal caused by a worn screen in the coal pulverizer. Sieve analyses for a feed coal sample taken while the pumping problem existed and one taken during the earlier M-series of runs are compared on the following page.

US Screen Sieve Mesh	Total Percentages On		Passing	
	L-2	M-Series	L-2	M-Series
65	21.9	0.4	78.1	99.6
100	39.5	3.3	60.6	96.7
150	63.1	16.2	36.9	83.8
170	78.5	43.5	21.5	56.5
230	89.3	71.6	10.8	28.4
325	95.3	90.7	4.8	9.3
Pan	100.0	100.0	0.0	0.0

There is a significant change in the particle size distribution between the M-series and L-2 feed coal samples. These larger particles are believed to have interfered with the proper sealing of the slurry pump check valves and consequently with the pump's overall performance.

When a new pulverizer screen had been installed and a finer feed coal prepared, the run progressed smoothly, although some minor problems did arise. Solvent recovery during the run was less than desired but better than during Run L-1. The loss amounted to about 10 percent of the hourly feed solvent rate and aside from the usual loss due to sampling occurred mainly in the waste water and the light ends column overhead streams.

The problem of solids accumulation in the reactor was also encountered. After processing coal for approximately 220 hours in Reactor R-1A, the melting point of the F-1 vacuum bottoms had risen to about 450°F. This high melting point material offered considerable resistance to removal from the vacuum flash tower. The high melting point of the F-1 vacuum bottoms also indicated a low level of conversion and preparations were made for switching to Reactor R-1B. The coal feed was stopped and Reactor R-1A was flushed with solvent for about 12 hours while cooling. The vessel was then depressured, disassembled and cleared of solids buildup which amounted to approximately 32 percent of the free volume of the reactor.

With Reactor R-1B in service, the unit was brought to reaction conditions and coal processing resumed. The effects of switching to a clean reactor were immediately apparent in the improved operation of the vacuum bottoms removal system and in the reduced malting point of the vacuum bottoms (320-350°F).

After switching reactors, the unit operated smoothly for another 70 hours of coal processing, then the back pressure control valve plugged causing a major upset in the liquefaction section and a forced shutdown resulted. Approximately 40 hours were required to clear or replace plugged lines, after which the unit was restarted and heated. Coal processing resumed and proceeded smoothly for about 110 hours then was interrupted because of plugging in vacuum flash drum F-1 and its bottoms drawoff line. Slurry overflowed the vacuum flash tower, plugging

the overhead vapor condenser, the condensate accumulator S-7, the line from S-7 to the condensate bottoms pump, the pump itself and the line from the pump to the solvent accumulator A-5A. The liquefaction section was flushed with raw solvent and cooled for shutdown. Complete disassembly of the vacuum flash - solvent recovery equipment was required for cleaning and this, along with reassembly, consumed the remaining 94 hours of the run period.

Eight yield periods, each nominally 12 hours long, and one overall material balance (441.4 hours long) were completed during Run L-2. Quantitative material balances were made for all, and elemental balances made for six of the nine yield periods. All nine data period workups, including quantitative and elemental balances, sample analyses, ASTM D-86 and D-1160 distillation data and the average run conditions are attached.

Material balance closure varied from 94.7 percent for the overall balance to an average of 98 percent for the eight standard length data periods. The 12 hour long yield periods were all adjusted to 100 percent recovery in similar fashion. The main adjustment was made by increasing the product gas rate and calculating the recycle gas rate so that its contribution to the feed gas was consistent with the total feed gas rate and composition. The makeup gas rate was assumed to be the difference between the feed gas and recycle gas rates. In addition, some minor adjustments to the F-1 vacuum bottoms and J-1 discharge rates were made for certain yield periods. These adjustments involved assuming a value of 1/2 pound per hour for the J-1 discharge rate in those cases where the metering orifice was not working properly and changing the F-1 vacuum bottoms rate so that the ash out was less than or equal to the ash measured in for that particular data period. In the case of the F-1 bottoms rate change, the adjustment involved approximately the amount of material contained in one cycle of the vacuum bottoms drawoff system. Thus, depending on how quickly the vacuum bottoms collection drum was changed at the end of the yield period, the drum may have contained slightly less or slightly more vacuum bottoms material than that actually produced during the time period in question. Finally, in those yield periods for which elemental analyses were available and carbon balances were poor, forced carbon balances were made by adjusting the oil-water ratio in the waste water streams.

In the overall material balance, adjustment to 100 percent recovery was slightly different from that of the shorter yield periods because of the greater uncertainty in product rate measurements. The first step in adjustment was to increase the product gas rate so that the total gaseous nitrogen out equaled that in the feed. Next the F-1 vacuum bottoms rate was adjusted to satisfy a forced ash balance and then any remaining error was

normalized among the other outgoing liquid streams. With this completed a forced carbon balance was made and the oil-water ratio of the waste water stream adjusted as required. The end result of these adjustments to the overall material balance agreed with the results obtained from the shorter yield periods.

A comparison of the results for the nine data periods along with the average for the eight 12 hour long yield periods is shown on the following page.

Conversion of MAF lignite to gas, oil and SRL varied from 83 to 91.5 weight percent with the overall conversion for the run being 88.7 percent.

In general, the net gas yield was equal to 30.6 weight percent of the MAF lignite charged and the net hydrocarbon liquid yield 63.5 weight percent. Distillable oil made up 24.6 percent of the total organic liquid yield while SRL comprised the remaining 75.4 percent.

Actual solvent recovery for recycle during the coal processing period was about 92.6 percent. For the entire 600 odd hours of operation it was necessary to add about 3400 pounds of fresh solvent to maintain the working inventory. This constituted as hourly loss of about six percent of the feed solvent.

The calculated maximum possible solvent recovery on a total oil basis was 104-105 percent and on a light oil free basis 90-94 percent.

Consumption of reducing gases on a hydrogen equivalent basis was 2.1 weight percent of the MAF lignite or 4.0 standard cubic feet per pound MAF lignite charged.

As mentioned earlier, the two general objectives of Run L-2 were (1) to determine the effects of partial product gas recycle and (2) to determine the effects of extended solvent reuse.

Analysis of the first objective is perhaps best accomplished by comparing the average results of all 12-hour yield periods for Run L-1 with a similar average from Run L-2. This is done in Table 2 on the following page. In the overall averages for these two runs, the effects of extended solvent reuse should be approximately the same in both cases and the differences in product yields then attributeable to gas recycle or to variations in other variables. The average results of the two runs in Table 2 do indicate some differences in net yields, but the magnitudes of the differences are small and perhaps due to experimental or material balance adjustment errors. Thus, the results of the two runs appear equivalvent.

In regard to plant operability, the same type of problems

Table 1

Process Development Unit Run L-2

Yield Period	L-2B	L-2C	L-2D	L-2E	L-2F	L-2G	L-2H	L-2I	Overall L-2	L-2B thru I Average
Reactor in Use	R-1A	R-1A	R-1A	R-1A	R-1B	R-1B	R-1A	R-1A	-	-
SLS System in Use	No	No	No	No	No	No	No	No	No	No
LHSV	1.38	1.37	1.38	1.48	1.41	1.40	1.40	1.42	1.42	1.40
GHSV	321	320	320	309	354	358	332	340	325	332
Solvent/MAF Coal Ratio	3.00	3.21	3.14	3.04	3.28	3.14	3.07	2.96	3.10	3.10
H_2/CO Mol Ratio	1.71	1.86	1.72	1.20	1.23	1.17	1.10	1.34	1.38	1.42
Temperatures, °F										
Preheater Outlet, E-1	746	751	747	741	726	721	729	738	737	737
Reactor 3 ft	778	776	752	739	747	745	777	699	752	752
Reactor 7 ft	823	825	809	808	791	788	786	765	799	799
Reactor 11 ft	820	816	793	780	818	824	786	777	802	802
Reactor 15 ft	820	822	808	798	832	829	785	787	810	810
Vacuum Flash Ovhd	512	505	503	496	509	505	496	492	502	502
Dissolver Pressure, psig	2460	2460	2450	2450	2460	2460	2450	2450	2460	2460
Solvent Recycle, %										
Actual	89.1	92.3	93.1	91.6	101.0	92.7	100.2	98.5	92.6	94.8
Possible	103.0	104.2	100.0	101.2	105.4	107.2	107.0	104.8	105.0	104.1
Possible (Ex Lt Oil)	94.3	92.8	91.9	89.5	95.6	94.7	95.7	96.7	90.7	93.9
Yields, Wt % MAF Coal										
Net Gas	36.6	38.3	23.6	21.8	38.2	36.7	28.4	22.3	30.6	30.7
Net Liquid	49.6	49.6	58.6	62.0	58.8	61.6	70.4	75.7	63.5	60.8
(Dist Oil)	(9.0)	(13.7)	(-0.1)	(3.7)	(17.7)	(22.6)	(21.3)	(14.3)	(15.6)	(12.8)
(SRL)	(40.6)	(35.9)	(58.7)	(58.3)	(41.1)	(39.0)	(49.1)	(61.4)	(47.9)	(48.0)
Net Water and Ash	-2.0	-1.9	0.7	-0.8	-5.8	-6.7	-8.1	-6.5	-5.4	-3.9
Unconverted Coal	15.8	14.0	17.1	17.0	8.8	8.4	9.3	8.5	11.3	12.4
Overall Material Balance, %	98.5	98.7	99.9	99.2	96.7	96.7	97.9	96.0	94.7	98.0
Solvent Passes @ Mid-Y.P.	1.3	2.4	12.0	14.9	4.5	5.5	15.6	16.8	-	-

Table 2

Process Development Unit Runs L-1 & L-2

Run	L-1B - L-1K Average	L-2B - L-2I Average
LHSV	1.42	1.40
GHSV	328	332
Solvent/MAF Coal Ratio	2.96	3.10
H_2/CO Mole Ratio	1.13	1.42
Temperatures, °F		
Preheater Outlet, E-1	730	737
Reactor, 3 ft	753	752
Reactor 7 ft	785	799
Reactor 11 ft	784	802
Reactor 15 ft	822	810
Maximum Reaction	822	810
Vacuum Flash Ovhd	515	502
Dissolver Pressure, psig	2500	2500
Solvent Recycle, %		
Actual	90.3	94.8
Possible	104.0	104.1
Yields, Wt % MAF Coal		
Net Gas	31.3	30.7
Net Liquid	66.1	60.8
(Dist. Oil)	(13.2)	(12.8)
(SRL)	(52.9)	(48.0)
Net Water and Ash	-5.2	-3.9
Unconverted Coal	7.8	12.4
Overall Material Balance, %	99.8	98.0

were encountered in both runs.

In summary then, operating with gas recycle posed no new operating problems and resulted in approximately the same net yields as operating with once-thru gas.

The effects of extended solvent recycle are more apparent in Run L-2 than in previous Run L-1, perhaps because of the better and longer operating periods without makeup solvent addition. The approximate number of solvent cycles without makeup solvent through the liquefaction reactor at the middle of each L-2 yield period was calculated and the net yields obtained in each data period plotted against the number of solvent passes. These are presented in Figure 1 on the following page.

Solvent recycle appears to have little effect on MAF lignite conversion. Conversion remains fairly constant at about 88 percent even though the temperature is lower in the runs with longer solvent recycle, which in this temperature range usually lowers conversion. Previous data obtained in Run M-29 indicated that the overall MAF lignite conversion increased with solvent recycle until about 8 passes, then leveled off and became constant. This trend might have been better demonstrated in Run L-2 had the temperatures been better controlled at the desired level.

Continued solvent recycle seems to favor increased total net liquid yields while the net gas yields decrease as the liquefaction solvent becomes more coal derived, though again this may be partially the effect of temperature. Water consumption remains relatively constant at about 4 weight percent of the MAF lignite.

Figure 2 presents a plot of the distillable oil and SRL components of the net liquid yield versus the number of solvent passes. With increasing solvent recycle and with decreasing temperature, the net SRL yield increases while net distillable oil yield decreases. If this trend persisted through greater solvent recycle, and perhaps decreasing temperature, only SRL might be generated, though in that case solvent production could be decreased below solvent sufficiency.

During Run L-2, the feed solvent was monitored by infrared spectroscopy for the aromatic-to-aliphatic carbon ratio, and analyzed for sulfur content periodically. Graphs of the IR ratio and sulfur content versus hours of use without make-up are shown on the following pages. In Figure 3, the infrared ratio (and consequently the solvent aromaticity) increases with time until approximately eleven solvent passes thru the liquefaction reactor have been completed. In this particular case, approximately 150 hours were required after initial startup to complete eleven passes. The starting solvent was the overhead condensate from

FIGURE 1
EFFECTS OF SOLVENT RECYCLE ON LIQUEFACTION YIELDS
RUN L-2
AUGUST 21-SEPTEMBER 23, 1977

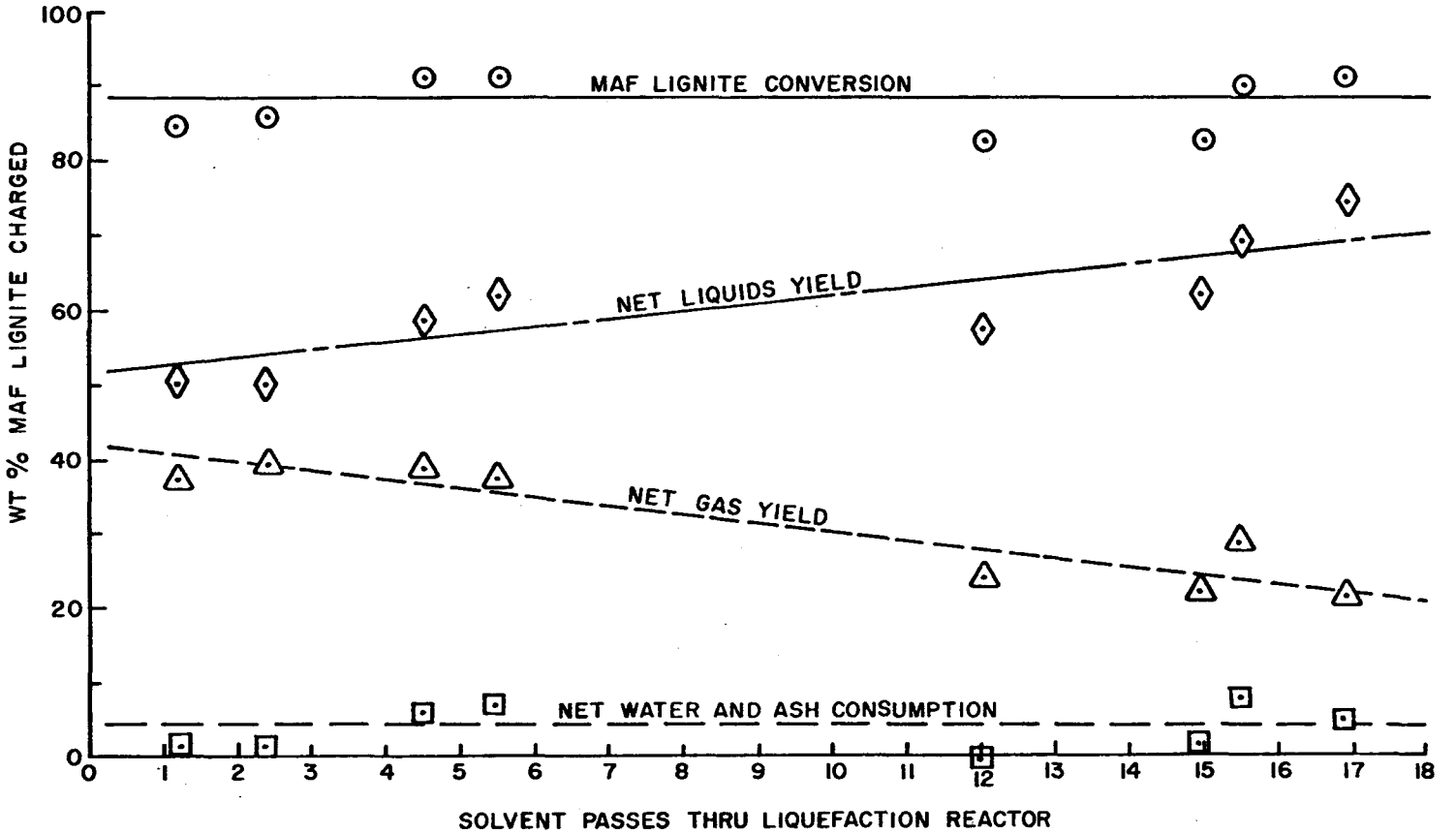


FIGURE 2

EFFECTS OF SOLVENT RECYCLE ON LIQUEFACTION YIELDS

RUN L-2

AUGUST 21 - SEPTEMBER 23, 1977

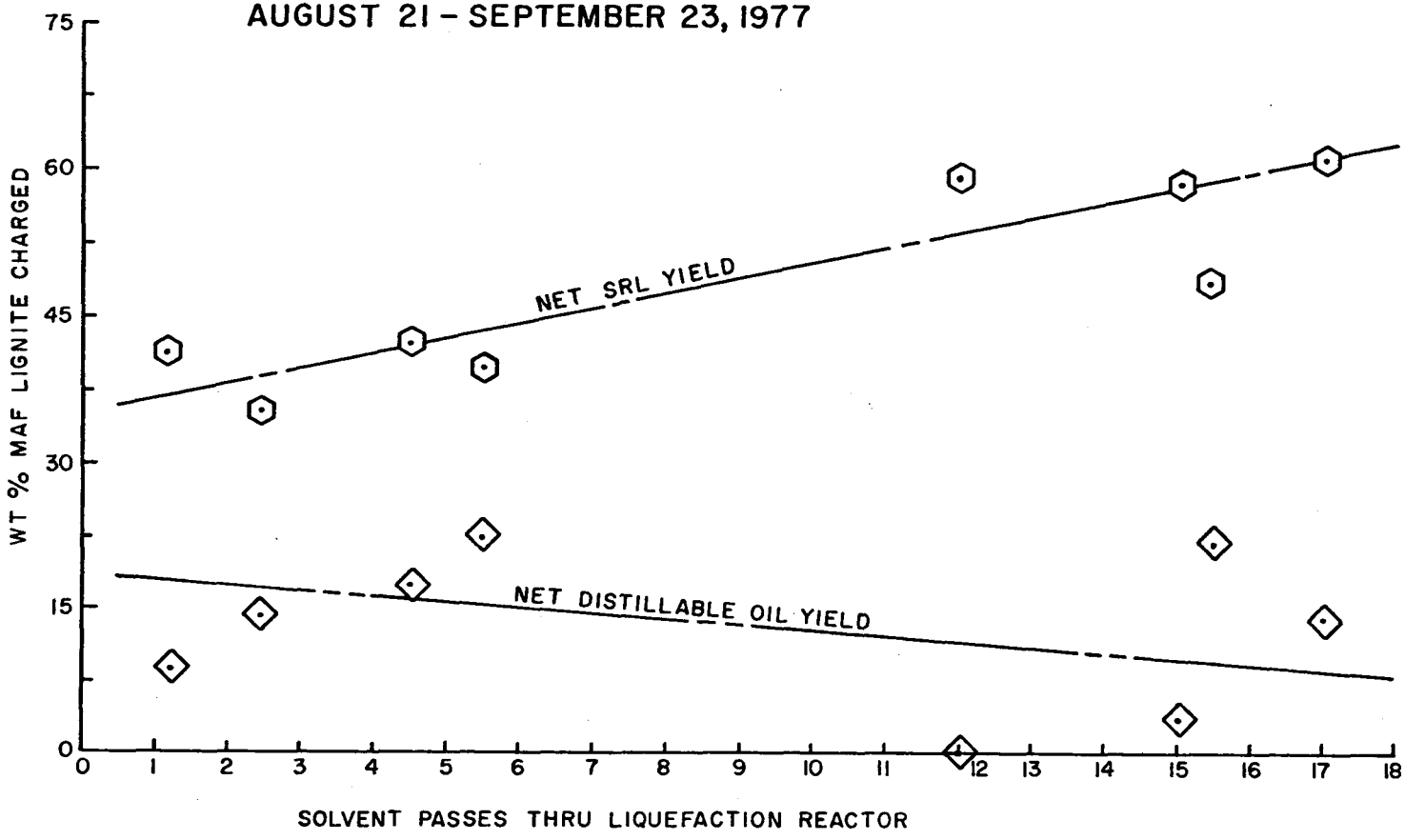


FIGURE 3
RUN L-2
INFRARED RATIO vs TIME
FEED SOLVENT (Sx-14)

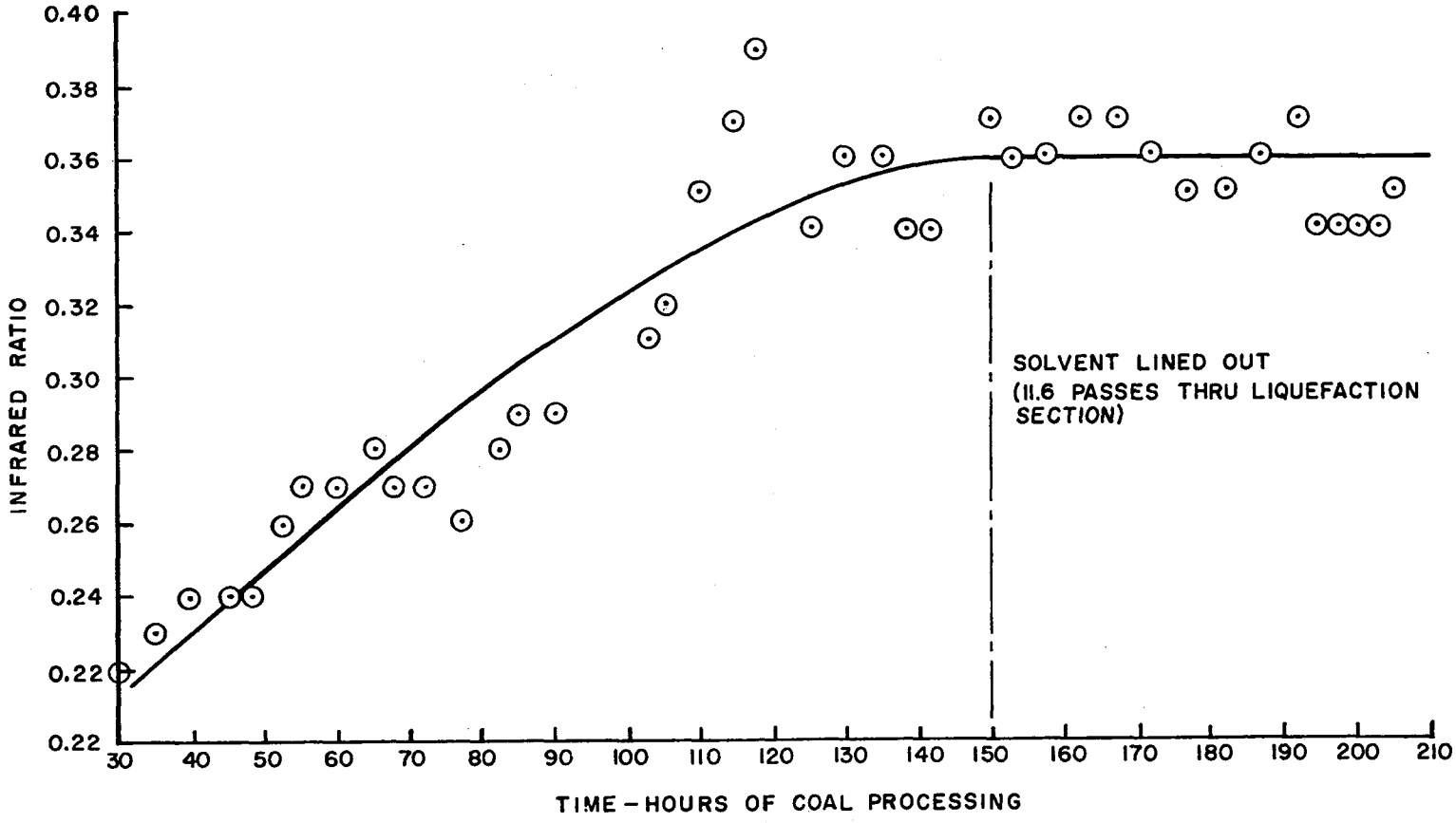
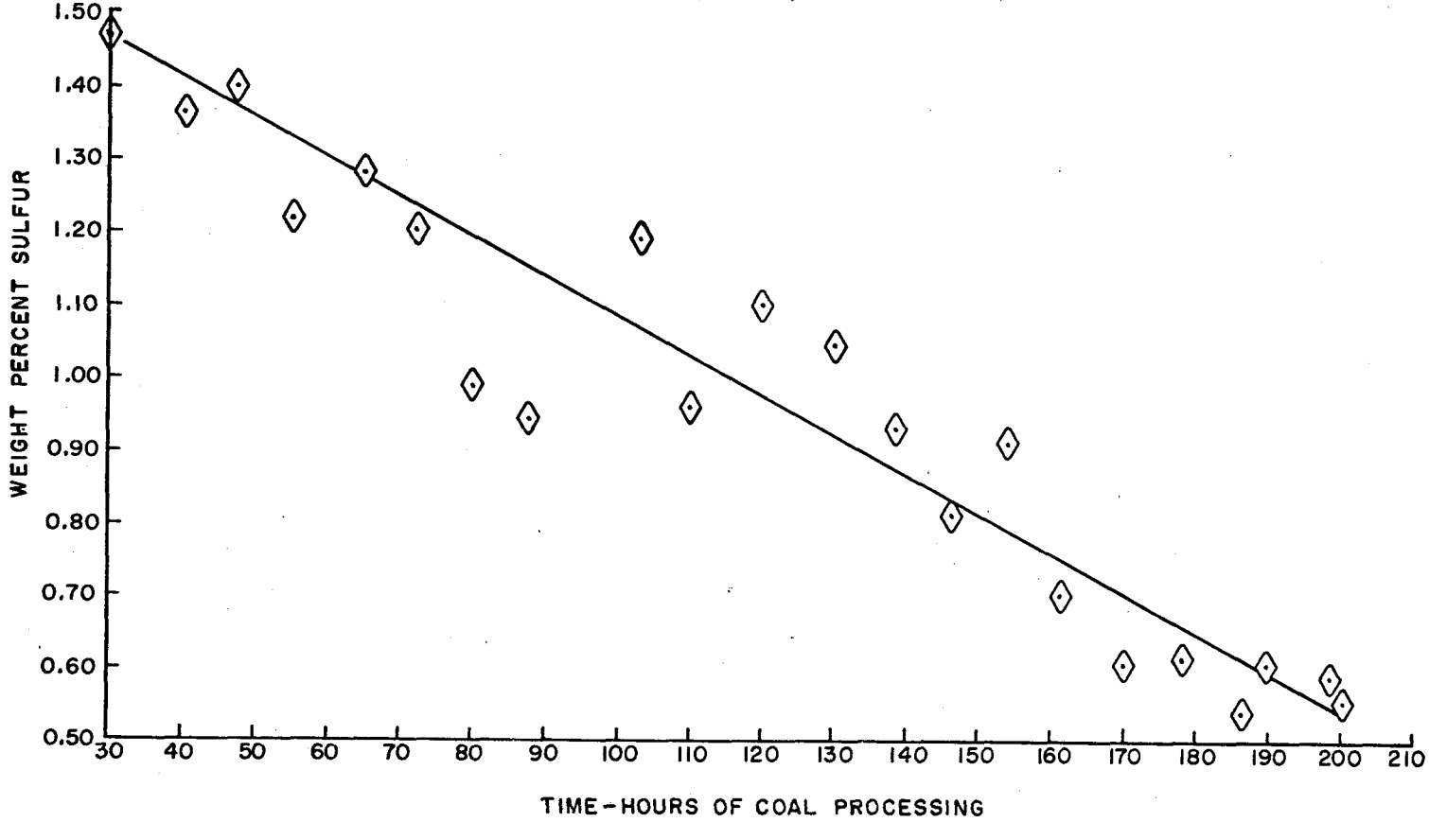


FIGURE 4
RUN L-2
WEIGHT PERCENT SULFUR vs TIME
FEED SOLVENT (Sx-14)



FS-120 carbon black feed stock that had been vacuum flashed at 20 Torr and about 525°F vapor temperature. In Figure 4, the sulfur content of the recycle solvent is shown to decrease steadily with time and apparently would level off at some equilibrium concentration below that shown on the graph. Batch autoclave experiments with low-sulfur solvents indicate the lignite derived sulfur content of SRL to be about 0.3 weight percent and a similar or slightly higher level might be expected for lignite derived solvent.

In review, some general statistics concerning Run L-2 are shown in the following table:

Total Time Scheduled	816	hours
Operating Time on Coal Scheduled	796	hours
Actual Operating Time*	591	hours
Actual Time on Coal during operating time	441.4	hours
Time on Coal as percent of		
Actual Operating Time	74.7%	
Scheduled Operating Time	55.5%	
Total Scheduled Time	54.1%	

*From time coal first introduced at 131 hours to time coal last shut off at 722 hours.

During the actual operating time on coal 21,468 pounds of lignite was processed at an average feed rate of 48.6 lbs/hr.

In Run L-2 two sets of reactor solids were obtained for analysis The first set was removed from dissolver R-1B, which had been shut-down after approximately 48 hours of coal processing because of a leaky bottom closure. During shutdown the reactor was cooled to about 600°F by flushing with solvent for six hours. Flows were then stopped and the reactor was isolated and allowed to cool to room temperature, after which it was depressured, disassembled and 40 pounds of solids removed by drilling. Samples were taken at different distances from the bottom of the reactor and each was analyzed for ash and pyridine insoluble material. The results of these tests are presented in Table 3, and shown graphically in Figure 5. The mineral residue appears to be somewhat more concentrated near the base of the reactor, probably because of settling, although a plating-out type of mechanism may also be involved. The pyridine insoluble material is somewhat more concentrated in the upper regions of the reactor, probably because the SRL product is more subject to coking in the upper sections of the reactor where the temperatures are higher.

The second set of reactor solids samples was obtained from dissolver R-1A which had been shutdown after approximately 220 hours of coal processing because the melting point of the F-1 vacuum bottoms had risen excessively and presented numerous operating difficulties. During shutdown, reactor R-1A was cooled to below

450°F by flushing with solvent for about 12 hours. It was then isolated and allowed to cool to ambient temperature after which it was depressured, disassembled and 43 pounds of solids removed by drilling. As with the solids removed from reactor R-1B, samples were taken at various points throughout the reactor and analyzed for ash and pyridine insoluble material. The results are shown in Table 4 and Figure 6. The same general trends in composition are apparent for the R-1A reactor solids as were indicated for the R-1B solids, although one important difference may be noted. The concentration of both the ash and pyridine insoluble material has been shifted to the right, indicating an increase in these materials with time. The average data for the R-1B and R-1A reactor solids are plotted versus hours of coal processing in Figure 7. It appears that the amount of total solids in the reactor remained fairly constant with time at about 29 pounds per cubic foot of reactor volume. However, the concentrations of both ash and pyridine insoluble material increased with time. The pyridine insoluble material and the ash were both higher after 220 hours of operation in reactor R-1A than after 48 hours of operation in reactor R-1B. The apparent rate of increase over the period from 48 hours to 220 hours was 0.027 and 0.018 pounds per hour per cubic foot of reactor volume for pyridine insolubles and for ash, respectively.

It is not clear as to what might happen to the reactor solids during longer periods of coal processing; however, in the present reactors the conversion of MAF lignite to gas, oil and SRL is greatly decreased after approximately 220 hours of operation on coal.

Table 3

R-1B Reactor Solids
Run L-2
August 29, 1977
48 hours of Coal Processing
40 pounds of solids removed

Sample Location (feet from bottom of Reactor)	Wt % Ash	Wt % Pyridine Insoluble Material
7	10.4	39.1
10	12.4	57.1
13	11.6	57.6
15	11.5	59.9
Top	9.0	50.8

Table 4

Reactor R-1A Solids
Run L-2
September 9, 1977
220 hours of Coal Processing
43 pounds of solids removed

Sample Location (feet from base of Reactor)	Wt % Ash	Wt % Pyridine Insoluble Materil
Btm	28.2	43.9
3	21.5	62.7
6	19.4	69.7
9	18.1	73.5
12	15.9	73.7

FIGURE 5
REACTOR R-1B SOLIDS
Run L-2
August 29, 1977
48 hours of coal processing
40 pounds of solids removed

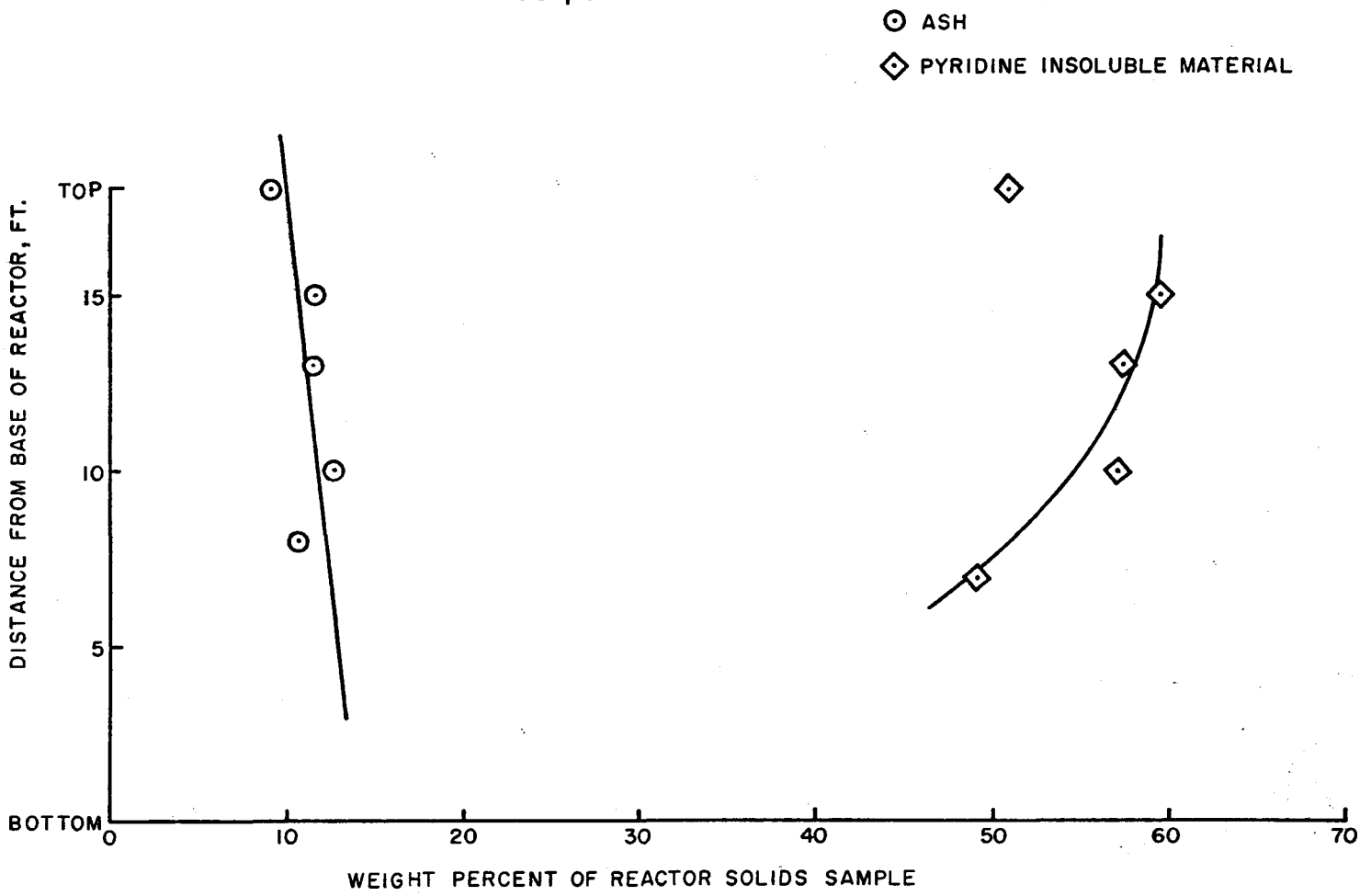


FIGURE 6
REACTOR R-IA SOLIDS
Run L-2
September 9, 1977
220 hours of coal processing
43 pounds of solids removed

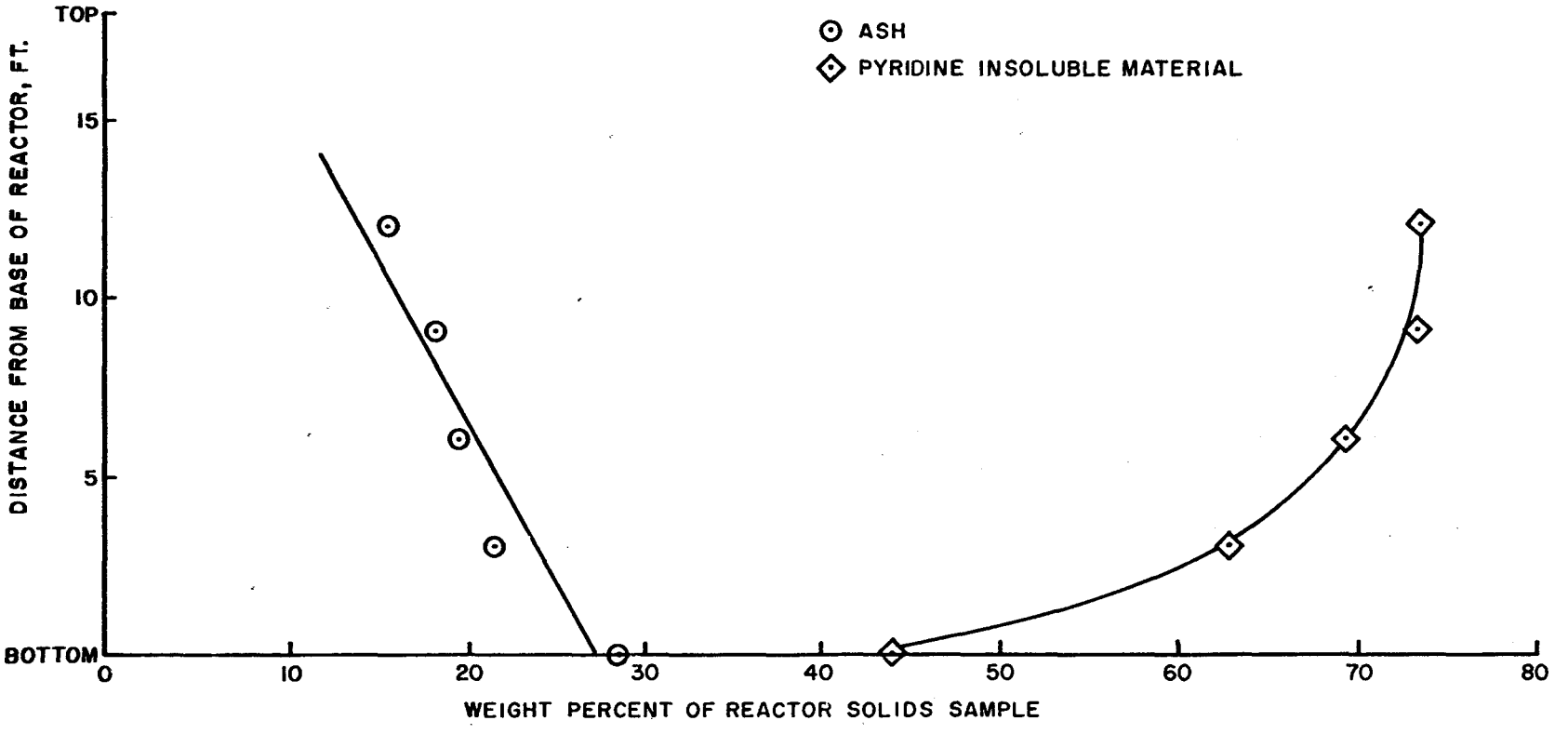
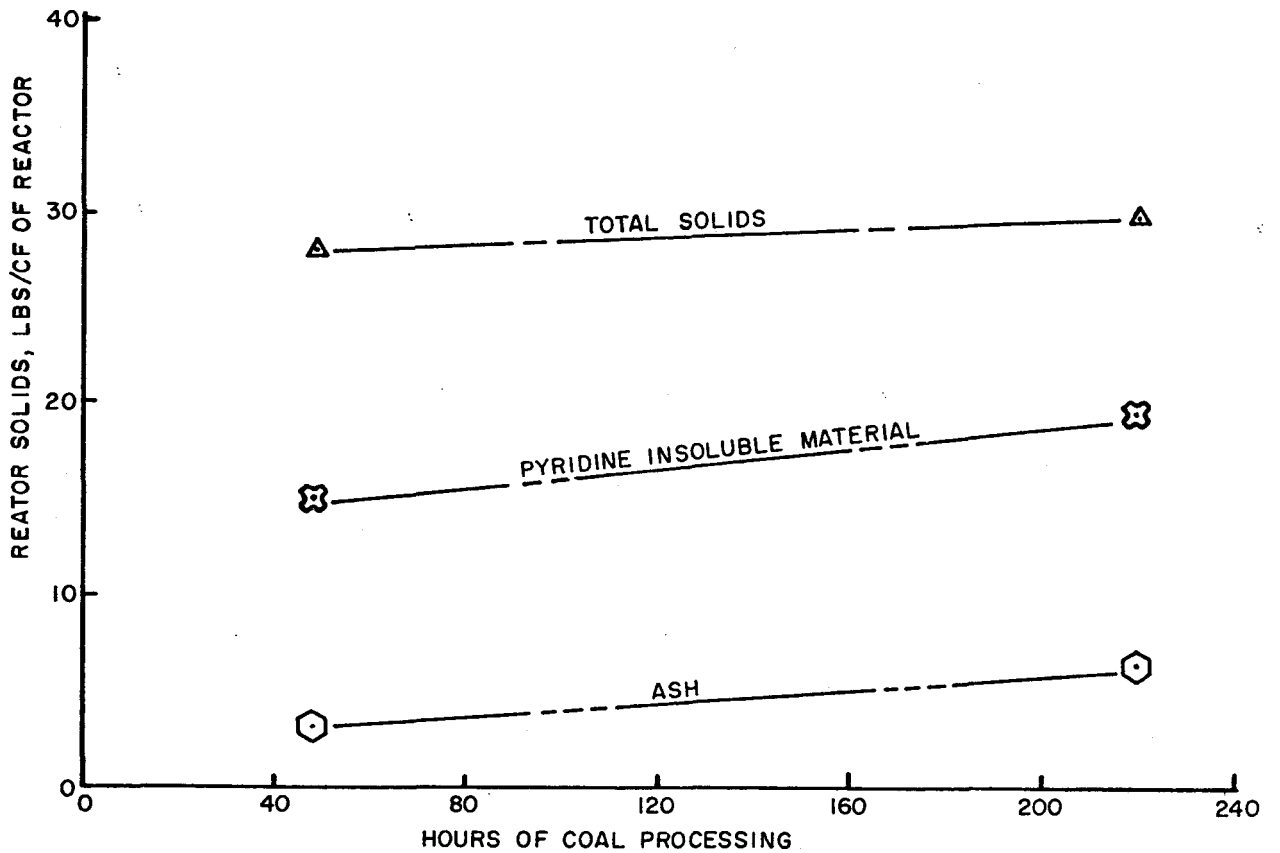


FIGURE 7
REACTOR SOLIDS ACCUMULATION
RUN L-2



RUN CONDITIONS

RUN NO. L-2
DATE MADE 8/21-9/23/77

Only one reactor in use at any one time

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 757
- INLET 276
- OUTLET 737

DISSOLVERS
- ~~XXXX~~ (1) 752
- (2) 799
- (3) 802
- (4) 810
- ~~XXXX~~ (1)
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 580
- S-2 80
- S-3 497
- S-4A 82
- S-4B 74

PREHEATER E-11
- DOWTHERM 682
- INLET 432
- OUTLET 644

VACUUM FLASH F-1
- OVERHEAD VAPOR 502
- UPPER WALL 606
- LOWER WALL 600
- DOWNCOMER 550
- CONDENSATE ACCUMULATOR, S-7 83

PREHEATER E-13
- DOWTHERM 403
- INLET 80
- OUTLET 176

LIGHT ENDS COLUMN, F-2
- REBOILER 314
- LOWER SECTION 229
- FEED SECTION 227
- OVERHEAD 180
- S-8 73
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

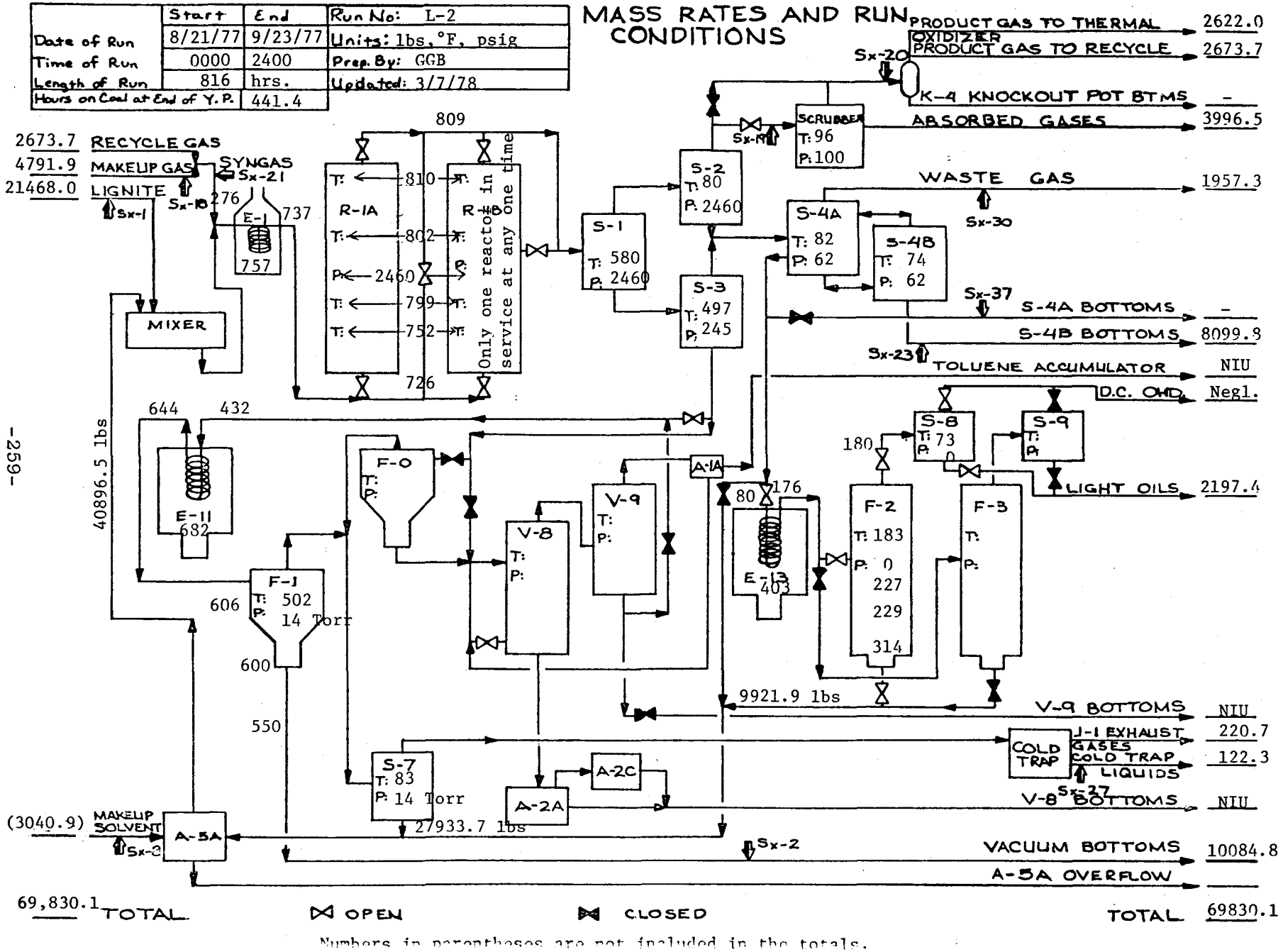
RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

- SEPARATORS S-1 and S-2: 2460
- SEPARATOR S-3: 245
- SEPARATORS S-4A and S-4B: 62
- VACUUM FLASH, F-1: 14 Torr
- LIGHT ENDS COLUMN, F-2: Atm
- SOLVENT COLUMN, F-3: NIU
- HEAVY ENDS COLUMN, F-4: NIU
- VACUUM FLASH, F-0: NIU
- SETTLING TOWER, V-8: NIU
- RECOVERY TOWER, V-7: NIU

MASS RATES AND RUN CONDITIONS

	Start	End	Run No: L-2
Date of Run	8/21/77	9/23/77	Units: lbs, °F, psig
Time of Run	0000	2400	Prep. By: GGB
Length of Run	816	hrs.	Updated: 3/7/78
Hours on Coal at End of Y.P.	441.4		



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas and F-1 Btms Rates Adjusted, then Normalized with Forced Carbon Balance
Revised: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs of Coal Processing

SUMMARY

Temperature: 737°F
Pressure: 2460 psig
LHSV: 1.42
GHSV: 325

lbs.

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
Quantitative	SAMPLE POINT						
	Hydrogen - H_2	554.4	473.9	-80.5			
	Carbon Monoxide - CO	5856.9	3095.7	-2761.2			
	Carbon Dioxide - CO_2	27.3	5398.1	5370.8			
	Hydrogen Sulfide - H_2S		90.6	90.6			
	Methane - CH_4	633.4	1429.6	796.2	4011.9	30.63	
	Ethane - C_2H_6	204.8	551.5	346.7			
	Propane - C_3H_8	95.2	328.5	233.3			
	Butane - C_4H_{10}						
	Nitrogen - N_2	93.6	93.6	-0-			
	Ammonia - NH_3		16.0	16.0			
	Light Oil - (0-100° C @ 1.6 Torr)	10011.5	14914.8	4903.3			
	Solvent - (100-230°C @ 1.6 Torr)	29543.6	26758.5	-2785.1	8319.1	63.52	
	Heavy Oil - (230-255°C @ 1.6 Torr)	1100.1	1029.3	-70.8			
	SRL		6271.7	6271.7			
	Coal (MAF)	13097.6	1474.4	-11623.2		-88.74	
	Ash	1283.8	1283.8	-0-		-0-	
	Water	7327.9	6620.1	-707.8		-5.41	
	Phenol						
	TOTAL	69830.1	69830.1	-0-			
Elemental	Carbon	48186.9	48186.9	-0-			
	Hydrogen	5433.5	5668.8	235.3			
	Nitrogen	334.6	335.1	0.5			
	Sulfur	582.8	578.6	-4.2			
	Oxygen (by diff)	14008.5	13776.9	-231.6			
	Ash	1283.8	1283.8	-0-			
	TOTAL	69830.1	69830.1	-0-			

PROJECT LIGNITE
MEASURED AND ADJUSTED MATERIAL BALANCE
Revised: 3/6/78

MATERIAL IN

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs Coal Processing

Temperature: 737°F
Pressure: 2460 psig
LHSV: 1.42
GHSV: 325

lbs.

	STREAM DESCRIPTION	←Feed Recycle Gas	Gas→ Makeup Gas	Lignite	Feed Solvent		Total In
Quantitative	SAMPLE POINT	Sx-20	Sx-18	Sx-1	*Sx-14		
	Hydrogen - H_2	223.3	331.1				554.4
	Carbon Monoxide - CO	1445.9	4411.0				5856.9
	Carbon Dioxide - CO_2	27.3					27.3
	Hydrogen Sulfide - H_2S						
	Methane - CH_4	633.4					633.4
	Ethane - C_2H_6	204.8					204.8
	Propane - C_3H_8	95.2					95.2
	Butane - C_4H_{10}						
	Nitrogen - N_2	43.8	49.8				93.6
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)				10011.5		10011.5
	Solvent - (100-230° C @ 1.6 Torr)				29543.6		29543.6
	Heavy Oil - (230-255°C @ 1.6 Torr)				1100.1		1100.1
	SRL						
	Coal (MAF)			13097.6			13097.6
	Ash			1283.8			1283.8
	Water			7086.6	241.3		7327.9
	Phenol						
	TOTAL	2673.7	4791.9	21468.0	40896.5		69830.1
Elemental	Carbon	1344.1	1890.4	9450.2	35502.2		48186.9
	Hydrogen	439.8	331.1	1386.8	3275.8		5433.5
	Nitrogen	43.8	49.8	122.4	118.6		334.6
	Sulfur			128.8	454.0		582.8
	Oxygen (by diff)	846.0	2520.6	9096.0	1545.9		14008.5
	Ash			1283.8			1283.8
	TOTAL	2673.7	4791.9	21468.0	40896.5		69830.1

*Based on average solvent/coal ratio (1.905)

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Product Gas and F-1 Btms Rates Adjusted, then Normalized with Forced Carbon Balance

Revised: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs of Coal processing

MATERIAL OUT

Temperature: 737°F
Pressure: 2460 psig
LHSV: 1.42
GHSV: 325

lbs

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
Quantitative	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Calc	Sx-44
	Hydrogen - H_2	218.9	223.3		30.1		
	Carbon Monoxide - CO	1418.0	1445.9		208.1		
	Carbon Dioxide - CO_2	26.7	27.3	3935.0	1263.2		
	Hydrogen Sulfide - H_2S			56.7	33.9		
	Methane - CH_4	621.2	633.4		162.1		
	Ethane - C_2H_6	200.9	204.8		129.0		
	Propane - C_3H_8	93.3	95.2		120.2		
	Butane - C_4H_{10}						
	Nitrogen - N_2	43.0	43.8		6.8		
	Ammonia - NH_3			4.8	3.9	7.3	
	Light Oil - (0-100° C @ 1.6 Torr)					1599.7	
	Solvent - (100-230° C @ 1.6 Torr)					631.8	
	Heavy Oil - (230-255° C @ 1.6 Torr)					34.0	
	SRL						
	Coal (MAF)						
	Ash						
	Water					5827.0	
	Phenol						
	TOTAL	2622.0	2673.7	3996.5	1957.3	8099.8	Negl.
Elemental	Carbon	1318.1	1344.1	1073.1	756.7	1884.2	
	Hydrogen	431.3	439.8	4.0	121.1	855.3	
	Nitrogen	43.0	43.8	4.0	10.0	13.8	
	Sulfur			53.5	31.9	11.4	
	Oxygen (by diff)	829.6	846.0	2861.9	1037.6	5335.1	
	Ash						
	TOTAL	2622.0	2673.7	3996.5	1957.3	8099.8	Negl.

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

[redacted]oduct Gas & F-1 Btms Rates Adjusted, then Normalized with Forced Carbon Balance

Revised: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs of Coal Processing

MATERIAL OUT

Temperature: 737°F
Pressure: 2460 psig
LHSV: 1.42
GHSV: 325

lbs.

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	LEC Btms
	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Quantitative	Hydrogen - H_2		1.6				
	Carbon Monoxide - CO		23.7				
	Carbon Dioxide - CO_2		145.9				
	Hydrogen Sulfide - H_2S						
	Methane - CH_4		12.9				
	Ethane - C_2H_6		16.8				
	Propane - C_3H_8		19.8				
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	1499.7		50.9		5807.4	5957.1
	Solvent - (100-230° C @ 1.6 Torr)	131.4		7.6	1054.9	21087.1	3845.7
	Heavy Oil - (230-255° C @ 1.6 Torr)	13.0				863.2	119.1
	SRL				6271.7		
	Coal (MAF)				1474.4		
	Ash				1283.8		
	Water	553.3		63.8		176.0	
	Phenol						
	TOTAL	2197.4	220.7	122.3	10084.8	27933.7	9921.9
Elemental	Carbon	1353.8	89.3	51.9	7755.2	24285.6	8274.9
	Hydrogen	253.8	11.8	11.8	476.0	2192.8	871.1
	Nitrogen	2.0		0.2	101.9	86.6	29.8
	Sulfur	4.4		0.4	99.8	329.6	47.6
	Oxygen (by diff)	583.4	119.6	58.0	368.1	1039.1	698.5
	Ash				1283.8		
	TOTAL	2197.4	220.7	122.3	10084.8	27933.7	9921.9

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Product Gas and F-1 Btms Rates Adjusted, then normalized with Forced Carbon Balance

Revised: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs of Coal Processing

MATERIAL OUT

lbs.

Temperature: 737°F
Pressure: 2460 psig
LHSV: 1.42
GHSV: 325

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						473.9
Carbon Monoxide - CO						3095.7
Carbon Dioxide - CO_2						5398.1
Hydrogen Sulfide - H_2S						90.6
Methane - CH_4						1429.6
Ethane - C_2H_6						551.5
Propane - C_3H_8						328.5
Butane - C_4H_{10}						
Nitrogen - N_2						93.6
Ammonia - NH_3						16.0
Light Oil - (0-100° C @ 1.6 Torr)						14914.8
Solvent - (100-230° C @ 1.6 Torr)						26758.5
Heavy Oil - (230-255° C @ 1.6 Torr)						1029.3
SRL						6271.7
Coal (MAF)						1474.4
Ash						1283.8
Water						6620.1
Phenol						
TOTAL						69830.1

Elemental

Carbon						48186.9
Hydrogen						5668.8
Nitrogen						335.1
Sulfur						578.6
Oxygen (by diff)						13776.9
Ash						1283.8
TOTAL						69830.1

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs.

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	LEC Btms	Feed Solvent	S-8 Oil	S-8 Water
	SAMPLE POINT	Sx-1	*Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			60.04	24.48	91.22	
	Solvent – (100-230°C @ 1.6 Torr)		10.46	38.76	72.24	7.99	
	Heavy Oil – (230-255°C @1.6 Torr)			1.20	2.69	0.79	
	SRL		62.19				
	Coal (MAF)	61.01	14.62				
	Ash	5.98	12.73				
	Water	33.01			0.59		100
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		83.25				
	Melting Point °F		345				
	Specific Gravity 60/60			0.990	1.042		
	Viscosity, cp						
Elemental	Carbon	44.02	76.90	83.40	86.81	82.35	
	Hydrogen	6.46	4.72	8.78	8.01	11.69	11.11
	Nitrogen	0.57	1.01	0.30	0.29	0.12	
	Sulfur	0.60	.99	0.48	1.11	0.27	
	Oxygen (by diff)	42.37	3.65	7.04	3.78	5.57	88.89
	Ash	5.98	12.73				
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.						

*Wt % distillable oil calculated by following equation:
Wt % distillable oil = -0.1273 (F-1 Btms melting point) + 54.38

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs.

WEIGHT PERCENT

SAMPLE DESCRIPTION	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4B Oil
Quantitative						
SAMPLE POINT	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21	Sx-23
Hydrogen – H_2		6.91	4.57	8.35	7.40	
Carbon Monoxide – CO		92.05	29.21	54.08	74.94	
Carbon Dioxide – CO_2			44.78	1.02	0.41	
Hydrogen Sulfide – H_2S			0.65			
Methane – CH_4			13.46	23.69	10.35	
Ethane – C_2H_6			4.42	7.66	3.59	
Propane – C_3H_8			2.06	3.56	2.17	
Butane – C_4H_{10}						
Nitrogen – N_2		1.04	0.79	1.64	1.14	
Ammonia – NH_3 (PPM)			0.06			
Light Oils – (0-100° C @ 1.6 Torr)	68.25					69.75
Solvent – (100-230°C @ 1.6 Torr)	5.98					27.56
Heavy Oil – (230-255°C @ 1.6 Torr)	0.59					1.49
SRL						
Coal (MAF)						
Ash						
Water	25.18					1.20
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60						0.979
Viscosity, cp						
Elemental						
Carbon	61.61	39.45	40.06	50.27	44.64	82.17
Hydrogen	11.55	6.91	9.23	16.45	11.10	9.15
Nitrogen	0.09	1.04	0.84	1.64	1.14	0.28
Sulfur	0.20		0.61			0.50
Oxygen (by diff)	26.55	52.60	49.26	31.64	43.12	7.90
Ash						
TOTAL	100	100	100	100	100	100
Number of Sample Avg.						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs.

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Water	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	S-7 Btms
	SAMPLE POINT	Sx-23	Sx-23	Sx-30	Sx-32	Sx-33	Sx-34/39
Quantitative	Hydrogen – H_2			1.54	0.71		
	Carbon Monoxide – CO			10.63	10.73		
	Carbon Dioxide – CO_2			64.54	66.13		
	Hydrogen Sulfide – H_2S			1.73			
	Methane – CH_4			8.28	5.84		
	Ethane – C_2H_6			6.59	7.63		
	Propane – C_3H_8			6.14	8.96		
	Butane – C_4H_{10}						
	Nitrogen – N_2			0.35			
	Ammonia – NH_3 (PPM)	0.13	0.11	0.20			
	Light Oils – (0-100° C @ 1.6 Torr)		8.86			41.65	20.79
	Solvent – (100-230°C @ 1.6 Torr)		3.50			6.19	75.49
	Heavy Oil – (230-255°C @ 1.6 Torr)		0.19				3.09
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.87	87.34			52.16	0.63
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						1.048
	Viscosity, cp						
Elemental	Carbon		10.44	38.66	40.45	42.47	86.94
	Hydrogen	11.12	10.87	6.19	5.33	9.62	7.85
	Nitrogen	0.12	0.14	0.51		0.13	0.31
	Sulfur		0.06	1.63		0.33	1.18
	Oxygen (by diff)	88.76	78.49	53.01	54.22	47.45	3.72
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs.

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Oil	S-4A Water	S-4A Total	S-7 Btms	Absorbed Gas	S-4B Btms
	SAMPLE POINT	Sx-37	Sx-37	Sx-37	Sx-34/39	Calc	Calc
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2					98.46	
	Hydrogen Sulfide – H_2S					1.42	
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)		0.12	0.01		0.12	0.09
	Light Oils – (0-100° C @ 1.6 Torr)	70.55		61.94	20.79		19.75
	Solvent – (100-230° C @ 1.6 Torr)	27.53		24.17	75.49		7.80
	Heavy Oil – (230-255° C @ 1.6 Torr)	0.98		0.86	3.09		0.42
	SRL						
	Coal (MAF)						
	Ash						
	Water	0.94	99.88	13.02	0.63		71.94
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60	0.964					
	Viscosity, cp						
Elemental	Carbon	82.25		72.21	86.94	26.85	23.26
	Hydrogen	9.25	11.12	9.48	7.85	0.10	10.56
	Nitrogen	0.25	0.10	0.23	0.31	0.10	0.17
	Sulfur	0.43		0.38	1.18	1.34	0.14
	Oxygen (by diff)	7.82	88.78	17.70	3.72	71.61	65.87
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs.

MOLE PERCENT

	SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Discharge
Quantitative	SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
	Hydrogen – H_2	50.96	42.09	52.17	51.11	21.55	11.54
	Carbon Monoxide – CO	48.49	19.20	24.12	36.94	10.64	12.51
	Carbon Dioxide – CO_2		18.73	0.29	0.13	41.12	49.07
	Hydrogen Sulfide – H_2S		0.35			1.43	
	Methane – CH_4		15.48	18.49	8.93	14.50	11.92
	Ethane – C_2H_6		2.71	3.19	1.65	6.16	8.31
	Propane – C_3H_8		0.86	1.01	0.68	3,91	6.65
	Butane – C_4H_{10}						
	Nitrogen – N_2	0.55	0.52	0.73	0.56	0.35	
	Ammonia – NH_3 (PPM)		0.06			0.34	
	Light Oils – (0-100° C @ 1.6 Torr)						
	Solvent – (100-230°C @ 1.6 Torr)						
	Heavy Oil – (230-255°C @1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water						
	Phenol						
	TOTAL	100	100	100	100	100	100
	Calc Mole Wt.	14.75	18.40	12.49	13.80	28.03	32.65
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/7/78

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs.

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Absorbed Gas					
SAMPLE POINT	Calc					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	97.86					
Hydrogen Sulfide – H_2S	1.83					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.31					
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc Mole Wt.	43.73					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.						

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2 Overall
DATE: 8/21-9/23/77
TIME: 0000-2400

SAMPLE DESCRIPTION	F-1 Btms	LEC Btms	Feed Solv.	S-8 Oil	S-4B Oil
SAMPLE POINT	Sx-2	Sx-12	Sx-14	Sx-16	Sx-23
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5		
IBP		45	48		
5%		67	83		
10%		72	94		
20%		80	116		
30%		88	137		
40%		97	155		
50%		108	170		
60%		122	180		
70%		141	188		
80%		162	198		
90%		182	222		
95%		198	254		
DRY PT.		202	256		
VOLUME PERCENT / TEMPERATURE, °C					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR				740	740
IBP				55	83
5%				71	131
10%				80	176
20%				96	200
30%				110	212
40%				126	224
50%				139	243
60%				156	266
70%				173	294
80%				173	336
90%				204	350
95%				280	
DRY PT.				281	352
VOLUME PERCENT / TEMPERATURE, °C					
ASPHALTENE TEST					
WT % ASH	12.73				
WT % UNCONVERTED COAL	14.62				
WT % PRE-ASPHALTENES	31.92				
WT % ASPHALTENES	20.58				
WT % MALTENES & DIST. OIL	20.15				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		9.3	11.5		
210° F		8.0	8.5		
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)		-	0.59		1.20
INFRARED RATIO		0.23	0.34		
SP. GRAV. 60/60 F		0.990	1.042		0.979

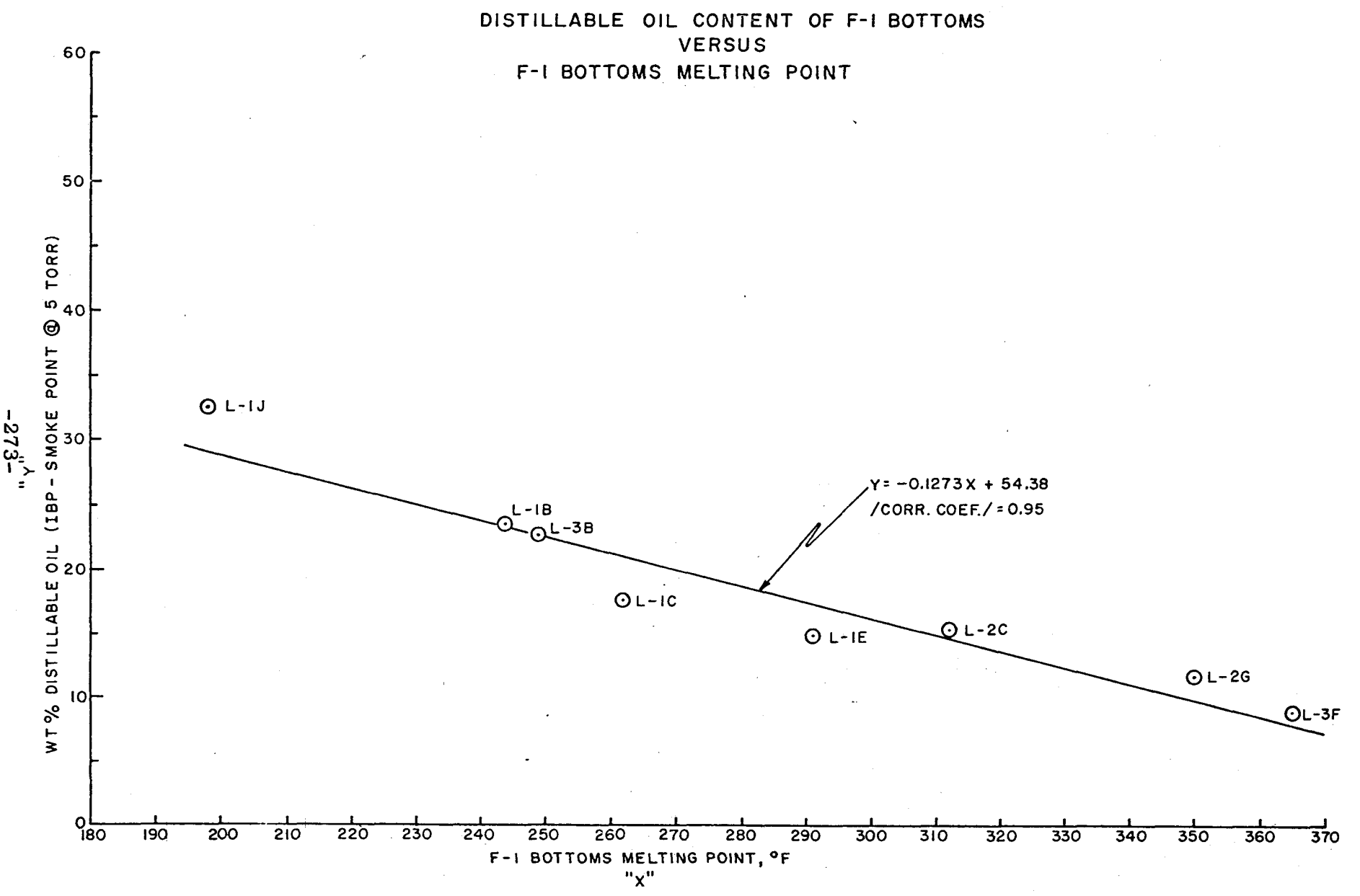
PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2 Overall
DATE: 8/21-9/23/77
TIME: 0000-2400

SAMPLE DESCRIPTION	Cold Trap Oil	S-7 Btms	S-4A Oil		
SAMPLE POINT	Sx-33	Sx-34/39	Sx-37		
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5			
IBP		47			
5%		83			
10%		97			
20%		124			
30%		146			
40%		164			
50%		174			
60%		182			
70%		189			
80%		200			
90%		226			
95%		256			
DRY PT.		258			
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	740		739		
IBP	86		88		
5%	93		121		
10%	97		171		
20%	98		192		
30%	131		203		
40%	140		216		
50%	146		230		
60%	162		252		
70%	170		279		
80%	173		312		
90%			344		
95%					
DRY PT.			347		
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT %. PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F		12.1			
210° F		8.6			
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)	52.16	0.63	0.94		
INFRARED RATIO		0.35			
SP. GRAV. 60/60 F		1.048	0.964		

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.


DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT
WT% DISTILLABLE OIL (IBP - SMOKE POINT @ 5 TORR)
"Y"
F-1 BOTTOMS MELTING POINT, °F
"X"
Y= -0.1273X + 54.38
/CORR. COEF./ = 0.95
L-1J
L-1B
L-3B
L-1C
L-1E
L-2C
L-2G
L-3F
0
10
20
30
40
50
60
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/7/78

MATERIAL OUT

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs of Coal Processing lbs.

Temperature: 737°F
Pressure: 2460 psig
LHSV: 1.42
GHSV: 325

Quantitative

STREAM DESCRIPTION	← Product Gas Vent Gas	Recycle Gas	Absorbed Gas →	S-4A Ovhd	S-4B Btms	S-8 Ovhd
SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Hydrogen - H_2	118.9	223.3		30.1		
Carbon Monoxide - CO	770.1	1445.9		208.1		
Carbon Dioxide - CO_2	14.5	27.3	3294.8	1263.2		
Hydrogen Sulfide - H_2S			47.5	33.9		
Methane - CH_4	337.3	633.4		162.1		
Ethane - C_2H_6	109.1	204.8		129.0		
Propane - C_3H_8	50.7	95.2		120.2		
Butane - C_4H_{10}						
Nitrogen - N_2	23.4	43.8		6.8		
Ammonia - NH_3			4.0	3.9	7.7	
Light Oil - (0-100° C @ 1.6 Torr)					621.2	
Solvent - (100-230°C @ 1.6 Torr)					245.4	
Heavy Oil - (230-255°C @ 1.6 Torr)					13.3	
SRL						
Coal (MAF)						
Ash						
Water					6123.4	
Phenol						
TOTAL	1424.0	2673.7	3346.3	1957.3	7011.0	Neg.

Elemental

Carbon	715.8	1344.1	898.5	756.7	732.0	
Hydrogen	234.2	439.8	3.3	121.1	762.1	
Nitrogen	23.4	43.8	3.3	10.0	9.8	
Sulfur			44.9	31.9	4.2	
Oxygen (by diff)	450.6	846.0	2396.3	1037.6	5502.9	
Ash						
TOTAL	1424.0	2673.7	3346.3	1957.3	7011.0	Negl.

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/7/78

MATERIAL OUT

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs of Coal Processing lbs.

Temperature: 737°F
Pressure: 2460 psig
LHSV: 1.42
GHSV: 325

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ LEC Btms
	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Quantitative	Hydrogen - H_2		1.6				
	Carbon Monoxide - CO		23.7				
	Carbon Dioxide - CO_2		145.9				
	Hydrogen Sulfide - H_2S						
	Methane - CH_4		12.9				
	Ethane - C_2H_6		16.8				
	Propane - C_3H_8		19.8				
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	1298.1		44.1		5807.4	5957.1
	Solvent - (100-230°C @ 1.6 Torr)	113.8		6.6	1008.5	21087.1	3845.7
	Heavy Oil - (230-255°C @ 1.6 Torr)	11.2				863.2	119.1
	SRL				5995.7		
	Coal (MAF)				1409.5		
	Ash				1227.3		
	Water	478.9		55.2		176.0	
	Phenol						
	TOTAL	1902.0	220.7	105.9	9641.0	27933.7	9921.9
Elemental	Carbon	1171.8	89.3	45.0	7413.9	24285.6	8274.9
	Hydrogen	219.7	11.8	10.2	455.0	2192.8	871.1
	Nitrogen	1.7		0.1	97.4	86.6	29.8
	Sulfur	3.8		0.3	95.5	329.6	47.6
	Oxygen (by diff)	505.0	119.6	50.3	351.9	1039.1	698.5
	Ash				1227.3		
	TOTAL	1902.0	220.7	105.9	9641.0	27933.7	9921.9

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/7/78

MATERIAL OUT

Run No: L-2 Overall
Date: 8/21-9/23/77
Time: 441.4 hrs of Coal Processing

Temperature: 737°F
Pressure: 2460 psig
LHSV: 1.42
GHSV: 325

lbs.

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						373.9
Carbon Monoxide - CO						2447.8
Carbon Dioxide - CO_2						4745.7
Hydrogen Sulfide - H_2S						81.4
Methane - CH_4						1145.7
Ethane - C_2H_6						459.7
Propane - C_3H_8						285.9
Butane - C_4H_{10}						
Nitrogen - N_2						74.0
Ammonia - NH_3						15.6
Light Oil - (0-100° C @ 1.6 Torr)						13727.9
Solvent - (100-230° C @ 1.6 Torr)						26307.1
Heavy Oil - (230-255°C @ 1.6 Torr)						1006.8
SRL						5995.7
Coal (MAF)						1409.5
Ash						1227.3
Water						6833.5
Phenol						
TOTAL						66137.5

Elemental

Carbon						45727.6
Hydrogen						5321.1
Nitrogen						305.9
Sulfur						557.8
Oxygen (by diff)						12997.8
Ash						1227.3
TOTAL						66137.5

RUN CONDITIONS

RUN NO. L-2B
DATE MADE 8/31/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 766
- INLET 298
- OUTLET 746

DISSOLVERS
- R-1A (1) 778
- (2) 823
- (3) 820
- (4) 820
- R-1B (1) NIU
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 595
- S-2 79
- S-3 514
- S-4A 82
- S-4B 74

PREHEATER E-11
- DOWTHERM 677
- INLET 440
- OUTLET 630

VACUUM FLASH F-1
- OVERHEAD VAPOR 512
- UPPER WALL 596
- LOWER WALL 571
- DOWNCOMER 544
- CONDENSATE ACCUMULATOR, S-7 84

PREHEATER E-13
- DOWTHERM 399
- INLET 80
- OUTLET 192

LIGHT ENDS COLUMN, F-2
- REBOILER 356
- LOWER SECTION 191
- FEED SECTION -
- OVERHEAD 180
- S-8 74
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2
2460

SEPARATOR S-3
250

SEPARATORS S-4A and S-4B
62

VACUUM FLASH, F-1
14 Torr

LIGHT ENDS COLUMN, F-2
Atm

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

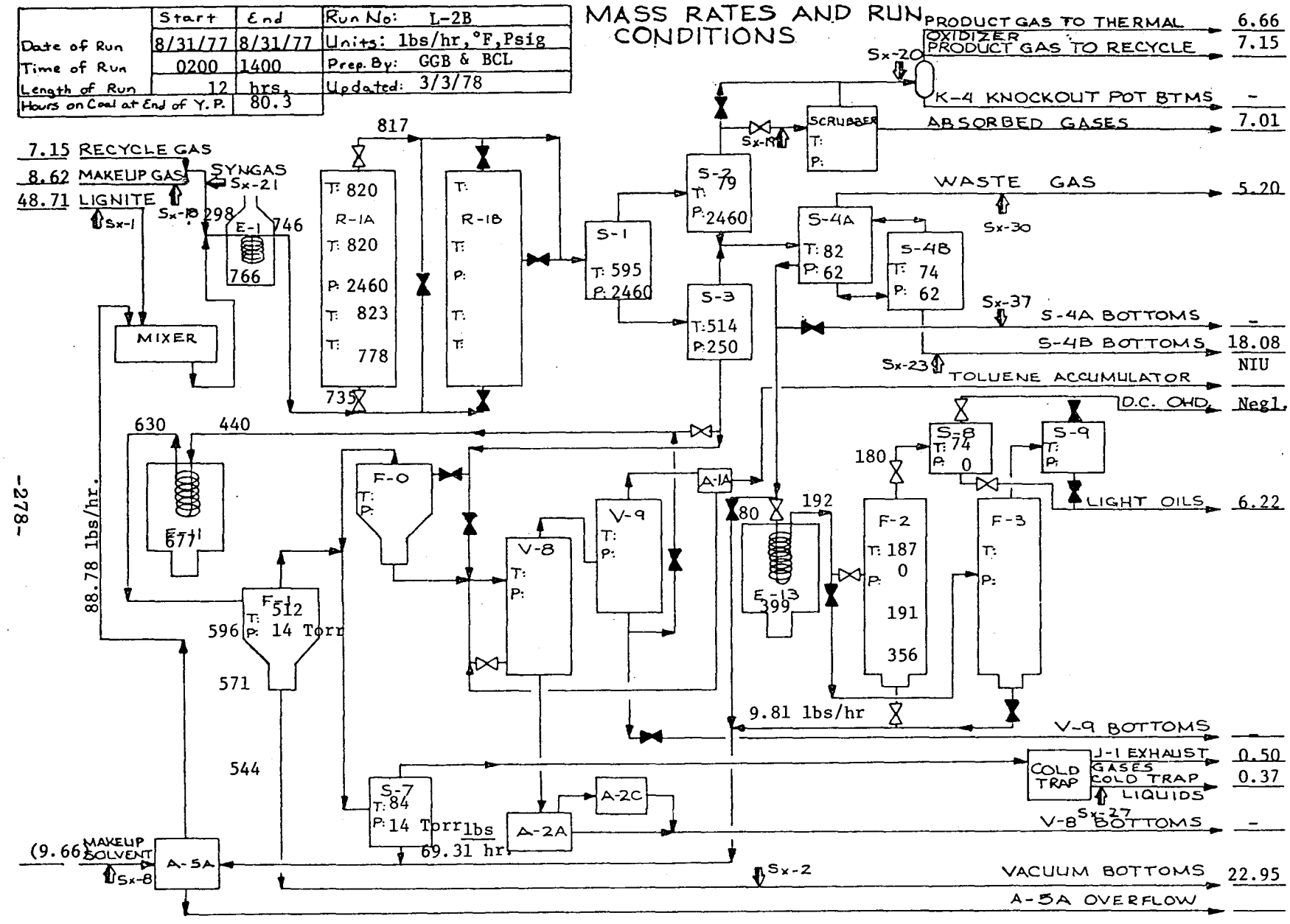
VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU

MASS RATES AND RUN CONDITIONS

	Start	End	Run No: L-2B
Date of Run	8/31/77	8/31/77	Units: lbs/hr, °F, Psig
Time of Run	0200	1400	Prep. By: GGB & BCL
Length of Run	12	hrs.	Updated: 3/3/78
Hours on Coal at End of Y.P.		80.3	



153.26 TOTAL ⋈ OPEN ⋈ CLOSED TOTAL 153.26

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas and F-1 Btms Rates Adjusted
Revised: 3/3/78

Run No:L-2B
Date: 8/31/77
Time: 0200-1400

SUMMARY

Temperature: 746°F
Pressure: 2460 psig
LHSV: 1.38
GHSV: 321

lbs/hour

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt% MAF Coal	
SAMPLE POINT						
Hydrogen - H_2	1.31	1.14	-0.17			
Carbon Monoxide - CO	10.70	6.04	-4.66			
Carbon Dioxide - CO_2	0.56	11.69	11.13			
Hydrogen Sulfide - H_2S		0.13	0.13			
Methane - CH_4	2.00	4.49	2.49	10.78	36.57	
Ethane - C_2H_6	0.64	1.68	1.04			
Propane - C_3H_8	0.40	1.19	0.79			
Butane - C_4H_{10}						
Nitrogen - N_2	0.16	0.14	-0.02			
Ammonia - NH_3		0.05	0.05			
Light Oil - (0-100° C @ 1.6 Torr)	9.50	16.68	7.18			
Solvent - (100-230°C @ 1.6 Torr)	77.31	71.99	-5.32	14.62	49.59	
Heavy Oil - (230-255°C @ 1.6 Torr)	1.61	2.41	0.80			
SRL		11.96	11.96			
Coal (MAF)	29.48	4.66	-24.82		-84.19	
Ash	3.14	3.14	-0-		-0-	
Water	16.45	15.87	-0.58		-1.97	
Phenol						
TOTAL	153.26	153.26	-0-			

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED & ADJUSTED MATERIAL BALANCE
Revised: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

MATERIAL IN

lbs/hr.

Temperature: 746°F
Pressure: 2460 psig
LHSV: 1.38
GHSV: 321

Quantitative

STREAM DESCRIPTION	←Feed Gas→ Recycle Gas	Makeup Gas	Lignite	Feed Solvent		Total In.
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.56	0.75				1.31
Carbon Monoxide - CO	2.93	7.77				10.70
Carbon Dioxide - CO_2	0.56					0.56
Hydrogen Sulfide - H_2S						
Methane - CH_4	2.00					2.00
Ethane - C_2H_6	0.64					0.64
Propane - C_3H_8	0.40					0.40
Butane - C_4H_{10}						
Nitrogen - N_2	0.06	0.10				0.16
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				9.50		9.50
Solvent - (100-230°C @ 1.6 Torr)				77.31		77.31
Heavy Oil - (230-255°C @ 1.6 Torr)				1.61		1.61
SRL						
Coal (MAF)			29.48			29.48
Ash			3.14			3.14
Water			16.09	0.36		16.45
Phenol						
TOTAL	7.15	8.62	48.71	88.78		153.26

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas and F-1 Btms Rates Adjusted
Revised: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

MATERIAL OUT
lbs/hr.

Temperature: 746°F
Pressure: 2460 psig
LHSV : 1.38
GHSV: 321

Quantitative

STREAM DESCRIPTION	← Product Gas Vent Gas	Product Gas Recycle Gas →	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd.
SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Hydrogen - H_2	0.52	0.56		0.06		
Carbon Monoxide - CO	2.73	2.93		0.36		
Carbon Dioxide - CO_2	0.52	0.56	6.92	3.36		
Hydrogen Sulfide - H_2S			0.09	0.04		
Methane - CH_4	1.86	2.00		0.58		
Ethane - C_2H_6	0.60	0.64		0.39		
Propane - C_3H_8	0.37	0.40		0.37		
Butane - C_4H_{10}						
Nitrogen - N_2	0.06	0.06		0.02		
Ammonia - NH_3				0.02	0.03	
Light Oil - (0-100° C @ 1.6 Torr)					2.40	
Solvent - (100-230°C @ 1.6 Torr)					1.65	
Heavy Oil - (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water					14.00	
Phenol						
TOTAL	6.66	7.15	7.01	5.20	18.08	Negl.

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas and F-1 Btms Rates Adjusted
Revised: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

MATERIAL OUT
lbs/hr.

Temperature: 746°F
Pressure: 2460 psig
LHSV: 1.38
GHSV: 321

Quantitative

STREAM DESCRIPTION	S-8 Btms	J-1 *Exhaust	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ LEC Btms
SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-1	Sx-39	Sx-12
Hydrogen - H_2						
Carbon Monoxide - CO		0.02				
Carbon Dioxide - CO_2		0.33				
Hydrogen Sulfide - H_2S						
Methane - CH_4		0.05				
Ethane - C_2H_6		0.05				
Propane - C_3H_8		0.05				
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)	3.50		0.26		6.69	3.83
Solvent - (100-230°C @ 1.6 Torr)	1.67		0.02	3.19	59.67	5.79
Heavy Oil - (230-255°C @ 1.6 Torr)					2.22	0.19
SRL				11.96		
Coal (MAF)				4.66		
Ash				3.14		
Water	1.05		0.09		0.73	
Phenol						
TOTAL	6.22	0.50	0.37	22.95	69.31	9.81

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

*Rate assumbed to be similar to those of the other L-2 yield periods in which the orifice meter was working properly.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas and F-1 Btms Rates Adjusted
Revised: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

MATERIAL OUT

lbs/hr.

Temperature: 746°F
Pressure: 2460 psig
LHSV : 1.38
GHSV: 321

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.14
Carbon Monoxide - CO						6.04
Carbon Dioxide - CO_2						11.69
Hydrogen Sulfide - H_2S						0.13
Methane - CH_4						4.49
Ethane - C_2H_6						1.68
Propane - C_3H_8						1.19
Butane - C_4H_{10}						
Nitrogen - N_2						0.14
Ammonia - NH_3						0.05
Light Oil - (0-100° C @ 1.6 Torr)						16.68
Solvent - (100-230°C @ 1.6 Torr)						71.99
Heavy Oil - (230-255°C @ 1.6 Torr)						2.41
SRL						11.96
Coal (MAF)						4.66
Ash						3.14
Water						15.87
Phenol						
TOTAL						153.26

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

WEIGHT PERCENT

Quantitative

SAMPLE DESCRIPTION	Lignite	F-1 Btms	LEC Btms	Feed Solvent	S-8 Oil	S-8 Water
SAMPLE POINT	Sx-1	*Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2						
Hydrogen Sulfide – H_2S						
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)						
Light Oils – (0-100° C @ 1.6 Torr)			39.05	10.70	67.60	
Solvent – (100-230° C @ 1.6 Torr)		13.90	58.98	87.08	32.40	
Heavy Oil – (230-255° C @ 1.6 Torr)			1.97	1.81		
SRL		52.13				
Coal (MAF)	60.53	20.29				
Ash	6.45	13.68				
Water	33.02			0.41		100
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)		76.49				
Melting Point °F		318				
Specific Gravity 60/60			0.997	1.040		
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

*Distillable oil calculated by following equation:
Wt % Distillabe Oil = -0.1273 (F-1 Btms Melting Point) + 54.38. See graph.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4B Oil
	SAMPLE POINT	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21	*Sx-23
Quantitative	Hydrogen – H_2		8.70	3.77	7.77	8.28	
	Carbon Monoxide – CO		90.13	20.21	41.03	67.89	
	Carbon Dioxide – CO_2			47.81	7.83	3.54	
	Hydrogen Sulfide – H_2S			0.79			
	Methane – CH_4			19.54	27.96	12.68	
	Ethane – C_2H_6			4.89	8.93	4.05	
	Propane – C_3H_8			2.51	5.61	2.53	
	Butane – C_4H_{10}						
	Nitrogen – N_2		1.17	0.44	0.87	1.03	
	Ammonia – NH_3 (PPM)			0.04			
	Light Oils – (0-100° C @ 1.6 Torr)	56.19					58.93
	Solvent – (100-230°C @ 1.6 Torr)	26.93					40.60
	Heavy Oil – (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water	16.88					0.47
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						0.956
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	2

*Insufficient sample for distillation. Assumed to be the same as the S-4A Oil.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Water	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	S-4A Oil
Quantitative	SAMPLE POINT	Sx-23	Sx-23	Sx-30	Sx-32	Sx-33	Sx-37
	Hydrogen – H_2			1.11	0.75		
	Carbon Monoxide – CO			6.94	4.31		
	Carbon Dioxide – CO_2			64.56	66.70		
	Hydrogen Sulfide – H_2S			0.82			
	Methane – CH_4			11.16	9.52		
	Ethane – C_2H_6			7.59	8.93		
	Propane – C_3H_8			7.05	9.79		
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.18	0.14	0.39			
	Light Oils – (0-100° C @ 1.6 Torr)		13.28	0.38		69.24	58.93
	Solvent – (100-230° C @ 1.6 Torr)		9.15			6.30	40.60
	Heavy Oil – (230-255° C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.82	77.43			24.46	0.47
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						0.956
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2		2	2	1	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Water	S-4A Total	S-7 Btms	Absorbed Gas		
	SAMPLE POINT	Sx-37	Sx-37	Sx-39	Calc.		
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2				98.67		
	Hydrogen Sulfide – H_2S				1.30		
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.18	0.01		0.03		
	Light Oils – (0-100° C @ 1.6 Torr)		55.07	9.65			
	Solvent – (100-230°C @ 1.6 Torr)		37.94	86.10			
	Heavy Oil – (230-255°C @ 1.6 Torr)			3.20			
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.82	6.98	1.05			
	Phenol						
	TOTAL	100	100	100	100		
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60			1.056			
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	-		

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Discharge
SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
Hydrogen – H_2	57.15	36.43	50.25	53.99	16.20	11.91
Carbon Monoxide – CO	42.30	13.94	18.95	31.63	7.20	4.87
Carbon Dioxide – CO_2		20.99	2.30	1.05	42.60	47.95
Hydrogen Sulfide – H_2S		0.45			0.70	
Methane – CH_4		23.59	22.60	10.34	20.25	18.81
Ethane – C_2H_6		3.15	3.85	1.76	7.35	9.42
Propane – C_3H_8		1.10	1.65	0.75	4.65	7.04
Butane – C_4H_{10}						
Nitrogen – N_2	0.55	0.30	0.40	0.48	0.40	
Ammonia – NH_3 (PPM)		0.05			0.65	
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230° C @ 1.6 Torr)						
Heavy Oil – (230-255° C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100	100	100
Calc Mole Wt.	13.14	19.32	12.93	13.04	29.04	31.63
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/3/78

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

MOLE PERCENT

Quantitative						
SAMPLE DESCRIPTION	Absorbed Gas					
SAMPLE POINT	Calc.					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	98.25					
Hydrogen Sulfide – H_2S	1.67					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.08					
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc. Mole Wt	43.81					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.						

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2B
DATE: 8/31/77
TIME: 0200-1400

SAMPLE DESCRIPTION	LEC Btms	Feed Solv.	S-8 Oil	Cold Trap	S-4A Oil
SAMPLE POINT	Sx-12	Sx-14	Sx-16	Sx-33	Sx-37
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5	5			
IBP	72.8	65.8			
5%	80.4	101			
10%	85.0	118.6			
20%	94.2	153.2			
30%	106.6	172			
40%	122.8	181.3			
50%	140	187			
60%	158.4	191.6			
70%	175.2	198.4			
80%	186.5	207.2			
90%	198.2	227.5			
95%	212.4	255.4			
DRY PT.	215	259			
(VOLUME PERCENT — TEMPERATURE, °C)					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR			739	742	741
IBP			67	84	112
5%			144	99	158
10%			157	100	173
20%			170	101	200
30%			180	114	212
40%			196	127	234
50%			219	127	248
60%			255	132	294
70%			301	137	328
80%				137	338
90%					
95%					
DRY PT.			310	137	343
(VOLUME PERCENT — TEMPERATURE, °C)					
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)		0.41		24.46	0.34
INFRARED RATIO					
SP. GRAV. 60/60 F	0.997	1.040			0.956

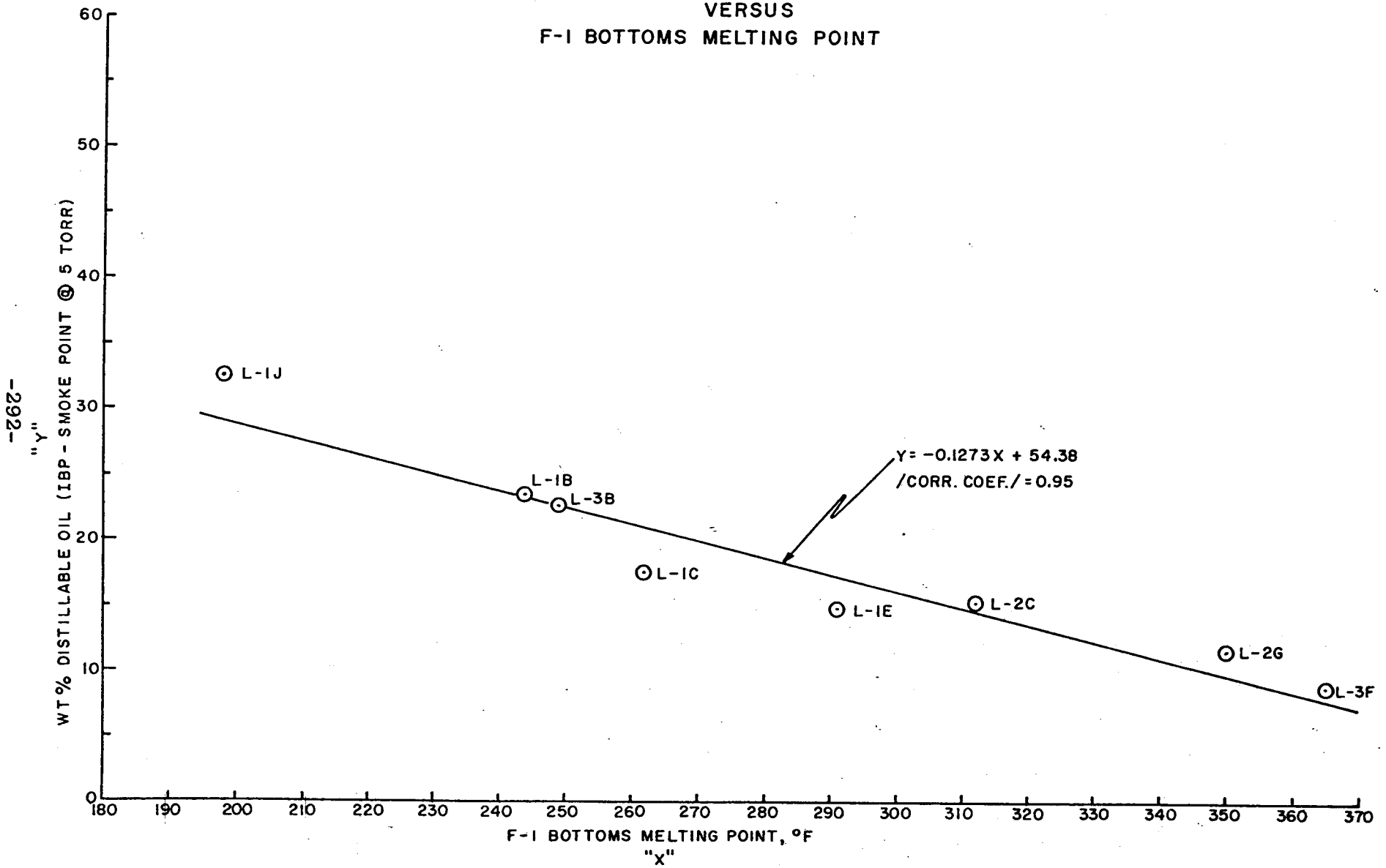
PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2B
DATE: 8/31/77
TIME: 0200-1400

SAMPLE DESCRIPTION	S-7 Btms				
SAMPLE POINT	Sx-39				
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5				
VOLUME PERCENT / TEMPERATURE, °C — IBP	21.4				
5%	101.3				
10%	119.6				
20%	156.8				
30%	173.2				
40%	180.6				
50%	185.6				
60%	190.8				
70%	199				
80%	209.3				
90%	234.8				
95%					
DRY PT.	260				
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR					
VOLUME PERCENT / TEMPERATURE, °C — IBP					
5%					
10%					
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
95%					
DRY PT.					
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)	1.05				
INFRARED RATIO					
SP. GRAV. 60/60 F	1.056				

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

DISTILLABLE OIL CONTENT OF F-1 BOTTOMS VERSUS F-1 BOTTOMS MELTING POINT



PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/3/78

MATERIAL OUT

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

Temperature: 746°F
Pressure: 2460 psig
LHSV: 1.38
GHSV: 321

lbs/hr.

	STREAM DESCRIPTION	←Product Gas→ Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Quantitative	Hydrogen - H_2	0.26	0.56		0.06		
	Carbon Monoxide - CO	1.36	2.93		0.36		
	Carbon Dioxide - CO_2	0.26	0.56	8.88	3.36		
	Hydrogen Sulfide - H_2S			0.12	0.04		
	Methane - CH_4	0.93	2.00		0.58		
	Ethane - C_2H_6	0.30	0.64		0.39		
	Propane - C_3H_8	0.18	0.40		0.37		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.03	0.06		0.02		
	Ammonia - NH_3				0.02	0.03	
	Light Oil - (0-100° C @ 1.6 Torr)					2.40	
	Solvent - (100-230°C @ 1.6 Torr)					1.65	
	Heavy Oil - (230-255°C @1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water					14.00	
	Phenol						
	TOTAL	3.32	7.15	9.00	5.20	18.08	Negl.

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/3/78

MATERIAL OUT

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

Temperature: 746°F
Pressure: 2460 psig
LHSV: 1.38
GHSV: 321

lbs/hr.

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	← Recycle S-7 Btms	Solvent → LEC Btms
	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-1	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100°C @ 1.6 Torr)	3.50		0.26		6.69	3.83
	Solvent - (100-230°C @ 1.6 Torr)	1.67		0.02	3.12	59.67	5.79
	Heavy Oil - (230-255°C @ 1.6 Torr)					2.22	0.19
	SRL				11.69		
	Coal (MAF)				4.55		
	Ash				3.07		
	Water	1.05		0.09		0.73	
	Phenol						
	TOTAL	6.22	NA	0.37	22.43	69.31	9.81

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						

NA - Not available

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/3/78

MATERIAL OUT

Run No: L-2B
Date: 8/31/77
Time: 0200-1400

Temperature: 746°F
Pressure: 2460 psig
LHSV: 1.38
GHSV:321

lbs/hr.

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						0.88
Carbon Monoxide - CO						4.65
Carbon Dioxide - CO_2						13.06
Hydrogen Sulfide - H_2S						0.16
Methane - CH_4						3.51
Ethane - C_2H_6						1.33
Propane - C_3H_8						0.95
Butane - C_4H_{10}						
Nitrogen - N_2						0.11
Ammonia - NH_3						0.05
Light Oil - (0-100° C @ 1.6 Torr)						16.68
Solvent - (100-230°C @ 1.6 Torr)						71.92
Heavy Oil - (230-255°C @ 1.6 Torr)						2.41
SRL						11.69
Coal (MAF)						4.55
Ash						3.07
Water						15.87
Phenol						
TOTAL						150.89

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

RUN CONDITIONS

RUN NO. L-2C
DATE MADE 9/7/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 770
- INLET 292
- OUTLET 751

DISSOLVERS
- R-1A (1) 776
- (2) 825
- (3) 816
- (4) 822
- R-1B (1) NIU
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 596
- S-2 77
- S-3 508
- S-4A 78
- S-4B 72

PREHEATER E-11
- DOWTHERM 677
- INLET 440
- OUTLET 639

VACUUM FLASH F-1
- OVERHEAD VAPOR 505
- UPPER WALL 597
- LOWER WALL 570
- DOWNCOMER 541
- CONDENSATE ACCUMULATOR, S-7 83

PREHEATER E-13
- DOWTHERM 398
- INLET 78
- OUTLET 221

LIGHT ENDS COLUMN, F-2
- REBOILER 354
- LOWER SECTION 372
- FEED SECTION 315
- OVERHEAD 192
- S-8 71
- S-9

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

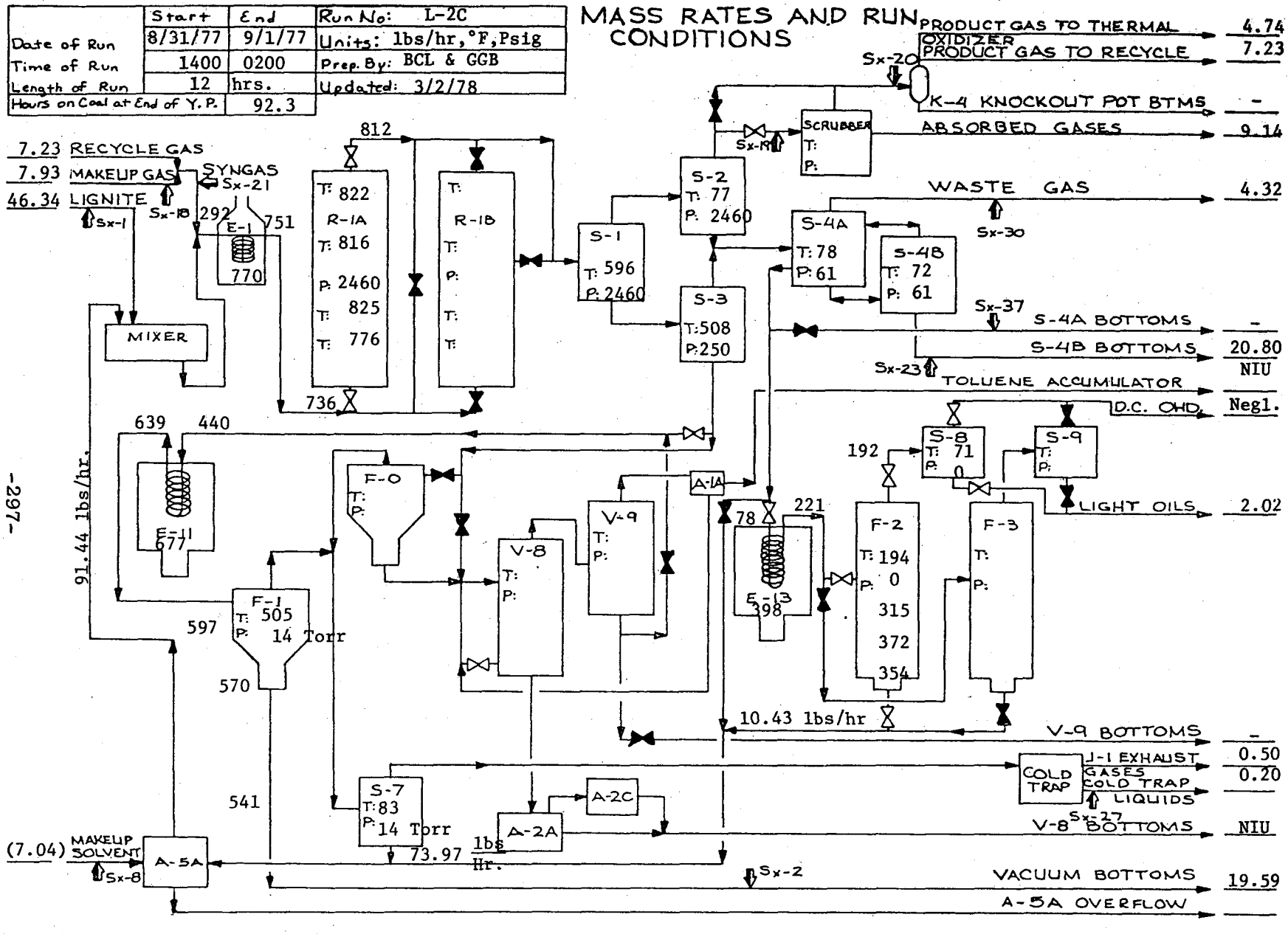
RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

- SEPARATORS S-1 and S-2: 2460
- SEPARATOR S-3: 250
- SEPARATORS S-4A and S-4B: 61
- VACUUM FLASH, F-1: 14 Torr
- LIGHT ENDS COLUMN, F-2: Atm
- SOLVENT COLUMN, F-3: NIU
- HEAVY ENDS COLUMN, F-4: NIU
- VACUUM FLASH, F-0: NIU
- SETTLING TOWER, V-8: NIU
- RECOVERY TOWER, V-7: NIU

MASS RATES AND RUN CONDITIONS

	Start	End	Run No: L-2C
Date of Run	8/31/77	9/1/77	Units: lbs/hr, °F, Psig
Time of Run	1400	0200	Prep. By: BCL & GGB
Length of Run	12	hrs.	Updated: 3/2/78
Hours on Coal at End of Y.P.		92.3	



152.94 TOTAL ⋈ OPEN ⋈ CLOSED TOTAL 152.94

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Product Gas, Recycle Gas and F-1 Bottoms Rates Adjusted

Revised: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

SUMMARY

lbs/hr.

Temperature: 751°F
Pressure: 2460 psig
LHSV: 1.37
GHSV: 320

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
SAMPLE POINT						
Hydrogen - H_2	1.03	1.15	0.12			
Carbon Monoxide - CO	10.57	5.44	-5.13			
Carbon Dioxide - CO_2		12.03	12.03			
Hydrogen Sulfide - H_2S		0.16	0.16			
Methane - CH_4	2.35	4.43	2.08	10.79	38.29	
Ethane - C_2H_6	0.71	1.56	0.85			
Propane - C_3H_8	0.35	1.01	0.66			
Butane - C_4H_{10}						
Nitrogen - N_2	0.15	0.14	-0.01			
Ammonia - NH_3		0.03	0.03			
Light Oil - (0-100° C @ 1.6 Torr)	9.26	18.99	9.73			
Solvent - (100-230°C @ 1.6 Torr)	78.18	73.07	-5.11	13.97	49.57	
Heavy Oil - (230-255°C @ 1.6 Torr)	3.11	2.34	-0.77			
SRL		10.12	10.12			
Coal (MAF)	28.18	3.96	-24.22		-85.95	
Ash	2.57	2.57	-0-		-0-	
Water	16.48	15.94	-0.54		-1.91	
Phenol						
TOTAL	152.94	152.94	-0-			

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGHTITE

ADJUSTED MATERIAL BALANCE

Product Gas, Recycle Gas and F-1 Btms Rates Adjusted

Revised: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

MATERIAL IN

lbs/hr.

Temperature:751°F
Pressure: 2460 psig
LHSV: 1.37
GHSV:320

Quantitative

STREAM DESCRIPTION	←Feed Gas Recycle Gas	Makeup Gas→	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.65	0.38				1.03
Carbon Monoxide - CO	3.09	7.48				10.57
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	2.35					2.35
Ethane - C_2H_6	0.71					0.71
Propane - C_3H_8	0.35					0.35
Butane - C_4H_{10}						
Nitrogen - N_2	0.08	0.07				0.15
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				9.26		9.26
Solvent - (100-230°C @ 1.6 Torr)				78.18		78.18
Heavy Oil - (230-255°C @1.6 Torr)				3.11		3.11
SRL						
Coal (MAF)			28.18			28.18
Ash			2.57			2.57
Water			15.59	0.89		16.48
Phenol						
TOTAL	7.23	7.93	46.34	91.44		152.94

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rates Adjusted
Revised: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

MATERIAL OUT
lbs/hr.

Temperature:751°F
Pressure: 2460 psig
LHSV: 1.37
GHSV: 320

Quantitative

STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
SAMPLE POINT	Sx-20	Sx-20	Calc.	Sx-30	Sx-23	Sx-44
Hydrogen - H_2	0.43	0.65		0.06		
Carbon Monoxide - CO	2.03	3.09		0.29		
Carbon Dioxide - CO_2			9.08	2.64		
Hydrogen Sulfide - H_2S			0.06	0.09		
Methane - CH_4	1.54	2.35		0.48		
Ethane - C_2H_6	0.46	0.71		0.35		
Propane - C_3H_8	0.23	0.35		0.39		
Butane - C_4H_{10}						
Nitrogen - N_2	0.05	0.08		0.01		
Ammonia - NH_3				0.01	0.02	
Light Oil - (0-100° C @ 1.6 Torr)					3.17	
Solvent - (100-230° C @ 1.6 Torr)					1.76	
Heavy Oil - (230-255° C @ 1.6 Torr)					0.24	
SRL						
Coal (MAF)						
Ash						
Water					15.61	
Phenol						
TOTAL	4.74	7.23	9.14	4.32	20.80	Negl.

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rates Adjusted
Revised: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

MATERIAL OUT
lbs/hr.

Temperature: 751°F
Pressure: 2460 psig
LHSV: 1.37
GHSV: 320

Quantitative

STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms
SAMPLE POINT	Sx-16	*Sx-32	Sx-33	Sx-2	Sx-34	Sx-12
Hydrogen - H_2		0.01				
Carbon Monoxide - CO		0.03				
Carbon Dioxide - CO_2		0.31				
Hydrogen Sulfide - H_2S		0.01				
Methane - CH_4		0.06				
Ethane - C_2H_6		0.04				
Propane - C_3H_8		0.04				
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)	1.99		0.07		9.26	4.50
Solvent - (100-230°C @ 1.6 Torr)	0.03		0.01	2.94	62.58	5.75
Heavy Oil - (230-255°C @1.6 Torr)					1.92	0.18
SRL				10.12		
Coal (MAF)				3.96		
Ash				2.57		
Water			0.12		0.21	
Phenol						
TOTAL	2.02	0.50	0.20	19.59	73.97	10.43

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

*Rate assumed similar to those of the other L-2 yield periods where the orifice meter was operating properly.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rates Adjusted
Revised: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

MATERIAL OUT

lbs/hr.

Temperature: 751°F
Pressure: 2460 psig
LHSV: 1.37
GHSV: 320

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.15
Carbon Monoxide - CO						5.44
Carbon Dioxide - CO_2						12.03
Hydrogen Sulfide - H_2S						0.16
Methane - CH_4						4.43
Ethane - C_2H_6						1.56
Propane - C_3H_8						1.01
Butane - C_4H_{10}						
Nitrogen - N_2						0.14
Ammonia - NH_3						0.03
Light Oil - (0-100° C @ 1.6 Torr)						18.99
Solvent - (100-230° C @ 1.6 Torr)						73.07
Heavy Oil - (230-255° C @ 1.6 Torr)						2.34
SRL						10.12
Coal (MAF)						3.96
Ash						2.57
Water						15.94
Phenol						
TOTAL						152.94

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

WEIGHT PERCENT

SAMPLE DESCRIPTION	Lignite	F-1 Btms	LEC Btms	Feed Solvent	S-8 Oil	S-8 Water
SAMPLE POINT	Sx-1	Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2						
Hydrogen Sulfide – H_2S						
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)						
Light Oils – (0-100° C @ 1.6 Torr)			43.20	10.13	98.70	
Solvent – (100-230° C @ 1.6 Torr)		15.00	55.10	85.50	1.30	
Heavy Oil – (230-255° C @ 1.6 Torr)			1.70	3.40		
SRL		51.68				
Coal (MAF)	60.81	20.20				
Ash	5.55	13.12				
Water	33.64			0.97		100
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)		76.75				
Melting Point °F		316				
Specific Gravity 60/60			1.006	1.062		
Viscosity, cp						

Quantitative

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

Elemental

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4B Oil
Quantitative	SAMPLE POINT	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21	Sx-23
	Hydrogen – H_2		4.77	4.39	9.05	8.79	
	Carbon Monoxide – CO		94.29	21.18	42.77	65.89	
	Carbon Dioxide – CO_2			45.73			
	Hydrogen Sulfide – H_2S			0.28			
	Methane – CH_4			18.12	32.45	14.53	
	Ethane – C_2H_6			5.88	9.76	4.42	
	Propane – C_3H_8			3.00	4.89	5.26	
	Butane – C_4H_{10}						
	Nitrogen – N_2		0.94	1.37	1.08	1.11	
	Ammonia – NH_3 (PPM)			0.05			
	Light Oils – (0-100° C @ 1.6 Torr)	98.70					61.05
	Solvent – (100-230°C @ 1.6 Torr)	1.30					33.90
	Heavy Oil – (230-255°C @ 1.6 Torr)						4.60
	SRL						
	Coal (MAF)						
	Ash						
	Water						0.45
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						0.966
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Water	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	S-4A Oil
Quantitative	SAMPLE POINT	Sx-23	Sx-23	Sx-30	Sx-32	Sx-33	Sx-37
	Hydrogen – H_2			1.48	0.80		
	Carbon Monoxide – CO			6.74	3.20		
	Carbon Dioxide – CO_2			61.12	67.83		
	Hydrogen Sulfide – H_2S			2.09			
	Methane – CH_4			11.21	9.13		
	Ethane – C_2H_6			7.99	8.99		
	Propane – C_3H_8			8.93	10.05		
	Butane – C_4H_{10}						
	Nitrogen – N_2			0.25			
	Ammonia – NH_3 (PPM)	0.11	0.08	0.19			
	Light Oils – (0-100° C @ 1.6 Torr)		15.26			36.01	58.23
	Solvent – (100-230°C @ 1.6 Torr)		8.48			6.10	41.30
	Heavy Oil – (230-255°C @1.6 Torr)		1.15				
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.89	75.03			57.89	0.47
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						0.956
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	1	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Water	S-4A Total	S-7 Btms	Absorbed Gas		
	SAMPLE POINT	Sx-37	Sx-37	Sx-39	Calc.		
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2				99.29		
	Hydrogen Sulfide – H_2S				0.61		
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.11	0.01		0.10		
	Light Oils – (0-100° C @ 1.6 Torr)		54.45	12.51			
	Solvent – (100-230° C @ 1.6 Torr)		38.62	84.60			
	Heavy Oil – (230-255° C @ 1.6 Torr)			2.60			
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.89	6.92	0.29			
	Phenol						
	TOTAL	100	100	100	100		
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						

Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2			-		

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

MOLE PERCENT

SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Discharge
SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
Hydrogen - H_2	41.22	40.32	52.90	55.20	20.45	12.67
Carbon Monoxide - CO	58.20	13.88	17.85	29.55	6.65	3.62
Carbon Dioxide - CO_2		19.07			38.35	48.87
Hydrogen Sulfide - H_2S		0.15			1.70	
Methane - CH_4		20.78	23.70	11.40	19.35	18.10
Ethane - C_2H_6		3.60	3.80	1.85	7.35	9.50
Propane - C_3H_8		1.25	1.30	1.50	5.60	7.24
Butane - C_4H_{10}						
Nitrogen - N_2	0.58	0.90	0.45	0.50	0.25	
Ammonia - NH_3 (PPM)		0.05			0.30	
Light Oils - (0-100° C @ 1.6 Torr)						
Solvent - (100-230°C @ 1.6 Torr)						
Heavy Oil - (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100	100	100
Calc Mole-Wt.	17.28	18.35	11.69	12.56	27.61	31.70
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

Elemental

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Absorbed Gas					
SAMPLE POINT	Calc.					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	98.96					
Hydrogen Sulfide – H_2S	0.78					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.26					
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc. Mole Wt.	43.85					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	–					

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2C
DATE: 8/31-9/1/77
TIME: 1400-0200

SAMPLE DESCRIPTION	LEC Btms	Feed Solv.	S-8 Oil	S-4B Oil	Cold Trap
SAMPLE POINT	Sx-12	Sx-14	Sx-16	Sx-23	Sx-33
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5	5			
IBP	72.4	36.4			
5%	82.6	102			
10%	85.6	117.2			
20%	93.2	153.2			
30%	103.6	173.4			
40%	116	181			
50%	130	186.3			
60%	151.6	191.8			
70%	169.4	199			
80%	179.8	209.6			
90%	190.6	231.6			
95%	204.8	260			
DRY PT.	214.8				
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR			732	741	742
IBP			57	76	79
5%			65	115	82
10%			69	162	87
20%			78	194	94
30%			88	208	99
40%			97	223	102
50%			107	246	110
60%			117	270	111
70%			126	297	114
80%			140	334	117
90%			161	349	
95%					
DRY PT.			169	350	117
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)		0.97		0.45	57.89
INFRARED RATIO					
SP. GRAV. 60/60 F	1.006	1.062		0.966	

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2C
DATE: 8/31-9/1/77
TIME: 1400-0200

SAMPLE DESCRIPTION	S-4A Oil	S-7 Btms			
SAMPLE POINT	Sx-37	Sx-39			
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5			
IBP		64.6			
5%		91			
10%		110.6			
20%		144.5			
30%		166			
40%		176.3			
50%		181			
60%		185			
70%		192			
80%		202			
90%		223			
95%		256			
DRY PT.		256			
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	736				
IBP	77				
5%	97				
10%	158				
20%	197				
30%	213				
40%	232				
50%	254				
60%	276				
70%	314				
80%	340				
90%	363				
95%					
DRY PT.	368				
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)	0.47	0.29			
INFRARED RATIO					
SP. GRAV. 60/60 F	0.961				

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/2/78

MATERIAL IN

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

Temperature: 751°F
Pressure. 2460 psig
LHSV: 1.37
GHSV: 320

lbs/hr.

Quantitative

STREAM DESCRIPTION	← Feed Gas Recycle Gas	Gas → Makeup Gas	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.57	0.43				1.00
Carbon Monoxide - CO	2.68	8.37				11.05
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	2.04					2.04
Ethane - C_2H_6	0.61					0.61
Propane - C_3H_8	0.31					0.31
Butane - C_4H_{10}						
Nitrogen - N_2	0.07	0.08				0.15
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				9.26		9.26
Solvent - (100-230° C @ 1.6 Torr)				78.18		78.18
Heavy Oil - (230-255° C @ 1.6 Torr)				3.11		3.11
SRL						
Coal (MAF)			28.18			28.18
Ash			2.57			2.57
Water			15.59	0.89		16.48
Phenol						
TOTAL	6.28	8.88	46.34	91.44		152.94

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/2/78

MATERIAL OUT

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

Temperature: 751°F
Pressure: 2460 psig
LHSV: 1.37
GHSV: 320

lbs/hr.

Quantitative

STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas →	S-4A Ovhd	S-4B Btms	S-8 Ovhd
SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Hydrogen - H_2	0.31	0.57		0.06		
Carbon Monoxide - CO	1.48	2.68		0.29		
Carbon Dioxide - CO_2			9.15	2.64		
Hydrogen Sulfide - H_2S			0.06	0.09		
Methane - CH_4	1.13	2.04		0.48		
Ethane - C_2H_6	0.34	0.61		0.35		
Propane - C_3H_8	0.17	0.31		0.39		
Butane - C_4H_{10}						
Nitrogen - N_2	0.04	0.07		0.01		
Ammonia - NH_3			0.01	0.01	0.02	
Light Oil - (0-100° C @ 1.6 Torr)					3.17	
Solvent - (100-230°C @ 1.6 Torr)					1.76	
Heavy Oil - (230-255°C @ 1.6 Torr)					0.24	
SRL						
Cool (MAF)						
Ash						
Water					15.61	
Phenol						
TOTAL	3.47	6.28	9.22	4.32	20.80	Negl.

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE

MEASURED MATERIAL BALANCE

Revised: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

MATERIAL OUT

lbs/hr.

Temperature: 751°F
Pressure: 2460 psig
LHSV: 1.37
GHSV: 320

Quantitative

STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	Recycle Solvent S-7 Btms	Recycle Solvent F-2 Btms
SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-34	Sx-12
Hydrogen - H_2						
Carbon Monoxide - CO						
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4						
Ethane - C_2H_6						
Propane - C_3H_8						
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)	1.99		0.07		9.26	4.50
Solvent - (100-230°C @ 1.6 Torr)	0.03		0.01	3.04	62.58	5.75
Heavy Oil - (230-255°C @ 1.6 Torr)					1.92	0.18
SRL				10.49		
Coal (MAF)				4.10		
Ash				2.66		
Water			0.12		0.21	
Phenol						
TOTAL	2.02	NA	0.20	20.29	73.97	10.43

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

NA - Not Available

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/2/78

Run No: L-2C
Date: 8/31-9/1/77
Time: 1400-0200

MATERIAL OUT

lbs/hour

Temperature: 751°F
Pressure: 2460 psig
LHSV: 1.37
GHSV: 320

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						0.94
Carbon Monoxide - CO						4.45
Carbon Dioxide - CO_2						11.79
Hydrogen Sulfide - H_2S						0.15
Methane - CH_4						3.65
Ethane - C_2H_6						1.30
Propane - C_3H_8						0.87
Butane - C_4H_{10}						
Nitrogen - N_2						0.12
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)						18.99
Solvent - (100-230°C @ 1.6 Torr)						73.17
Heavy Oil - (230-255°C @ 1.6 Torr)						2.34
SRL						10.49
Coal (MAF)						4.10
Ash						2.66
Water						15.94
Phenol						
TOTAL						151.00

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

RUN CONDITIONS

RUN NO. L-2D
DATE MADE 9/3/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 770
- INLET 295
- OUTLET 747

DISSOLVERS
- R-1A (1) 752
- (2) 809
- (3) 793
- (4) 808
- R-1B (1) NIU
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 615
- S-2 79
- S-3 501
- S-4A 80
- S-4B 74

PREHEATER E-11
- DOWTHERM 682
- INLET 418
- OUTLET 644

VACUUM FLASH F-1
- OVERHEAD VAPOR 503
- UPPER WALL 607
- LOWER WALL 571
- DOWNCOMER 569
- CONDENSATE ACCUMULATOR, S-7 80

PREHEATER E-13
- DOWTHERM 398
- INLET 77
- OUTLET 160

LIGHT ENDS COLUMN, F-2
- REBOILER 323
- LOWER SECTION 214
- FEED SECTION 212
- OVERHEAD 179
- S-8 75
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2
2450

SEPARATOR S-3
250

SEPARATORS S-4A and S-4B
60

VACUUM FLASH, F-1
15 Torr

LIGHT ENDS COLUMN, F-2
Atm

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

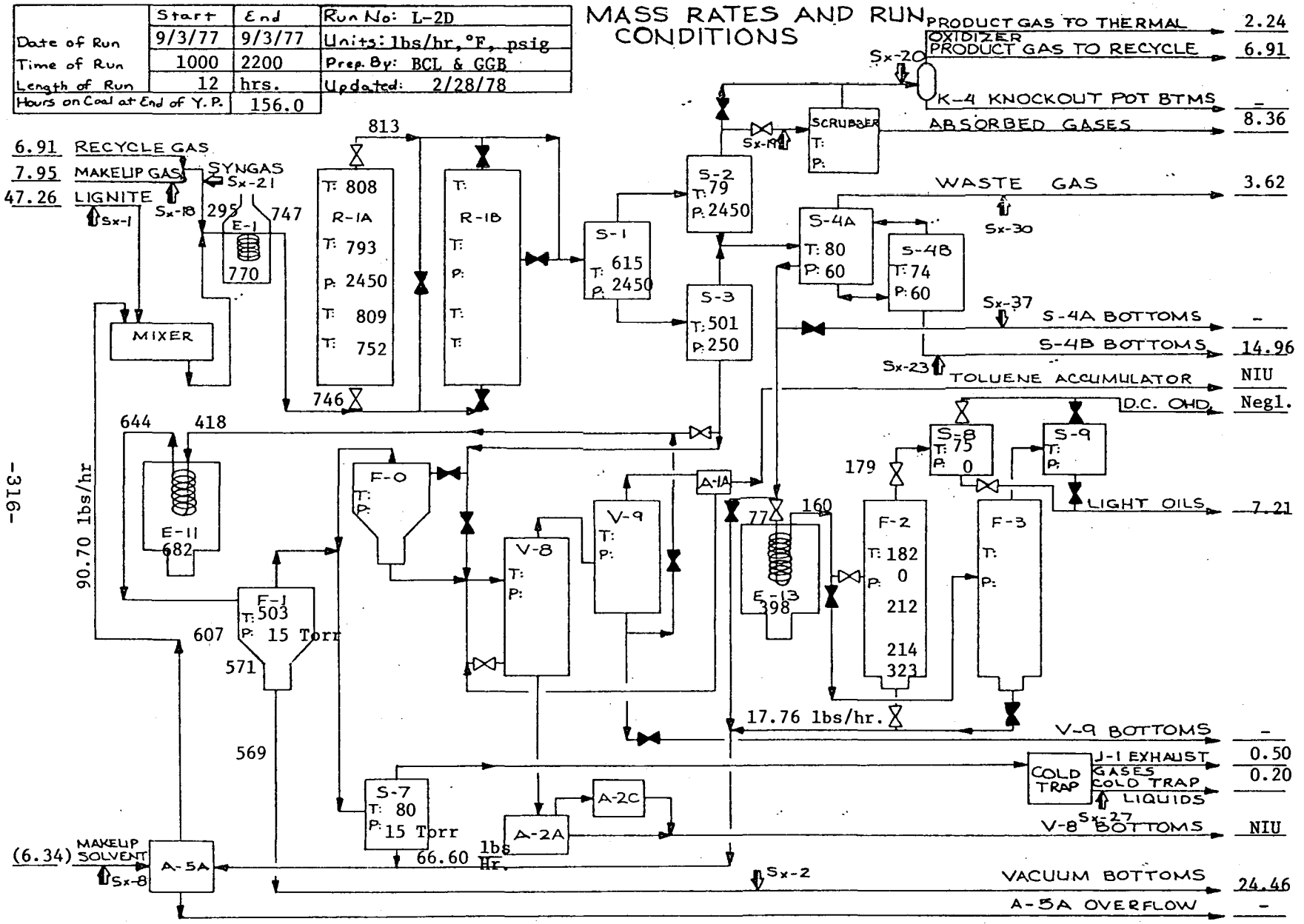
VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU

MASS RATES AND RUN CONDITIONS

	Start	End	Run No: L-2D
Date of Run	9/3/77	9/3/77	Units: lbs/hr, °F, psig
Time of Run	1000	2200	Prep. By: BCL & GGB
Length of Run	12	hrs.	Updated: 2/28/78
Hours on Coal at End of Y.P.	156.0		



PRODUCT GAS TO THERMAL OXIDIZER	2.24
PRODUCT GAS TO RECYCLE	6.91
K-4 KNOCKOUT POT BTMS	-
ABSORBED GASES	8.36
WASTE GAS	3.62
S-4A BOTTOMS	-
S-4B BOTTOMS	14.96
TOLUENE ACCUMULATOR	NIU
D.C. OHD	Negl.
LIGHT OILS	7.21
V-9 BOTTOMS	-
J-1 EXHAUST GASES	0.50
COLD TRAP LIQUIDS	0.20
V-8 BOTTOMS	NIU
VACUUM BOTTOMS	24.46
A-5A OVERFLOW	-
TOTAL	152.82

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rate Adjusted followed by a Forced Carbon Balance
Revised: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

SUMMARY

Temperature: 747°F
Pressure: 2450 psig
LHSV: 1.38
GHSV: 320

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
	SAMPLE POINT						
Quantitative	Hydrogen - H_2	1.62	1.08	-0.54			
	Carbon Monoxide - CO	11.00	5.77	-5.23			
	Carbon Dioxide - CO_2		10.91	10.91			
	Hydrogen Sulfide - H_2S		0.21	0.21			
	Methane - CH_4	1.35	2.10	0.75	6.79	23.60	
	Ethane - C_2H_6	0.52	0.95	0.43			
	Propane - C_3H_8	0.14	0.43	0.29			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.23	0.17	-0.06			
	Ammonia - NH_3		0.03	0.03			
	Light Oil - (0-100° C @ 1.6 Torr)	23.51	28.90	5.39			
	Solvent - (100-230°C @ 1.6 Torr)	64.49	59.72	-4.77	16.87	58.64	
	Heavy Oil - (230-255°C @ 1.6 Torr)	2.45	1.81	-0.64			
	SRL		16.89	16.89			
	Coal (MAF)	28.77	4.92	-23.85		-82.90	
	Ash	2.69	2.65	-0.04		-0.14	
	Water	16.05	16.28	0.23		0.80	
	Phenol						
	TOTAL	152.82	152.82	-0-			

Elemental	Carbon	106.56	106.56	-0-			
	Hydrogen	12.03	11.98	-0.05			
	Nitrogen	0.73	0.70	-0.03			
	Sulfur	1.26	1.41	0.15			
	Oxygen (by diff)	29.55	29.52	-0.03			
	Ash	2.69	2.65	-0.04			
	TOTAL	152.82	152.82	-0-			

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Product Gas, Recycle Gas and F-1 Btms Rate Adjusted followed by a Forced Carbon Balance

Revised: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MATERIAL IN

lbs/hr

Temperature: 747°F
Pressure: 2450 psig
LHSV: 1.38
GHSV: 320

Quantitative

STREAM DESCRIPTION	← Feed Gas → Recycle Gas	Makeup Gas	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.76	0.86				1.62
Carbon Monoxide - CO	4.02	6.98				11.00
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	1.35					1.35
Ethane - C_2H_6	0.52					0.52
Propane - C_3H_8	0.14					0.14
Butane - C_4H_{10}						
Nitrogen - N_2	0.12	0.11				0.23
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				23.51		23.51
Solvent - (100-230°C @ 1.6 Torr)				64.49		64.49
Heavy Oil - (230-255°C @ 1.6 Torr)				2.45		2.45
SRL						
Coal (MAF)			28.77			28.77
Ash			2.69			2.69
Water			15.80	0.25		16.05
Phenol						
TOTAL	6.91	7.95	47.26	90.70		152.82

Elemental

Carbon	3.26	2.99	20.76	79.55		106.56
Hydrogen	1.23	0.86	3.06	6.88		12.03
Nitrogen	0.12	0.11	0.26	0.24		0.73
Sulfur			0.25	1.01		1.26
Oxygen (by diff)	2.30	3.99	20.24	3.02		29.55
Ash			2.69			2.69
TOTAL	6.91	7.95	47.26	90.70		152.82

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rate Adjusted followed by a Forced Carbon Balance
Revised: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MATERIAL OUT
lbs/hr.

Temperature: 747°F
Pressure: 2450 psig
LHSV: 1.38
GHSV: 320

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc.	Sx-30	Calc.	Sx-44
Quantitative	Hydrogen - H_2	0.25	0.76		0.07		
	Carbon Monoxide - CO	1.30	4.02		0.40		
	Carbon Dioxide - CO_2			8.24	2.30		
	Hydrogen Sulfide - H_2S			0.12	0.09		
	Methane - CH_4	0.44	1.35		0.28		
	Ethane - C_2H_6	0.17	0.52		0.24		
	Propane - C_3H_8	0.04	0.14		0.22		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.04	0.12		0.01		
	Ammonia - NH_3				0.01	0.02	
	Light Oil - (0-100° C @ 1.6 Torr)					0.44	
	Solvent - (100-230°C @ 1.6 Torr)					0.21	
	Heavy Oil - (230-255°C @ 1.6 Torr)					0.02	
	SRL						
	Coal (MAF)						
	Ash						
	Water					14.27	
	Phenol						
	TOTAL	2.24	6.91	8.36	3.62	14.96	Negl.
Elemental	Carbon	1.06	3.26	2.25	1.38	0.56	
	Hydrogen	0.40	1.23	0.01	0.24	1.65	
	Nitrogen	0.04	0.12		0.01	0.02	
	Sulfur			0.11	0.08		
	Oxygen (by diff)	0.74	2.30	5.99	1.91	12.73	
	Ash						
	TOTAL	2.24	6.91	8.36	3.62	14.96	Negl.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE

Product Gas, Recycle Gas and F-1 Btms Rates Adjusted followed by a Forced Carbon Balance

Revised: 2/28/77

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MATERIAL OUT

lbs/hr.

Temperature: 747°F
Pressure: 2450 psig
LHSV: 1.38
GHSV: 320

Quantitative

STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	LEC Btms
SAMPLE POINT	Sx-16	*Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Hydrogen - H_2						
Carbon Monoxide - CO		0.05				
Carbon Dioxide - CO_2		0.37				
Hydrogen Sulfide - H_2S						
Methane - CH_4		0.03				
Ethane - C_2H_6		0.02				
Propane - C_3H_8		0.03				
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)	4.78		0.07		12.83	10.78
Solvent - (100-230°C @ 1.6 Torr)	0.81		0.03		52.01	6.66
Heavy Oil - (230-255°C @ 1.6 Torr)	0.20				1.27	0.32
SRL				16.89		
Coal (MAF)				4.92		
Ash				2.65		
Water	1.42		0.10		0.49	
Phenol						
TOTAL	7.21	0.50	0.20	24.46	66.60	17.76

Elemental

Carbon	4.81	0.18	0.09	19.25	58.61	15.11
Hydrogen	0.74	0.02	0.02	1.15	5.02	1.50
Nitrogen	0.01			0.25	0.20	0.05
Sulfur	0.02			0.21	0.87	0.12
Oxygen (by diff)	1.63	0.30	0.09	0.95	1.90	0.98
Ash				2.65		
TOTAL	7.21	0.50	0.20	24.46	66.60	17.76

* Rate assumed similar to those of the other L-2 yield periods where the orifice meter was operating properly.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rate Adjusted followed by a Forced Carbon Balance
Revised: 2/28/77

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MATERIAL OUT
lbs/hr.

Temperature: 747°F
Pressure: 2450 psig
LHSV: 1.38
GHSV: 320

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.08
Carbon Monoxide - CO						5.77
Carbon Dioxide - CO_2						10.91
Hydrogen Sulfide - H_2S						0.21
Methane - CH_4						2.10
Ethane - C_2H_6						0.95
Propane - C_3H_8						0.43
Butane - C_4H_{10}						
Nitrogen - N_2						0.17
Ammonia - NH_3						0.03
Light Oil - (0-100° C @ 1.6 Torr)						28.90
Solvent - (100-230°C @ 1.6 Torr)						59.72
Heavy Oil - (230-255°C @1.6 Torr)						1.81
SRL						16.89
Coal (MAF)						4.92
Ash						2.65
Water						16.28
Phenol						
TOTAL						152.82

Elemental

Carbon						106.56
Hydrogen						11.98
Nitrogen						0.70
Sulfur						1.41
Oxygen (by diff)						29.52
Ash						2.65
TOTAL						152.82

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	LEC Btms	Feed Solvent	S-8 Oil	S-8 Water
	SAMPLE POINT	Sx-1	Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			60.70	25.92	82.50	
	Solvent – (100-230°C @ 1.6 Torr)			37.50	71.10	14.00	
	Heavy Oil – (230-255°C @ 1.6 Torr)			1.80	2.70	3.50	
	SRL		69.06				
	Coal (MAF)	60.88	20.11				
	Ash	5.70	10.83				
	Water	33.42			0.28		100
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		77.45				
	Melting Point °F		440				
	Specific Gravity 60/60			1.010	1.054		
	Viscosity, cp						
Elemental	Carbon	43.92	78.69	85.08	87.71	83.02	
	Hydrogen	6.47	4.72	8.45	7.58	10.01	11.11
	Nitrogen	0.56	1.00	0.27	0.27	0.21	
	Sulfur	0.52	0.86	0.70	1.11	0.40	
	Oxygen (by diff)	42.83	3.90	5.50	3.33	6.36	88.89
	Ash	5.70	10.83				
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	4	2	2	2	-

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4B Oil
	SAMPLE POINT	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21	*Sx-23
Quantitative	Hydrogen – H_2		10.80	6.08	11.01	9.31	
	Carbon Monoxide – CO		87.76	34.53	58.24	75.94	
	Carbon Dioxide – CO_2			42.52			
	Hydrogen Sulfide – H_2S			0.62			
	Methane – CH_4			10.02	19.50	8.95	
	Ethane – C_2H_6			3.92	7.56	3.53	
	Propane – C_3H_8			1.61	2.02	1.25	
	Butane – C_4H_{10}						
	Nitrogen – N_2		1.44	0.68	1.67	1.02	
	Ammonia – NH_3 (PPM)			0.02			
	Light Oils – (0-100° C @ 1.6 Torr)	66.21					64.64
	Solvent – (100-230°C @ 1.6 Torr)	11.24					31.20
	Heavy Oil – (230-255°C @ 1.6 Torr)	2.81					3.10
	SRL						
	Coal (MAF)						
	Ash						
	Water	19.74					1.06
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						0.988
	Viscosity, cp						
Elemental	Carbon	66.63	37.61	38.38	47.28	43.10	82.11
	Hydrogen	10.22	10.80	9.69	17.77	12.49	8.69
	Nitrogen	0.17	1.44	0.70	1.67	1.02	0.33
	Sulfur	0.32		0.58			0.77
	Oxygen (by diff)	22.66	50.15	50.65	33.28	43.39	8.10
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

*Insufficient oil sample-distillation data assumed to be the same as the S-4A Oil.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Water	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	S-7 Btms
	SAMPLE POINT	Sx-23	Sx-23	Sx-30	Sx-32	Sx-33	Sx-34/39
Quantitative	Hydrogen – H_2			2.07	0.81		
	Carbon Monoxide – CO			11.14	10.07		
	Carbon Dioxide – CO_2			63.64	74.13		
	Hydrogen Sulfide – H_2S			2.46			
	Methane – CH_4			7.64	5.01		
	Ethane – C_2H_6			6.74	4.71		
	Propane – C_3H_8			5.94	5.27		
	Butane – C_4H_{10}						
	Nitrogen – N_2			0.21			
	Ammonia – NH_3 (PPM)	0.13	0.12	0.16			
	Light Oils – (0-100° C @ 1.6 Torr)		6.20			34.03	19.26
	Solvent – (100-230° C @ 1.6 Torr)		3.00			16.40	78.10
	Heavy Oil – (230-255° C @ 1.6 Torr)		0.30				1.90
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.87	90.38			49.57	0.74
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						1.059
	Viscosity, cp						
Elemental	Carbon		7.88	38.11	36.38	44.31	88.00
	Hydrogen	11.12	10.89	6.58	3.96	9.81	7.54
	Nitrogen	0.11	0.13	0.34		0.10	0.30
	Sulfur		0.07	2.32		0.32	1.30
	Oxygen (by diff)	88.77	81.03	52.65	59.66	45.46	2.86
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	1	4

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Oil	S-4A Water	S-4A Total	S-7 Btms	Absorbed Gas	S-4B Btms
	SAMPLE POINT	Sx-37	Sx-37	Sx-37	Sx-34/39	Calc	Calc.
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2					98.52	
	Hydrogen Sulfide – H_2S					1.44	
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)		0.08	0.02		0.04	0.12
	Light Oils – (0-100° C @ 1.6 Torr)	64.64		49.42	19.26		2.94
	Solvent – (100-230°C @ 1.6 Torr)	31.20		23.86	78.10		1.42
	Heavy Oil – (230-255°C @ 1.6 Torr)	3.10		2.37	1.90		0.14
	SRL						
	Coal (MAF)						
	Ash						
	Water	1.06	99.92	24.33	0.74		95.38
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60	0.984			1.059		
	Viscosity, cp						
Elemental	Carbon	82.40		63.00	88.00	26.87	3.74
	Hydrogen	8.39	11.11	9.03	7.54	0.09	11.01
	Nitrogen	0.28	0.07	0.23	0.30	0.03	0.12
	Sulfur	0.55		0.42	1.30	1.36	0.03
	Oxygen (by diff)	8.38	88.82	27.32	2.86	71.65	85.10
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	4	-	-

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MOLE PERCENT

SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Exhaust
SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
Hydrogen – H_2	62.90	50.04	60.10	57.40	27.20	13.30
Carbon Monoxide – CO	36.50	20.29	22.70	33.45	10.45	11.83
Carbon Dioxide – CO_2		15.90			38.00	55.45
Hydrogen Sulfide – H_2S		0.30			1.90	
Methane – CH_4		10.30	13.30	6.90	12.55	10.31
Ethane – C_2H_6		2.15	2.75	1.45	5.90	5.17
Propane – C_3H_8		0.60	0.50	0.35	3.55	3.94
Butane – C_4H_{10}						
Nitrogen – N_2	0.60	0.40	0.65	0.45	0.20	
Ammonia – NH_3 (PPM)		0.02			0.25	
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100	100	100
Calc Mole Wt	11.65	16.45	10.91	12.33	26.27	32.91
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

Elemental

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MOLE PERCENT

Quantitative						
SAMPLE DESCRIPTION	Absorbed Gas					
SAMPLE POINT	Calc					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	98.03					
Hydrogen Sulfide – H_2S	1.85					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.12					
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230° C @ 1.6 Torr)						
Heavy Oil – (230-255° C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc. Mole Wt.	43.78					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	–					

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2D
DATE: 9/3/77
TIME: 1000-2200

SAMPLE DESCRIPTION	F-1 Btms	LEC Btms	Feed Solv.	S-8 Oil	S-7 Btms
SAMPLE POINT	Sx-2	Sx-12	Sx-14	Sx-16	Sx-34/39
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5		5
IBP		28.6	54.4		68.6
5%		67.2	79		83
10%		72.3	87.8		92.6
20%		79.3	106.5		118.1
30%		85.8	131		147.2
40%		93.8	157		166.2
50%		104	170.5		174.6
60%		118.4	177.3		180.4
70%		143.2	184.2		185.5
80%		165.8	193.2		192.6
90%		180.2	211.8		212
95%		192.2	237.5		248.4
DRY PT.		197.2	245.7		255.4
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR				752	
IBP				62	
5%				68	
10%				85	
20%				112	
30%				140	
40%				171	
50%				191	
60%				210	
70%				235	
80%				266	
90%				344	
95%				347	
DRY PT.					
ASPHALTENE TEST					
WT % ASH	10.83				
WT % UNCONVERTED COAL	20.11				
WT % PRE-ASPHALTENES	37.25				
WT % ASPHALTENES	15.05				
WT % MALTENES & DIST. OIL	16.76				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		9.7	11.7		12.8
210° F		8.2	8.5		8.5
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)			0.28		0.74
INFRARED RATIO		0.32	0.38		0.37
SP. GRAV. 60/60 F		1.010	1.054		1.059

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2D
DATE: 9/3/77
TIME: 1000-2200

SAMPLE DESCRIPTION	S-4A Oil				
SAMPLE POINT	Sx-37				
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR					
IBP					
5%					
10%					
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
95%					
DRY PT.					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	738				
IBP	89				
5%	161				
10%	188				
20%	201				
30%	209				
40%	221				
50%	238				
60%	261				
70%	295				
80%	336				
90%	355				
95%					
DRY PT.	357				
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)	1.06				
INFRARED RATIO					
SP. GRAV. 60/60 F	0.984				

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/28/78

MATERIAL OUT

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

Temperature: 747°F
Pressure: 2450 psig
LHSV: 1.38
GHSV: 320

lbs/hr.

Quantitative

STREAM DESCRIPTION	←Feed Gas→ Recycle Gas	Makeup Gas	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.65	0.97				1.62
Carbon Monoxide - CO	3.44	7.86				11.30
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	1.15					1.15
Ethane - C_2H_6	0.44					0.44
Propane - C_3H_8	0.12					0.12
Butane - C_4H_{10}						
Nitrogen - N_2	0.10	0.13				0.23
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				23.51		23.51
Solvent - (100-230° C @ 1.6 Torr)				64.49		64.49
Heavy Oil - (230-255°C @ 1.6 Torr)				2.45		2.45
SRL						
Coal (MAF)			28.77			28.77
Ash			2.69			2.69
Water			15.80	0.25		16.05
Phenol						
TOTAL	5.90	8.96	47.26	90.70		152.82

Elemental

Carbon	2.79	3.37	20.76	79.55		106.47
Hydrogen	1.05	0.97	3.06	6.88		11.96
Nitrogen	0.10	0.13	0.26	0.24		0.73
Sulfur			0.25	1.01		1.26
Oxygen (by diff)	1.96	4.49	20.24	3.02		29.71
Ash			2.69			2.69
TOTAL	5.90	8.96	47.26	90.70		152.82

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MATERIAL OUT

Temperature: 747°F
Pressure: 2450 psig
LHSV: 1.38
GHSV: 320

lbs./hr

	STREAM DESCRIPTION	←Product Gas→ Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Quantitative	Hydrogen - H_2	0.40	0.65		0.07		
	Carbon Monoxide - CO	2.14	3.44		0.40		
	Carbon Dioxide - CO_2			7.54	2.30		
	Hydrogen Sulfide - H_2S			0.11	0.09		
	Methane - CH_4	0.72	1.15		0.28		
	Ethane - C_2H_6	0.28	0.44		0.24		
	Propane - C_3H_8	0.07	0.12		0.22		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.06	0.10		0.01		
	Ammonia - NH_3				0.01	0.02	
	Light Oil - (0-100° C @ 1.6 Torr)					0.93	
	Solvent - (100-230° C @ 1.6 Torr)					0.45	
	Heavy Oil - (230-255°C @ 1.6 Torr)					0.04	
	SRL						
	Coal (MAF)						
	Ash						
	Water					13.52	
	Phenol						
	TOTAL	3.67	5.90	7.65	3.62	14.96	Negl.
Elemental	Carbon	1.74	2.79	2.06	1.38	1.18	
	Hydrogen	0.65	1.05	0.01	0.24	1.63	
	Nitrogen	0.06	0.10		0.01	0.02	
	Sulfur			0.10	0.08	0.01	
	Oxygen (by diff)	1.22	1.96	5.48	1.91	12.12	
	Ash						
	TOTAL	3.67	5.90	7.65	3.62	14.96	Negl.

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MATERIAL OUT

lbs/hr.

Temperature:747°F
Pressure:2450 psig
LHSV: 1.38
GHSV: 320

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	← Recycle Solvent → S-7 Btms	LEC Btms
Quantitative	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	4.78		0.07		12.83	10.78
	Solvent - (100-230°C @ 1.6 Torr)	0.81		0.03		52.01	6.66
	Heavy Oil - (230-255°C @ 1.6 Torr)	0.20				1.27	0.32
	SRL				17.31		
	Coal (MAF)				5.04		
	Ash				2.72		
	Water	1.42		0.10		0.49	
	Phenol						
	TOTAL	7.21	NA	0.20	25.07	66.60	17.76
Elemental	Carbon	4.81		0.09	19.73	58.61	15.11
	Hydrogen	0.74		0.02	1.18	5.02	1.50
	Nitrogen	0.01			0.25	0.20	0.05
	Sulfur	0.02			0.21	0.87	0.12
	Oxygen (by diff)	1.63		0.09	0.98	1.90	0.98
	Ash				2.72		
	TOTAL	7.21	NA	0.20	25.07	66.60	17.76

NA - Not Available

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/28/78

Run No: L-2D
Date: 9/3/77
Time: 1000-2200

MATERIAL OUT

LBS/HR.

Temperature: 747°F
Pressure: 2450 psig
LHSV: 1.38
GHSV: 320

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.12
Carbon Monoxide - CO						5.98
Carbon Dioxide - CO_2						9.84
Hydrogen Sulfide - H_2S						0.20
Methane - CH_4						2.15
Ethane - C_2H_6						0.96
Propane - C_3H_8						0.41
Butane - C_4H_{10}						
Nitrogen - N_2						0.17
Ammonia - NH_3						0.03
Light Oil - (0-100° C @ 1.6 Torr)						29.39
Solvent - (100-230° C @ 1.6 Torr)						59.96
Heavy Oil - (230-255°C @ 1.6 Torr)						1.83
SRL						17.31
Coal (MAF)						5.04
Ash						2.72
Water						15.53
Phenol						
TOTAL						152.64

Elemental

Carbon						107.50
Hydrogen						12.04
Nitrogen						0.70
Sulfur						1.41
Oxygen (by diff)						28.27
Ash						2.72
TOTAL						152.64

RUN CONDITIONS

RUN NO. L-2E

DATE MADE 9/3-4/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 760
- INLET 291
- OUTLET 741

DISSOLVERS
- R-1A (1) 739
- (2) 808
- (3) 780
- (4) 798
- R-1B (1) NIU
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 589
- S-2 78
- S-3 493
- S-4A 78
- S-4B 73

PREHEATER E-11
- DOWTHERM 680
- INLET 432
- OUTLET 641

VACUUM FLASH F-1
- OVERHEAD VAPOR 496
- UPPER WALL 602
- LOWER WALL 570
- DOWNCOMER 562
- CONDENSATE ACCUMULATOR, S-7 79

PREHEATER E-13
- DOWTHERM 397
- INLET 79
- OUTLET 170

LIGHT ENDS COLUMN, F-2
- REBOILER 321
- LOWER SECTION 212
- FEED SECTION 213
- OVERHEAD 180
- S-8 74
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2
2450

SEPARATOR S-3
250

SEPARATORS S-4A and S-4B
62

VACUUM FLASH, F-1
15 Torr

LIGHT ENDS COLUMN, F-2
Atm

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

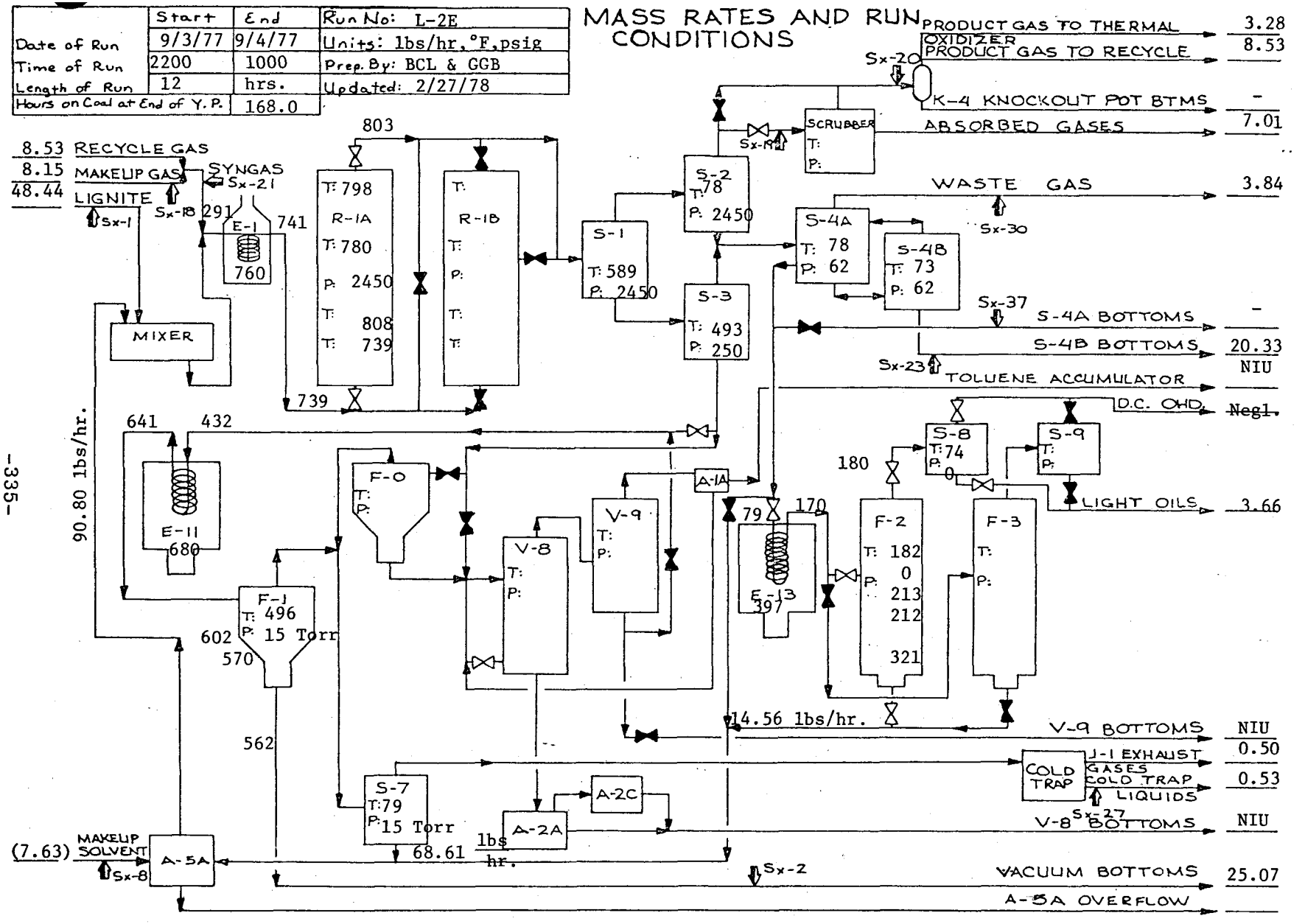
VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU

	Start	End	Run No: L-2E
Date of Run	9/3/77	9/4/77	Units: lbs/hr, °F, psig
Time of Run	2200	1000	Prep. By: BCL & GGB
Length of Run	12	hrs.	Updated: 2/27/78
Hours on Coal at End of Y.P.		168.0	

MASS RATES AND RUN CONDITIONS



⋈ OPEN ⋈ CLOSED

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Product Gas, Recycle Gas and F-1 Btms Rates Adjusted followed by a Forced Carbon Balance

Revised: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

SUMMARY

lbs/hr

Temperature: 741°F
Pressure: 2450 psig
LHSV: 1.48
GHSV:309

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
	SAMPLE POINT						
Quantitative	Hydrogen - H_2	1.10	1.05	-0.05			
	Carbon Monoxide - CO	13.65	8.87	-4.78			
	Carbon Dioxide - CO_2		9.88	9.88			
	Hydrogen Sulfide - H_2S		0.09	0.09			
	Methane - CH_4	1.21	1.93	0.72			
	Ethane - C_2H_6	0.39	0.77	0.38	6.49	21.85	
	Propane - C_3H_8	0.13	0.40	0.27			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.20	0.17	-0.03			
	Ammonia - NH_3		0.01	0.01			
	Light Oil - (0-100° C @ 1.6 Torr)	22.04	30.34	8.30			
	Solvent - (100-230°C @ 1.6 Torr)	66.01	58.56	-7.45	18.41	61.99	
	Heavy Oil - (230-255°C @1.6 Torr)	2.36	2.61	0.25			
	SRL		17.31	17.31			
	Coal (MAF)	29.70	5.04	-24.66		-83.03	
	Ash	2.72	2.72	-0-		-0-	
	Water	16.41	16.17	-0.24		-0.81	
	Phenol						
	TOTAL	155.92	155.92	-0-			
Elemental	Carbon	108.38	108.38	-0-			
	Hydrogen	11.31	11.94	0.63			
	Nitrogen	0.74	0.69	-0.05			
	Sulfur	1.52	1.34	-0.18			
	Oxygen (by diff)	31.25	30.85	-0.40			
	Ash	2.72	2.72	-0-			
	TOTAL	155.92	155.92	-0-			

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

P[redacted]ct Gas, Recycle Gas and F-1 Btms Rates Adjusted followed by a Forced Carbon Balance

Revised: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MATERIAL IN

lbs/hr.

Temperature: 741°F
Pressure: 2450 psig
LHSV: 1.48
GHSV: 309

	STREAM DESCRIPTION	← Feed Gas → Recycle Gas	Makeup Gas	Lignite	Feed Solvent		Total In
	SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Quantitative	Hydrogen - H_2	0.71	0.39				1.10
	Carbon Monoxide - CO	5.98	7.67				13.65
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4	1.21					1.21
	Ethane - C_2H_6	0.39					0.39
	Propane - C_3H_8	0.13					0.13
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.11	0.09				0.20
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)				22.04		22.04
	Solvent - (100-230°C @ 1.6 Torr)				66.01		66.01
	Heavy Oil - (230-255°C @ 1.6 Torr)				2.36		2.36
	SRL						
	Coal (MAF)			29.70			29.70
	Ash			2.72			2.72
	Water			16.02	0.39		16.41
	Phenol						
	TOTAL	8.53	8.15	48.44	90.80		155.92
Elemental	Carbon	3.89	3.29	21.56	79.64		108.38
	Hydrogen	1.11	0.39	3.11	6.70		11.31
	Nitrogen	0.11	0.09	0.28	0.26		0.74
	Sulfur			0.27	1.25		1.52
	Oxygen (by diff)	3.42	4.38	20.50	2.95		31.25
	Ash			2.72			2.72
	TOTAL	8.53	8.15	48.44	90.80		155.92

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Product Gas, Recycle Gas and F-1 Btms Rates Adjusted followed by a Forced Carbon Balance

Revised: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MATERIAL OUT

lbs/hr.

Temperature: 741°F
Pressure: 2450 psig
LHSV: 1.48
GHSV: 309

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc.	Sx-30	Calc.	Sx-44
Quantitative	Hydrogen - H_2	0.27	0.71		0.07		
	Carbon Monoxide - CO	2.30	5.98		0.52		
	Carbon Dioxide - CO_2			6.98	2.57		
	Hydrogen Sulfide - H_2S			0.03	0.06		
	Methane - CH_4	0.47	1.21		0.22		
	Ethane - C_2H_6	0.15	0.39		0.20		
	Propane - C_3H_8	0.05	0.13		0.18		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.04	0.11		0.02		
	Ammonia - NH_3					0.01	
	Light Oil - (0-100° C @ 1.6 Torr)					3.22	
	Solvent - (100-230°C @ 1.6 Torr)					1.58	
	Heavy Oil - (230-255°C @ 1.6 Torr)					0.22	
	SRL						
	Coal (MAF)						
	Ash						
	Water					15.30	
	Phenol						
	TOTAL	3.28	8.53	7.01	3.84	20.33	Negl.
Elemental	Carbon	1.50	3.89	1.90	1.39	4.27	
	Hydrogen	0.43	1.11		0.20	2.11	
	Nitrogen	0.04	0.11		0.02	0.02	
	Sulfur			0.03	0.06	0.03	
	Oxygen (by diff)	1.31	3.42	5.08	2.17	13.90	
	Ash						
	TOTAL	3.28	8.53	7.01	3.84	20.33	Negl.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rate Adjusted followed by a Forced Carbon Balance
Revised: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MATERIAL OUT
lbs/hr

Temperature: 741°F
Pressure: 2450 psig
LHSV: 1.48
GHSV: 309

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms
	SAMPLE POINT	Sx-16	*Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO		0.07				
	Carbon Dioxide - CO_2		0.33				
	Hydrogen Sulfide - H_2S						
	Methane - CH_4		0.03				
	Ethane - C_2H_6		0.03				
	Propane - C_3H_8		0.04				
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	3.31		0.17		14.96	8.68
	Solvent - (100-230°C @ 1.6 Torr)	0.25				51.12	5.61
	Heavy Oil - (230-255°C @ 1.6 Torr)	0.10				2.02	0.27
	SRL				17.31		
	Coal (MAF)				5.04		
	Ash				2.72		
	Water			0.36		0.51	
	Phenol						
	TOTAL	3.66	0.50	0.53	25.07	68.61	14.56
Elemental	Carbon	3.18	0.20	0.16	19.73	60.23	11.93
	Hydrogen	0.40	0.02	0.05	1.18	5.24	1.20
	Nitrogen	0.01			0.25	0.20	0.04
	Sulfur	0.02			0.21	0.90	0.09
	Oxygen (by diff)	0.05	0.28	0.32	0.98	2.04	1.30
	Ash				2.72		
	TOTAL	3.66	0.50	0.53	25.07	68.61	14.56

*Rate assumed similar to those of the other L-2 yield periods where the orifice meter was operating properly.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rate Adjusted followed by a Forced Carbon Balance
Revised: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MATERIAL OUT

lbs/hr.

Temperature:741°F
Pressure:2450 psig
LHSV: 1.48
GHSV:309

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.05
Carbon Monoxide - CO						8.87
Carbon Dioxide - CO_2						9.88
Hydrogen Sulfide - H_2S						0.09
Methane - CH_4						1.93
Ethane - C_2H_6						0.77
Propane - C_3H_8						0.40
Butane - C_4H_{10}						
Nitrogen - N_2						0.17
Ammonia - NH_3						0.01
Light Oil - (0-100° C @ 1.6 Torr)						30.34
Solvent - (100-230°C @ 1.6 Torr)						58.56
Heavy Oil - (230-255°C @ 1.6 Torr)						2.61
SRL						17.31
Coal (MAF)						5.04
Ash						2.72
Water						16.17
Phenol						
TOTAL						155.92

Elemental

Carbon						108.38
Hydrogen						11.94
Nitrogen						0.69
Sulfur						1.34
Oxygen (by diff)						30.85
Ash						2.72
TOTAL						155.92

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	Makeup Solvent	LEC Btms	Feed Solvent	S-8 Oil
	SAMPLE POINT	Sx-1	Sx-2	Sx-8	Sx-12	Sx-14	Sx-16
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3 (PPM)						
	Light Oils - (0-100° C @ 1.6 Torr)			1.79	59.60	24.27	90.40
	Solvent - (100-230°C @ 1.6 Torr)			94.00	38.50	72.70	6.80
	Heavy Oil - (230-255°C @ 1.6 Torr)			4.00	1.90	2.60	2.80
	SRL		69.06				
	Coal (MAF)	61.32	20.11				
	Ash	5.61	10.83				
	Water	33.07		0.21		0.43	
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		77.45				
	Melting Point °F		488				
	Specific Gravity 60/60			1.043	1.005	1.053	
	Viscosity, cp						
Elemental	Carbon	44.51	78.69	88.84	81.92	87.71	86.87
	Hydrogen	6.42	4.72	8.52	8.23	7.38	11.16
	Nitrogen	0.58	1.00	0.13	0.30	0.29	0.19
	Sulfur	0.56	0.86	1.82	0.62	1.37	0.48
	Oxygen (by diff)	42.32	3.90	0.69	8.93	3.25	1.30
	Ash	5.61	10.83				
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	4	1	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Water	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas
	SAMPLE POINT	Sx-16	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21
Quantitative	Hydrogen – H_2			4.79	4.95	8.30	7.00
	Carbon Monoxide – CO			94.15	41.00	70.11	81.28
	Carbon Dioxide – CO_2				40.42		
	Hydrogen Sulfide – H_2S				0.28		
	Methane – CH_4				9.09	14.19	6.82
	Ethane – C_2H_6				2.34	4.55	2.79
	Propane – C_3H_8				1.22	1.54	1.29
	Butane – C_4H_{10}						
	Nitrogen – N_2			1.06	0.70	1.31	0.82
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)		90.40				
	Solvent – (100-230°C @ 1.6 Torr)		6.80				
	Heavy Oil – (230-255°C @1.6 Torr)		2.80				
	SRL						
	Coal (MAF)						
	Ash						
	Water	100					
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon		86.87	40.35	38.28	45.59	43.24
	Hydrogen	11.11	11.16	4.79	7.93	13.04	9.49
	Nitrogen		0.19	1.06	0.70	1.31	0.82
	Sulfur		0.48		0.26		
	Oxygen (by diff)	88.89	1.30	53.80	52.83	40.06	46.45
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Oil	S-4B Water	S-4B Total	S-4A Ovhd	J-1 Disch.	Cold Trap
Quantitative	SAMPLE POINT	Sx-23	Sx-23	Sx-23	Sx-30	Sx-32	Sx-33
	Hydrogen – H_2				1.78	0.74	
	Carbon Monoxide – CO				13.45	13.60	
	Carbon Dioxide – CO_2				67.07	65.69	
	Hydrogen Sulfide – H_2S				1.65		
	Methane – CH_4				5.76	4.97	
	Ethane – C_2H_6				5.13	6.38	
	Propane – C_3H_8				4.59	8.62	
	Butane – C_4H_{10}						
	Nitrogen – N_2				0.45		
	Ammonia – NH_3 (PPM)		0.09	0.09	0.12		
	Light Oils – (0-100° C @ 1.6 Torr)	62.18					32.28
	Solvent – (100-230° C @ 1.6 Torr)	30.50					
	Heavy Oil – (230-255° C @ 1.6 Torr)	4.20					
	SRL						
	Coal (MAF)						
	Ash						
	Water	3.12	99.91	99.91			67.72
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60	0.992					
	Viscosity, cp						
Elemental	Carbon	82.42			36.23	39.63	30.10
	Hydrogen	8.11	11.12	11.12	5.10	4.83	9.27
	Nitrogen	0.28	0.07	0.07	0.65		0.07
	Sulfur	0.62			1.55		0.36
	Oxygen (by diff)	8.57	88.81	88.81	56.47	55.54	60.20
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	1

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-7 Btms	S-4A Oil	S-4A Water	S-4A Total	S-7 Btms	Absorbed Gas
Quantitative	SAMPLE POINT	Sx-34/39	Sx-37	Sx-37	Sx-37	Sx-34/39	Calc.
	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						99.56
	Hydrogen Sulfide – H_2S						0.44
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)			0.08	0.03		
	Light Oils – (0-100° C @ 1.6 Torr)	21.81	71.28		47.70	21.81	
	Solvent – (100-230°C @ 1.6 Torr)	74.50	23.00		15.39	74.50	
	Heavy Oil – (230-255°C @ 1.6 Torr)	2.95	4.70		3.15	2.95	
	SRL						
	Coal (MAF)						
	Ash						
	Water	0.74	1.02	99.92	33.73	0.74	
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60	1.056	0.974			1.056	
	Viscosity, cp						
Elemental	Carbon	87.79	82.70		55.34	87.79	27.15
	Hydrogen	7.64	8.97	11.11	9.68	7.64	0.03
	Nitrogen	0.29	0.24	0.07	0.18	0.29	
	Sulfur	1.31	0.47		0.32	1.31	0.41
	Oxygen (by diff)	2.97	7.62	88.82	34.48	2.97	72.41
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	4	2	2	2	4	-

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Btms					
Quantitative	SAMPLE POINT	Calc					
	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.07					
	Light Oils – (0-100° C @ 1.6 Torr)	15.84					
	Solvent – (100-230° C @ 1.6 Torr)	7.77					
	Heavy Oil – (230-255° C @ 1.6 Torr)	1.07					
	SRL						
	Coal (MAF)						
	Ash						
	Water	75.25					
	Phenol						
	TOTAL	100					
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						

Elemental	Carbon	21.00					
	Hydrogen	10.36					
	Nitrogen	0.12					
	Sulfur	0.16					
	Oxygen (by diff)	68.36					
	Ash						
	TOTAL	100					
	Number of Sample Avg.	–					

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Disch
SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
Hydrogen – H_2	41.35	44.50	53.40	50.13	24.65	12.04
Carbon Monoxide – CO	58.00	26.30	32.20	41.59	13.35	15.84
Carbon Dioxide – CO_2		16.50			42.35	48.67
Hydrogen Sulfide – H_2S		0.15			1.35	
Methane – CH_4		10.20	11.40	6.11	10.00	10.13
Ethane – C_2H_6		1.40	1.95	1.33	4.75	6.93
Propane – C_3H_8		0.50	0.45	0.42	2.90	6.39
Butane – C_4H_{10}						
Nitrogen – N_2	0.65	0.45	0.60	0.42	0.45	
Ammonia – NH_3 (PPM)					0.20	
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230° C @ 1.6 Torr)						
Heavy Oil – (230-255° C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100	100	100
Calc Mole Wt	17.25	17.96	12.86	14.33	27.78	32.60
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MOLE PERCENT

SAMPLE DESCRIPTION	Absorbed Gas					
SAMPLE POINT	Calc.					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	99.43					
Hydrogen Sulfide – H_2S	0.57					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)						
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230° C @ 1.6 Torr)						
Heavy Oil – (230-255° C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc Mole Wt.	43.94					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2					

Elemental

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2E
DATE: 9/3-4/77
TIME: 2200-1000

SAMPLE DESCRIPTION	F-1 Btms	LEC Btms	Feed Solv.	S-8 Oil	S-4B Oil
SAMPLE POINT	Sx-2	Sx-12	Sx-14	Sx-16	Sx-23
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5		
IBP		58	61.6		
5%		70	81.0		
10%		74	90.2		
20%		80	108.5		
30%		86	135.0		
40%		94	157.8		
50%		105	169.2		
60%		120	174.8		
70%		145	182.3		
80%		165.5	190.2		
90%		181	207.2		
95%		195.5	248.2		
DRY PT.		198.5	248.2		
(VOLUME PERCENT — TEMPERATURE, °C)					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR				740	739
IBP				57	90
5%				66	147
10%				78	190
20%				106	207
30%				129	215
40%				145	226
50%				154	240
60%				167	261
70%				182	291
80%				203	338
90%				243	351
95%				316	
DRY PT.				318	354
(VOLUME PERCENT — TEMPERATURE, °C)					
ASPHALTENE TEST					
WT % ASH	10.83				
WT % UNCONVERTED COAL	20.11				
WT % PRE-ASPHALTENES	37.25				
WT % ASPHALTENES	15.05				
WT % MALTENES & DIST. OIL	16.76				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		9.9	11.5		
210° F		8.1	8.5		
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)		-	0.43		3.12
INFRARED RATIO		0.21	0.41		
SP. GRAV. 60/60 F		1.005	1.053		0.992

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2E
DATE: 9/3-4/77
TIME: 2200-1000

SAMPLE DESCRIPTION	Cold Trap	S-7 Btms	S-4A Oil		
SAMPLE POINT	Sx-33	Sx-34/39	Sx-37		
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5			
IBP		32.7			
5%		81.5			
10%		92.4			
20%		115.2			
30%		143.8			
40%		163			
50%		171.8			
60%		177.5			
70%		182			
80%		189.9			
90%		211.6			
95%		252.9			
DRY PT.					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	739		739		
IBP	86		83		
5%	95		159		
10%	102		179		
20%	103		189		
30%	103		197		
40%	104		206		
50%	104		212		
60%	105		241		
70%	106		269		
80%	113		318		
90%			350		
95%					
DRY PT.	113		353		
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F		11.9			
210° F		8.5			
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)	67.72	0.74	1.02		
INFRARED RATIO		0.43			
SP. GRAV. 60/60 F		1.056	0.974		

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MATERIAL IN

lbs/hr.

Temperature: 741°F
Pressure: 2450 psig
LHSV: 1.48
GHSV: 309

Quantitative

STREAM DESCRIPTION	← Feed Gas → Recycle Gas	Makeup Gas	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.59	0.46				1.05
Carbon Monoxide - CO	4.97	9.03				14.00
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	1.01					1.01
Ethane - C_2H_6	0.32					0.32
Propane - C_3H_8	0.11					0.11
Butane - C_4H_{10}						
Nitrogen - N_2	0.09	0.10				0.19
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				22.04		22.04
Solvent - (100-230° C @ 1.6 Torr)				66.01		66.01
Heavy Oil - (230-255°C @ 1.6 Torr)				2.36		2.36
SRL						
Coal (MAF)			29.70			29.70
Ash			2.72			2.72
Water			16.02	0.39		16.41
Phenol						
TOTAL	7.09	9.59	48.44	90.80		155.92

Elemental

Carbon	3.23	3.87	21.56	79.64		108.30
Hydrogen	0.93	0.46	3.11	6.70		11.20
Nitrogen	0.09	0.10	0.28	0.26		0.73
Sulfur			0.27	1.25		1.52
Oxygen (by diff)	2.84	5.16	20.50	2.95		31.45
Ash			2.72			2.72
TOTAL	7.09	9.59	48.44	90.80		155.92

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MATERIAL OUT

lbs/hr.

Temperature: 741°F
Pressure: 2450 psig
LHSV: 1.48
GHSV: 309

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas →	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Quantitative	Hydrogen - H_2	0.34	0.59		0.07		
	Carbon Monoxide - CO	2.84	4.97		0.52		
	Carbon Dioxide - CO_2			7.49	2.57		
	Hydrogen Sulfide - H_2S			0.03	0.06		
	Methane - CH_4	0.58	1.01		0.22		
	Ethane - C_2H_6	0.18	0.32		0.20		
	Propane - C_3H_8	0.06	0.11		0.18		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.05	0.09		0.02		
	Ammonia - NH_3					0.02	
	Light Oil - (0-100° C @ 1.6 Torr)						
	Solvent - (100-230°C @ 1.6 Torr)						
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water					20.31	
	Phenol						
	TOTAL	4.05	7.09	7.52	3.84	20.33	Negl.
Elemental	Carbon	1.85	3.23	2.04	1.39		
	Hydrogen	0.53	0.93		0.20	2.26	
	Nitrogen	0.05	0.09		0.02	0.01	
	Sulfur			0.03	0.06		
	Oxygen (by diff)	1.62	2.84	5.45	2.17	18.06	
	Ash						
	TOTAL	4.05	7.09	7.52	3.84	20.33	Negl.

PROJECT LIGNITE

MEASURED MATERIAL BALANCE

Revised: 2/27/78

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

MATERIAL OUT

lbs/hr.

Temperature: 741°F
Pressure: 2450 psig
LHSV: 1.48
GHSV:309

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms
	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO						
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4						
	Ethane - C_2H_6						
	Propane - C_3H_8						
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	3.31		0.17		14.96	8.68
	Solvent - (100-230°C @ 1.6 Torr)	0.25				51.12	5.61
	Heavy Oil - (230-255°C @ 1.6 Torr)	0.10				2.02	0.27
	SRL				16.89		
	Coal (MAF)				4.92		
	Ash				2.65		
	Water			0.36		0.51	
	Phenol						
	TOTAL	3.66	NA	0.53	24.46	68.61	14.56
Elemental	Carbon	3.18		0.16	19.26	60.23	11.93
	Hydrogen	0.40		0.05	1.15	5.24	1.20
	Nitrogen	0.01			0.24	0.20	0.04
	Sulfur	0.02			0.21	0.90	0.09
	Oxygen (by diff)	0.05		0.32	0.95	2.04	1.30
	Ash				2.65		
	TOTAL	3.66	NA	0.53	24.46	68.61	14.56

NA - Not Available

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/27/78

MATERIAL OUT

Run No: L-2E
Date: 9/3-4/77
Time: 2200-1000

Temperature: 741°F
Pressure: 2450 psig
LHSV: 1.48
GHSV: 309

lbs/hr.

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.00
Carbon Monoxide - CO						8.33
Carbon Dioxide - CO_2						10.06
Hydrogen Sulfide - H_2S						0.09
Methane - CH_4						1.81
Ethane - C_2H_6						0.70
Propane - C_3H_8						0.35
Butane - C_4H_{10}						
Nitrogen - N_2						0.16
Ammonia - NH_3						0.02
Light Oil - (0-100° C @ 1.6 Torr)						27.12
Solvent - (100-230°C @ 1.6 Torr)						56.98
Heavy Oil - (230-255°C @ 1.6 Torr)						2.39
SRL						16.89
Coal (MAF)						4.92
Ash						2.65
Water						21.18
Phenol						
TOTAL						154.65

Elemental

Carbon						103.27
Hydrogen						11.96
Nitrogen						0.66
Sulfur						1.31
Oxygen (by diff)						34.80
Ash						2.65
TOTAL						154.65

RUN CONDITIONS

RUN NO. L-2F

DATE MADE 9/11-12/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 743
- INLET 309
- OUTLET 726

DISSOLVERS
- R-1A (1) NIU
- (2)
- (3)
- (4)
- R-1B (1) 747
- (2) 791
- (3) 818
- (4) 832

REACTOR PRODUCT SEPARATORS
- S-1 545
- S-2 84
- S-3 479
- S-4A 90
- S-4B 77

PREHEATER E-11
- DOWTHERM 686
- INLET 446
- OUTLET 643

VACUUM FLASH F-1
- OVERHEAD VAPOR 509
- UPPER WALL 618
- LOWER WALL 581
- DOWNCOMER 523
- CONDENSATE ACCUMULATOR, S-7 91

PREHEATER E-13
- DOWTHERM 408
- INLET 87
- OUTLET 185

LIGHT ENDS COLUMN, F-2
- REBOILER 275
- LOWER SECTION 215
- FEED SECTION 214
- OVERHEAD 171
- S-8 73
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-O
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2: 2460

SEPARATOR S-3: 240

SEPARATORS S-4A and S-4B: 60

VACUUM FLASH, F-1: 14 Torr

LIGHT ENDS COLUMN, F-2: Atm

SOLVENT COLUMN, F-3: NIU

HEAVY ENDS COLUMN, F-4: NIU

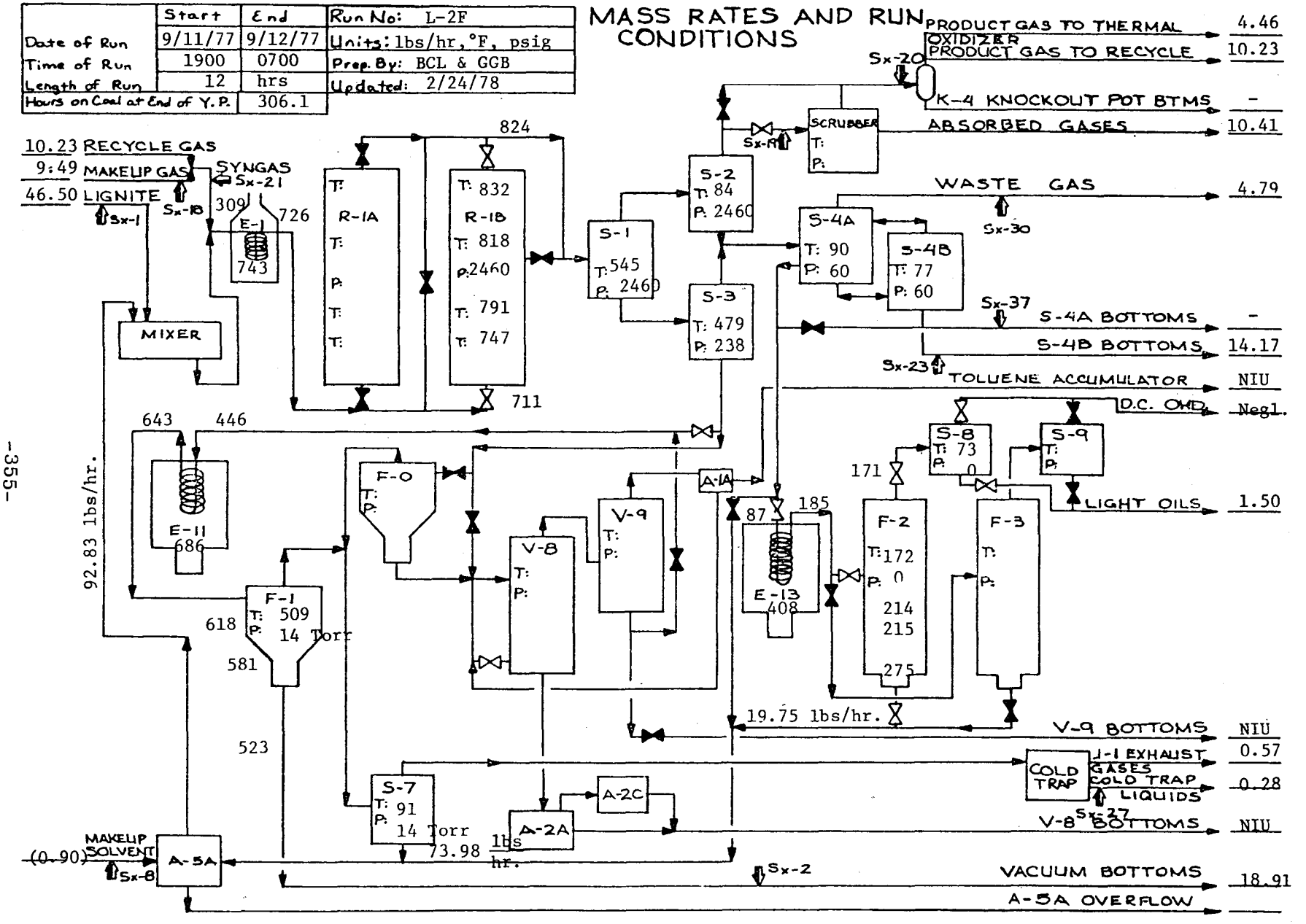
VACUUM FLASH, F-O: NIU

SETTLING TOWER, V-8: NIU

RECOVERY TOWER, V-7: NIU

	Start	End	Run No: L-2F
Date of Run	9/11/77	9/12/77	Units: lbs/hr, °F, psig
Time of Run	1900	0700	Prep. By: BCL & GGB
Length of Run	12	hrs	Updated: 2/24/78
Hours on Coal at End of Y.P.		306.1	

MASS RATES AND RUN CONDITIONS



PRODUCT GAS TO THERMAL	4.46
OXIDIZER PRODUCT GAS TO RECYCLE	10.23
K-4 KNOCKOUT POT BTMS	-
ABSORBED GASES	10.41
WASTE GAS	4.79
S-4A BOTTOMS	-
S-4B BOTTOMS	14.17
TOLUENE ACCUMULATOR	NIU
D.C. OIL	Negl.
LIGHT OILS	1.50
V-9 BOTTOMS	NIU
J-1 EXHAUST GASES	0.57
COLD TRAP LIQUIDS	0.28
V-8 BOTTOMS	NIU
VACUUM BOTTOMS	18.91
A-5A OVERFLOW	
159.05 TOTAL	TOTAL 159.05

⋈ OPEN ⋈ CLOSED

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2F
Date: 9/11- 12/77
Time: 1900-0700

SUMMARY
lbs/hr.

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

Quantitative

STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
SAMPLE POINT						
Hydrogen - H_2	1.38	1.09	-0.29			
Carbon Monoxide - CO	13.61	7.62	-5.99			
Carbon Dioxide - CO_2		13.20	13.20			
Hydrogen Sulfide - H_2S		0.32	0.32			
Methane - CH_4	3.05	4.99	1.94	10.76	38.26	
Ethane - C_2H_6	0.98	1.90	0.92			
Propane - C_3H_8	0.43	1.06	0.63			
Butane - C_4H_{10}						
Nitrogen - N_2	0.27	0.25	-0.02			
Ammonia - NH_3		0.05	0.05			
Light Oil - (0-100° C @ 1.6 Torr)	19.78	27.93	8.15			
Solvent - (100-230° C @ 1.6 Torr)	70.46	67.39	-3.07	16.53	58.78	
Heavy Oil - (230-255° C @ 1.6 Torr)	2.14	2.02	-0.12			
SRL		11.57	11.57			
Coal (MAF)	28.12	2.47	-25.65		-91.21	
Ash	2.89	2.49	-0.40		-1.42	
Water	15.94	14.70	-1.24		-4.41	
Phenol						
TOTAL	159.05	159.05	-0-			

Elemental

Carbon	110.67	110.42	-0.25			
Hydrogen	13.02	13.33	0.31			
Nitrogen	0.77	0.72	-0.05			
Sulfur	1.51	1.60	0.09			
Oxygen (by diff)	30.19	30.49	0.30			
Ash	2.89	2.49	-0.40			
TOTAL	159.05	159.05	-0-			

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MATERIAL IN
lbs/hr.

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

	STREAM DESCRIPTION	←Feed Gas Recycle Gas	Makeup Gas→	Lignite	Feed Solvent		Total In
	SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Quantitative	Hydrogen - H_2	0.71	0.67				1.38
	Carbon Monoxide - CO	4.90	8.71				13.61
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4	3.05					3.05
	Ethane - C_2H_6	0.98					0.98
	Propane - C_3H_8	0.43					0.43
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.16	0.11				0.27
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)				19.78		19.78
	Solvent - (100-230°C @ 1.6 Torr)				70.46		70.46
	Heavy Oil - (230-255°C @ 1.6 Torr)				2.14		2.14
	SRL						
	Coal (MAF)			28.12			28.12
	Ash			2.89			2.89
	Water			15.49	0.45		15.94
	Phenol						
	TOTAL	10.23	9.49	46.50	92.83		159.05

Elemental	Carbon	5.52	3.73	20.17	81.25		110.67
	Hydrogen	1.75	0.67	3.01	7.59		13.02
	Nitrogen	0.16	0.11	0.26	0.24		0.77
	Sulfur			0.29	1.22		1.51
	Oxygen (by diff)	2.80	4.98	19.88	2.53		30.19
	Ash			2.89			2.89
	TOTAL	10.23	9.49	46.50	92.83		159.05

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MATERIAL OUT

lbs/hr.

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc.	Sx-30	Sx-23	Sx-44
Quantitative	Hydrogen - H_2	0.31	0.71		0.07		
	Carbon Monoxide - CO	2.14	4.90		0.51		
	Carbon Dioxide - CO_2			10.16	2.77		
	Hydrogen Sulfide - H_2S			0.23	0.09		
	Methane - CH_4	1.33	3.05		0.57		
	Ethane - C_2H_6	0.43	0.98		0.41		
	Propane - C_3H_8	0.18	0.43		0.34		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.07	0.16		0.02		
	Ammonia - NH_3			0.02	0.01	0.02	
	Light Oil - (0-100° C @ 1.6 Torr)					0.26	
	Solvent - (100-230°C @ 1.6 Torr)					0.08	
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Cool (MAF)						
	Ash						
	Water					13.81	
	Phenol						
	TOTAL	4.46	10.23	10.41	4.79	14.17	Negl.
Elemental	Carbon	2.41	5.52	2.77	2.01	0.28	
	Hydrogen	0.76	1.75	0.02	0.37	1.57	
	Nitrogen	0.07	0.16	0.02	0.03	0.02	
	Sulfur			0.21	0.08		
	Oxygen (by diff)	1.22	2.80	7.39	2.30	12.30	
	Ash						
	TOTAL	4.46	10.23	10.41	4.79	14.17	Negl.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MATERIAL OUT
lbs/hr.

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	LEC Btms
	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO		0.07				
	Carbon Dioxide - CO_2		0.27				
	Hydrogen Sulfide - H_2S						
	Methane - CH_4		0.04				
	Ethane - C_2H_6		0.08				
	Propane - C_3H_8		0.11				
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	1.21		0.13		13.18	13.15
	Solvent - (100-230°C @ 1.6 Torr)	0.02			2.38	58.41	6.50
	Heavy Oil - (230-255°C @ 1.6 Torr)					1.92	0.10
	SRL				11.57		
	Coal (MAF)				2.47		
	Ash				2.49		
	Water	0.27		0.15		0.47	
	Phenol						
	TOTAL	1.50	0.57	0.28	18.91	73.98	19.75
Elemental	Carbon	1.02	0.28	0.08	14.56	64.88	16.61
	Hydrogen	0.18	0.05	0.03	0.90	5.87	1.83
	Nitrogen				0.18	0.19	0.05
	Sulfur				0.21	1.01	0.09
	Oxygen (by diff)	0.30	0.24	0.17	0.57	2.03	1.17
	Ash				2.49		
	TOTAL	1.50	0.57	0.28	18.91	73.98	19.75

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MATERIAL OUT

lbs/hr.

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.09
Carbon Monoxide - CO						7.62
Carbon Dioxide - CO_2						13.20
Hydrogen Sulfide - H_2S						0.32
Methane - CH_4						4.99
Ethane - C_2H_6						1.90
Propane - C_3H_8						1.06
Butane - C_4H_{10}						
Nitrogen - N_2						0.25
Ammonia - NH_3						0.05
Light Oil - (0-100° C @ 1.6 Torr)						27.93
Solvent - (100-230° C @ 1.6 Torr)						67.39
Heavy Oil - (230-255°C @ 1.6 Torr)						2.02
SRL						11.57
Coal (MAF)						2.47
Ash						2.49
Water						14.70
Phenol						
TOTAL						159.05

Elemental

Carbon						110.42
Hydrogen						13.33
Nitrogen						0.72
Sulfur						1.60
Oxygen (by diff)						30.49
Ash						2.49
TOTAL						159.05

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	LEC Btms	Feed Solvent	S-8 Water	S-8 Oil
	SAMPLE POINT	Sx-1	*Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			66.60	21.31		98.40
	Solvent – (100-230°C @ 1.6 Torr)		12.57	32.90	75.90		1.60
	Heavy Oil – (230-255°C @ 1.6 Torr)			0.50	2.30		
	SRL		61.19				
	Coal (MAF)	60.47	13.08				
	Ash	6.22	13.16				
	Water	33.31			0.49	100	
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		84.94				
	Melting Point °F		330				
	Specific Gravity 60/60			0.959	1.030		
	Viscosity, cp						
Elemental	Carbon	43.37	77.00	84.09	87.52		82.84
	Hydrogen	6.47	4.75	9.28	8.18	11.11	12.18
	Nitrogen	0.56	0.97	0.24	0.26		0.10
	Sulfur	0.63	1.10	0.46	1.31		0.18
	Oxygen (by diff)	42.75	3.02	5.93	2.73	88.89	4.70
	Ash	6.22	13.16				
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	4	2	2	2	2

*Distillable oil calculated by following equation: Wt % Distillable oil = -0.1273 (F-1 Btms melting point) + 54.38. See attached graph.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4B Water
Quantitative	SAMPLE POINT	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21	Sx-23
	Hydrogen – H_2		7.10	4.10	6.95	6.11	
	Carbon Monoxide – CO		91.74	27.25	47.93	69.54	
	Carbon Dioxide – CO_2			41.18			
	Hydrogen Sulfide – H_2S			0.91			
	Methane – CH_4			17.28	29.79	15.27	
	Ethane – C_2H_6			5.62	9.61	4.77	
	Propane – C_3H_8			2.82	4.14	2.98	
	Butane – C_4H_{10}						
	Nitrogen – N_2		1.16	0.75	1.58	1.33	
	Ammonia – NH_3 (PPM)			0.09			0.13
	Light Oils – (0-100° C @ 1.6 Torr)	80.69					
	Solvent – (100-230°C @ 1.6 Torr)	1.31					
	Heavy Oil – (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water	18.00					99.87
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon	67.93	39.32	42.68	53.96	47.51	
	Hydrogen	11.99	7.10	10.12	17.07	11.42	11.12
	Nitrogen	0.08	1.16	0.82	1.58	1.33	0.11
	Sulfur	0.15		0.86			
	Oxygen (by diff)	19.85	52.42	45.52	27.39	39.74	88.77
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

WEIGHT PERCENT

SAMPLE DESCRIPTION	S-4B Oil	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	S-7 Btms
SAMPLE POINT	*Sx-23	Sx-23	Sx-30	Sx-32	Sx-33	Sx-34/39
Hydrogen – H_2			1.53	0.44		
Carbon Monoxide – CO			10.55	12.22		
Carbon Dioxide – CO_2			57.79	48.03		
Hydrogen Sulfide – H_2S			1.90			
Methane – CH_4			11.97	6.99		
Ethane – C_2H_6			8.51	13.10		
Propane – C_3H_8			7.14	19.22		
Butane – C_4H_{10}						
Nitrogen – N_2			0.42			
Ammonia – NH_3 (PPM)		0.13	0.19			
Light Oils – (0-100° C @ 1.6 Torr)	76.12	1.83			47.66	17.81
Solvent – (100-230°C @ 1.6 Torr)	23.00	0.55				78.95
Heavy Oil – (230-255°C @1.6 Torr)						2.60
SRL						
Coal (MAF)						
Ash						
Water	0.88	97.49			52.34	0.64
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60	0.935					1.036
Viscosity, cp						

Quantitative

Carbon	81.65	1.96	41.91	49.79	28.11	87.70
Hydrogen	9.42	11.08	7.66	8.30	10.09	7.94
Nitrogen	0.20	0.11	0.58		0.05	0.26
Sulfur	0.40	0.01	1.79		0.45	1.36
Oxygen (by diff)	8.33	86.84	48.06	41.91	61.30	2.74
Ash						
TOTAL	100	100	100	100	100	100
Number of Sample Avg.	2	2	2	2	1	4

Elemental

*Insufficient oil sample. Analysis assumed to be the same as the S-4A oil

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Water	S-4A Oil	S-4A Total	S-7 Btms	Absorbed Gas	
	SAMPLE POINT	Sx-37	Sx-37	Sx-37	Sx-34/39	Calc.	
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2					97.63	
	Hydrogen Sulfide – H_2S					2.15	
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.10				0.22	
	Light Oils – (0-100° C @ 1.6 Torr)		76.12	75.83	17.81		
	Solvent – (100-230°C @ 1.6 Torr)		23.00	22.91	78.95		
	Heavy Oil – (230-255°C @1.6 Torr)				2.60		
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.90	0.88	1.26	0.64		
	Phenol						
	TOTAL	100	100	100	100	100	
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60		0.935		1.036		
	Viscosity, cp						
Elemental	Carbon		81.65	81.34	87.70	26.63	
	Hydrogen	11.12	9.42	9.42	7.94	0.17	
	Nitrogen	0.08	0.20	0.20	0.26	0.18	
	Sulfur		0.40	0.40	1.36	2.02	
	Oxygen (by diff)	88.80	8.33	8.64	2.74	71.00	
	Ash						
	TOTAL	100	100	100	100	100	
	Number of Sample Avg.	2	2	2	2	-	

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MOLE PERCENT

SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Discharge
SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
Hydrogen – H_2	51.70	38.30	46.22	45.15	20.50	7.14
Carbon Monoxide – CO	47.70	18.20	22.76	36.70	10.10	14.28
Carbon Dioxide – CO_2		17.50			35.20	35.71
Hydrogen Sulfide – H_2S		0.50			1.50	
Methane – CH_4		20.20	24.76	14.10	20.05	14.29
Ethane – C_2H_6		3.50	4.26	2.35	7.60	14.29
Propane – C_3H_8		1.20	1.25	1.00	4.35	14.29
Butane – C_4H_{10}						
Nitrogen – N_2	0.60	0.50	0.75	0.70	0.40	
Ammonia – NH_3 (PPM)		0.10			0.30	
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100	100	100
Calc. Mole Wt.	14.56	18.70	13.30	14.78	26.80	32.71
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

Elemental

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Absorbed Gas					
SAMPLE POINT	Calc					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	96.69					
Hydrogen Sulfide – H_2S	2.76					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.55					
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc Mole Wt	43.58					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.						

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2F
DATE: 9/11-12/77
TIME: 1900-0700

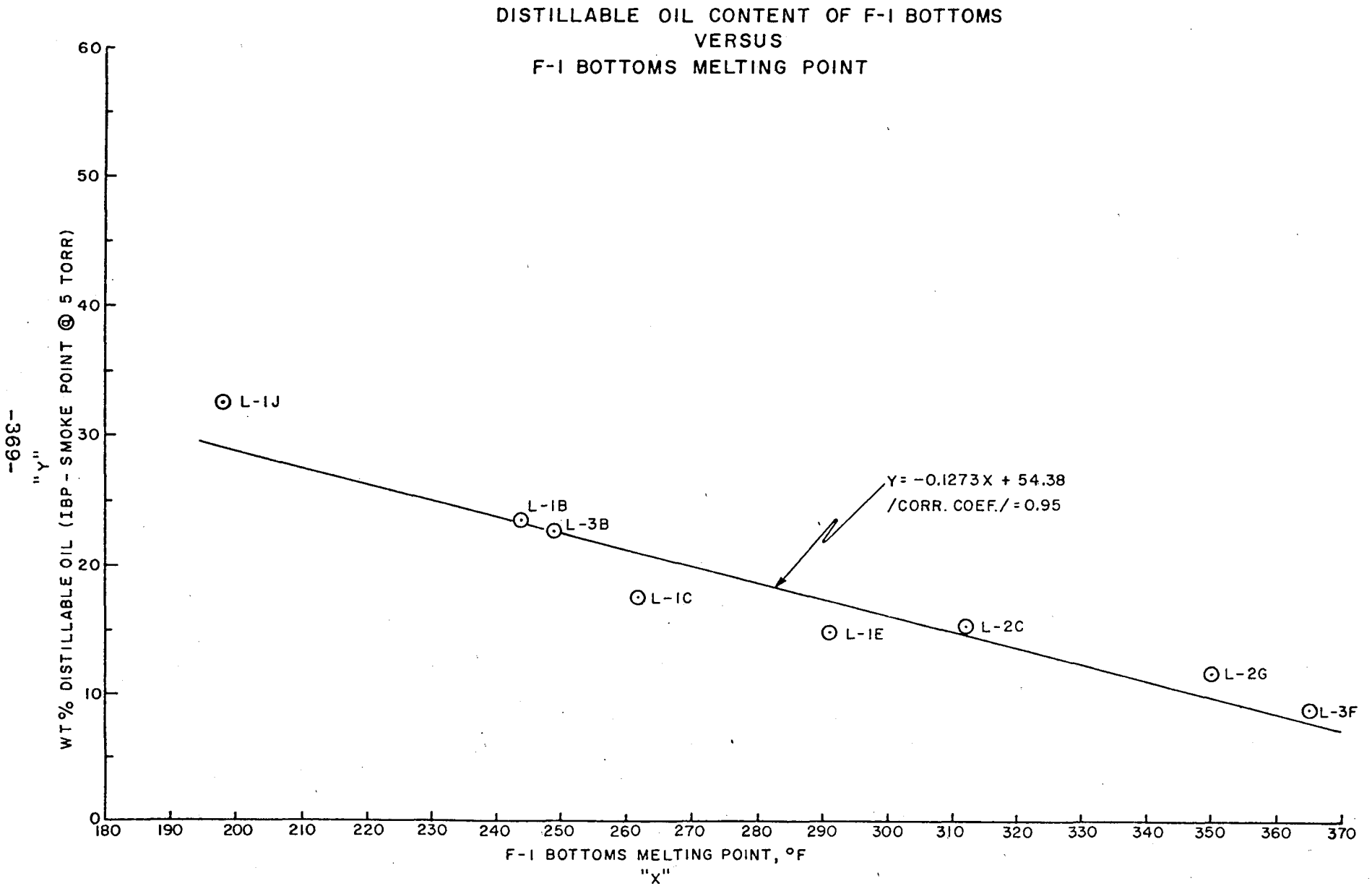
SAMPLE DESCRIPTION	F-1 Btms	LEC Btms	Feed Solv	S-8 Oil	S-7 Btms
SAMPLE POINT	Sx-2	Sx-12	Sx-14	Sx-16	Sx-34/39
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5		5
VOLUME PERCENT / TEMPERATURE, °C — IBP		24.2	41.5		54
5%		51.6	76.5		85.6
10%		62.0	90.0		98.2
20%		71.5	116.		139.2
30%		78.8	146.3		159.4
40%		88.8	166		173.6
50%		98.2	176		181.6
60%		112.0	183		187.8
70%		128.8	189		191.2
80%		157.8	197		202.4
90%		180.6	217		226.2
95%		194.6	249		260
DRY PT.		195.3	254		260
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR				741	
VOLUME PERCENT / TEMPERATURE, °C — IBP				45	
5%				52	
10%				57	
20%				64	
30%				72	
40%				80	
50%				88	
60%				97	
70%				107	
80%				121	
90%				129	
95%					
DRY PT.				132	
ASPHALTENE TEST					
WT % ASH	13.16				
WT % UNCONVERTED COAL	13.08				
WT % PRE-ASPHALTENES	26.96				
WT % ASPHALTENES	22.10				
WT % MALTENES & DIST. OIL	24.70				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		8.9	11.8		11.8
210° F		8.2	8.5		8.7
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)			0.49		0.64
INFRARED RATIO		0.16	0.29		0.30
SP. GRAV. 60/60 F		0.959	1.030		1.036

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2F
DATE: 9/11-12/77
TIME: 1900-0700

SAMPLE DESCRIPTION	S-4A Oil				
SAMPLE POINT	Sx-37				
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR					
IBP					
5%					
10%					
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
95%					
DRY PT.					
VOLUME PERCENT / TEMPERATURE, °C					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	741				
IBP	80				
5%	89				
10%	149				
20%	179				
30%	192				
40%	206				
50%	219				
60%	239				
70%	261				
80%	302				
90%					
95%					
DRY PT.	320				
VOLUME PERCENT / TEMPERATURE, °C					
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)	0.88				
INFRARED RATIO					
SP. GRAV. 60/60 F	0.935				

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.


DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT
WT% DISTILLABLE OIL (IBP - SMOKE POINT @ 5 TORR)
"Y"
F-1 BOTTOMS MELTING POINT, °F
"X"
Y = -0.1273X + 54.38
/CORR. COEF./ = 0.95
L-1J
L-1B
L-3B
L-1C
L-1E
L-2C
L-2G
L-3F
0
10
20
30
40
50
60
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370

PROJECT LIGNITE

MEASURED MATERIAL BALANCE

Revised: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MATERIAL IN

lbs/hr.

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

Quantitative

STREAM DESCRIPTION	←Feed Gas Recycle Gas	Gas→ Makeup Gas	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.59	0.79				1.38
Carbon Monoxide - CO	4.09	10.27				14.36
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	2.54					2.54
Ethane - C_2H_6	0.82					0.82
Propane - C_3H_8	0.36					0.36
Butane - C_4H_{10}						
Nitrogen - N_2	0.13	0.13				0.26
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				19.78		19.78
Solvent - (100-230°C @ 1.6 Torr)				70.46		70.46
Heavy Oil - (230-255°C @ 1.6 Torr)				2.14		2.14
SRL						
Coal (MAF)			28.12			28.12
Ash			2.89			2.89
Water			15.49	0.45		15.94
Phenol						
TOTAL	8.53	11.19	46.50	92.83		159.05

Elemental

Carbon	4.60	4.40	20.17	81.25		110.42
Hydrogen	1.46	0.79	3.01	7.59		12.85
Nitrogen	0.13	0.13	0.26	0.24		0.76
Sulfur			0.29	1.22		1.51
Oxygen (by diff)	2.34	5.87	19.88	2.53		30.62
Ash			2.89			2.89
TOTAL	8.53	11.19	46.50	92.83		159.05

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MATERIAL OUT

lbs/hr.

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Quantitative	Hydrogen - H_2	0.21	0.59		0.07		
	Carbon Monoxide - CO	1.44	4.09		0.51		
	Carbon Dioxide - CO_2			8.08	2.77		
	Hydrogen Sulfide - H_2S			0.18	0.09		
	Methane - CH_4	0.90	2.54		0.57		
	Ethane - C_2H_6	0.29	0.82		0.41		
	Propane - C_3H_8	0.12	0.36		0.34		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.05	0.13		0.02		
	Ammonia - NH_3			0.02	0.01	0.02	
	Light Oil - (0-100° C @ 1.6 Torr)					0.26	
	Solvent - (100-230°C @ 1.6 Torr)					0.08	
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water					13.81	
	Phenol						
	TOTAL	3.01	8.53	8.28	4.79	14.17	Negl.
Elemental	Carbon	1.62	4.60	2.20	2.01	0.28	
	Hydrogen	0.51	1.46	0.01	0.37	1.57	
	Nitrogen	0.05	0.13	0.02	0.03	0.02	
	Sulfur			0.17	0.08		
	Oxygen (by diff)	0.83	2.34	5.88	2.30	12.30	
	Ash						
	TOTAL	3.01	8.53	8.28	4.79	14.17	Negl.

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/24/78

MATERIAL OUT

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

lbs/hr.

Quantitative

STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	LEC Btms
SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Hydrogen - H_2						
Carbon Monoxide - CO		0.07				
Carbon Dioxide - CO_2		0.27				
Hydrogen Sulfide - H_2S						
Methane - CH_4		0.04				
Ethane - C_2H_6		0.08				
Propane - C_3H_8		0.11				
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)	1.21		0.13		13.18	13.15
Solvent - (100-230° C @ 1.6 Torr)	0.02			2.38	58.41	6.50
Heavy Oil - (230-255°C @ 1.6 Torr)					1.92	0.10
SRL				11.57		
Cool (MAF)				2.47		
Ash				2.49		
Water	0.27		0.15		0.47	
Phenol						
TOTAL	1.50	0.57	0.28	18.91	73.98	19.75

Elemental

Carbon	1.02	0.28	0.08	14.56	64.88	16.61
Hydrogen	0.18	0.05	0.03	0.90	5.87	1.83
Nitrogen				0.18	0.19	0.05
Sulfur				0.21	1.01	0.09
Oxygen (by diff)	0.30	0.24	0.17	0.57	2.03	1.17
Ash				2.49		
TOTAL	1.50	0.57	0.28	18.91	73.98	19.75

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/24/78

Run No: L-2F
Date: 9/11-12/77
Time: 1900-0700

MATERIAL OUT

lbs/hr.

Temperature: 726°F
Pressure: 2460 psig
LHSV: 1.41
GHSV: 354

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						0.87
Carbon Monoxide - CO						6.11
Carbon Dioxide - CO_2						11.12
Hydrogen Sulfide - H_2S						0.27
Methane - CH_4						4.05
Ethane - C_2H_6						1.60
Propane - C_3H_8						0.93
Butane - C_4H_{10}						
Nitrogen - N_2						0.20
Ammonia - NH_3						0.05
Light Oil - (0-100° C @ 1.6 Torr)						27.93
Solvent - (100-230°C @ 1.6 Torr)						67.39
Heavy Oil - (230-255°C @ 1.6 Torr)						2.02
SRL						11.57
Coal (MAF)						2.47
Ash						2.49
Water						14.70
Phenol						
TOTAL						153.77

Elemental

Carbon						108.14
Hydrogen						12.78
Nitrogen						0.67
Sulfur						1.56
Oxygen (by diff)						28.13
Ash						2.49
TOTAL						153.77

RUN CONDITIONS

RUN NO. L-2G
DATE MADE 9/12/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 740
- INLET 305
- OUTLET 721

DISSOLVERS
- R-1A (1) NIU
- (2)
- (3)
- (4)
- R-1B (1) 745
- (2) 788
- (3) 824
- (4) 829

REACTOR PRODUCT SEPARATORS
- S-1 548
- S-2 88
- S-3 507
- S-4A 94
- S-4B 81

PREHEATER E-11
- DOWTHERM 685
- INLET 446
- OUTLET 646

VACUUM FLASH F-1
- OVERHEAD VAPOR 505
- UPPER WALL 620
- LOWER WALL 584
- DOWNCOMER 528
- CONDENSATE ACCUMULATOR, S-7 97

PREHEATER E-13
- DOWTHERM 408
- INLET 91
- OUTLET 178

LIGHT ENDS COLUMN, F-2
- REBOILER 282
- LOWER SECTION 215
- FEED SECTION 216
- OVERHEAD 176
- S-8 77
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

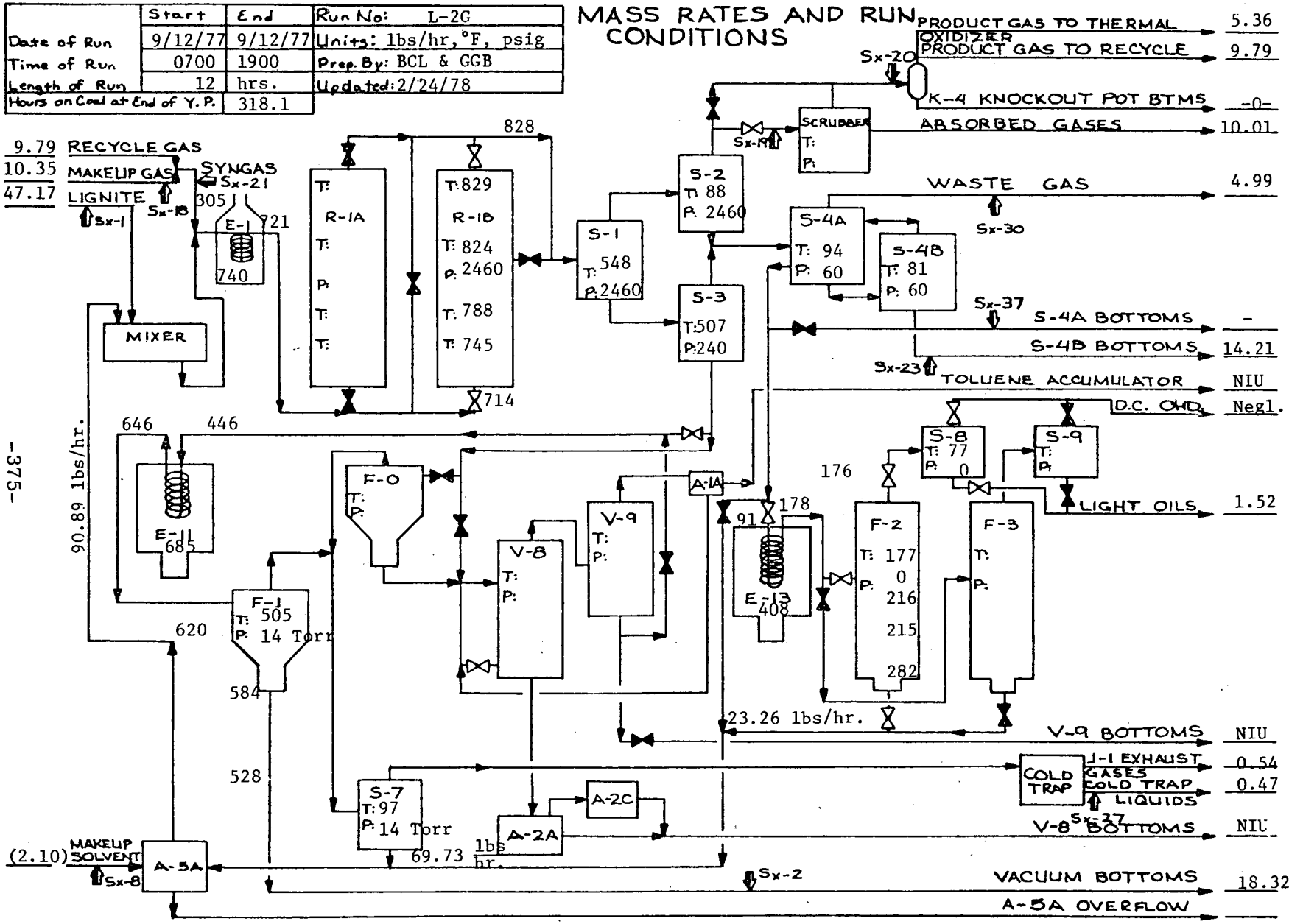
RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

- SEPARATORS S-1 and S-2: 2460
- SEPARATOR S-3: 240
- SEPARATORS S-4A and S-4B: 60
- VACUUM FLASH, F-1: 14 Torr
- LIGHT ENDS COLUMN, F-2: Atm
- SOLVENT COLUMN, F-3: NIU
- HEAVY ENDS COLUMN, F-4: NIU
- VACUUM FLASH, F-0: NIU
- SETTLING TOWER, V-8: NIU
- RECOVERY TOWER, V-7: NIU

	Start	End	Run No: L-2G
Date of Run	9/12/77	9/12/77	Units: lbs/hr, °F, psig
Time of Run	0700	1900	Prep. By: BCL & GGB
Length of Run	12	hrs.	Updated: 2/24/78
Hours on Coal at End of Y.P.		318.1	

MASS RATES AND RUN CONDITIONS



158.20 TOTAL ⋈ OPEN ⋈ CLOSED TOTAL 158.20

Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

SUMMARY

lbs/hr.

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
Quantitative	SAMPLE POINT						
	Hydrogen - H_2	1.50	1.01	-0.49			
	Carbon Monoxide - CO	14.40	8.78	-5.62			
	Carbon Dioxide - CO_2		12.83	12.83			
	Hydrogen Sulfide - H_2S		0.37	0.37			
	Methane - CH_4	2.66	4.66	2.00			
	Ethane - C_2H_6	0.86	1.76	0.90	10.57	36.74	
	Propane - C_3H_8	0.40	0.93	0.53			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.32	0.31	-0.01			
	Ammonia - NH_3		0.06	0.06			
	Light Oil - (0-100° C @ 1.6 Torr)	24.14	34.14	10.00			
	Solvent - (100-230° C @ 1.6 Torr)	64.54	60.85	-3.69	17.72	61.59	
	Heavy Oil - (230-255°C @ 1.6 Torr)	1.79	1.99	0.20			
	SRL		11.21	11.21			
	Coal (MAF)	28.77	2.40	-26.37		-91.65	
	Ash	2.85	2.41	-0.44		-1.53	
	Water	15.97	14.49	-1.48		-5.15	
	Phenol						
	TOTAL	158.20	158.20	-0-			
Elemental	Carbon	108.47	108.55	0.08			
	Hydrogen	13.36	13.23	-0.13			
	Nitrogen	0.85	0.82	-0.03			
	Sulfur	1.30	1.49	0.19			
	Oxygen (by diff)	31.37	31.70	0.33			
	Ash	2.85	2.41	-0.44			
	TOTAL	158.20	158.20	-0-			

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MATERIAL IN
lbs/hr.

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

	STREAM DESCRIPTION	← Feed Gas Recycle Gas	Gas → Makeup Gas	Lignite	Feed Solvent		Total In.
	SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Quantitative	Hydrogen - H_2	0.60	0.90				1.50
	Carbon Monoxide - CO	5.09	9.31				14.40
	Carbon Dioxide - CO_2						
	Hydrogen Sulfide - H_2S						
	Methane - CH_4	2.66					2.66
	Ethane - C_2H_6	0.86					0.86
	Propane - C_3H_8	0.40					0.40
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.18	0.14				0.32
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)				24.14		24.14
	Solvent - (100-230°C @ 1.6 Torr)				64.54		64.54
	Heavy Oil - (230-255°C @ 1.6 Torr)				1.79		1.79
	SRL						
	Coal (MAF)			28.77			28.77
	Ash			2.85			2.85
	Water			15.55	0.42		15.97
	Phenol						
	TOTAL	9.79	10.35	47.17	90.89		158.20
Elemental	Carbon	5.19	3.99	20.25	79.04		108.47
	Hydrogen	1.51	0.90	3.09	7.86		13.36
	Nitrogen	0.18	0.14	0.26	0.27		0.85
	Sulfur			0.29	1.01		1.30
	Oxygen (by diff)	2.91	5.32	20.43	2.71		31.37
	Ash			2.85			2.85
	TOTAL	9.79	10.35	47.17	90.89		158.20

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MATERIAL OUT
lbs/hr.

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Quantitative	Hydrogen - H_2	0.33	0.60		0.08		
	Carbon Monoxide - CO	2.79	5.09		0.77		
	Carbon Dioxide - CO_2			9.72	2.82		
	Hydrogen Sulfide - H_2S			0.25	0.12		
	Methane - CH_4	1.45	2.66		0.52		
	Ethane - C_2H_6	0.47	0.86		0.37		
	Propane - C_3H_8	0.22	0.40		0.28		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.10	0.18		0.03		
	Ammonia - NH_3			0.04		0.02	
	Light Oil - (0-100° C @ 1.6 Torr)						
	Solvent - (100-230° C @ 1.6 Torr)						
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water					14.19	
	Phenol						
	TOTAL	5.36	9.79	10.01	4.99	14.21	Negl.
Elemental	Carbon	2.84	5.19	2.65	2.02		
	Hydrogen	0.83	1.51	0.02	0.34	1.58	
	Nitrogen	0.10	0.18	0.04	0.03	0.02	
	Sulfur			0.23	0.11		
	Oxygen (by diff)	1.59	2.91	7.07	2.49	12.61	
	Ash						
	TOTAL	5.36	9.79	10.01	4.99	14.21	Negl.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MATERIAL OUT
lbs/hr.

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ F-2 Btms
Quantitative	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
	Hydrogen - H_2						
	Carbon Monoxide - CO		0.13				
	Carbon Dioxide - CO_2		0.29				
	Hydrogen Sulfide - H_2S						
	Methane - CH_4		0.03				
	Ethane - C_2H_6		0.06				
	Propane - C_3H_8		0.03				
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	1.50		0.44		16.15	16.05
	Solvent - (100-230° C @ 1.6 Torr)	0.02			2.30	51.32	7.21
	Heavy Oil - (230-255°C @ 1.6 Torr)					1.99	
	SRL				11.21		
	Coal (MAF)				2.40		
	Ash				2.41		
	Water			0.03		0.27	
	Phenol						
	TOTAL	1.52	0.54	0.47	18.32	69.73	23.26
Elemental	Carbon	1.21	0.23	0.37	14.11	60.25	19.68
	Hydrogen	0.20	0.03	0.04	0.87	5.63	2.18
	Nitrogen				0.18	0.21	0.06
	Sulfur				0.20	0.86	0.09
	Oxygen (by diff)	0.11	0.28	0.06	0.55	2.78	1.25
	Ash				2.41		
	TOTAL	1.52	0.54	0.47	18.32	69.73	23.26

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product & Recycle Gas Rates Adjusted
Revised: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MATERIAL OUT
lbs/hr.

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.01
Carbon Monoxide - CO						8.78
Carbon Dioxide - CO_2						12.83
Hydrogen Sulfide - H_2S						0.37
Methane - CH_4						4.66
Ethane - C_2H_6						1.76
Propane - C_3H_8						0.93
Butane - C_4H_{10}						
Nitrogen - N_2						0.31
Ammonia - NH_3						0.06
Light Oil - (0-100° C @ 1.6 Torr)						34.14
Solvent - (100-230°C @ 1.6 Torr)						60.85
Heavy Oil - (230-255°C @ 1.6 Torr)						1.99
SRL						11.21
Coal (MAF)						2.40
Ash						2.41
Water						14.49
Phenol						
TOTAL						158.20

Elemental

Carbon						108.55
Hydrogen						13.23
Nitrogen						0.82
Sulfur						1.49
Oxygen (by diff)						31.70
Ash						2.41
TOTAL						158.20

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	LEC Btms	Feed Solvent	S-8 Water	S-8 Oil
	SAMPLE POINT	Sx-1	Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			69.00	26.56		98.40
	Solvent – (100-230° C @ 1.6 Torr)		12.57	31.00	71.01		1.60
	Heavy Oil – (230-255° C @ 1.6 Torr)				1.97		
	SRL		61.19				
	Coal (MAF)	60.99	13.08				
	Ash	6.05	13.16				
	Water	32.96			0.46	100	
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		84.94				
	Melting Point °F		330				
	Specific Gravity 60/60			0.960	1.027		
	Viscosity, cp						
Elemental	Carbon	42.93	77.00	84.60	86.96		79.45
	Hydrogen	6.55	4.75	9.38	8.65	11.11	12.94
	Nitrogen	0.55	0.97	0.28	0.30		0.01
	Sulfur	0.62	1.10	0.38	1.11		0.20
	Oxygen (by diff)	43.30	3.02	5.36	2.98	88.89	7.40
	Ash	6.05	13.16				
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	4	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4B Water
Quantitative	SAMPLE POINT	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21	Sx-23
	Hydrogen – H_2		8.65	4.09	6.16	6.05	
	Carbon Monoxide – CO		89.97	27.05	52.03	72.51	
	Carbon Dioxide – CO_2			42.39			
	Hydrogen Sulfide – H_2S			1.08			
	Methane – CH_4			16.31	27.13	13.08	
	Ethane – C_2H_6			5.34	8.80	4.34	
	Propane – C_3H_8			2.45	4.08	2.18	
	Butane – C_4H_{10}						
	Nitrogen – N_2		1.38	1.11	1.80	1.84	
	Ammonia – NH_3 (PPM)			0.18			0.15
	Light Oils – (0-100° C @ 1.6 Torr)	98.40					
	Solvent – (100-230°C @ 1.6 Torr)	1.60					
	Heavy Oil – (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water						99.85
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						
	Viscosity, cp						
Elemental	Carbon	79.45	38.56	41.65	53.03	46.14	
	Hydrogen	12.94	8.65	9.78	15.44	10.59	11.12
	Nitrogen	0.01	1.38	1.11	1.80	1.84	0.12
	Sulfur	0.20		1.17			
	Oxygen (by diff)	7.40	51.41	46.29	29.73	41.43	88.76
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

WEIGHT PERCENT

SAMPLE DESCRIPTION	S-4B Oil	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	S-7 Btms
SAMPLE POINT	*Sx-23	Sx-23	Sx-30	Sx-32	Sx-33	Sx-34/39
Hydrogen – H_2			1.52	0.90		
Carbon Monoxide – CO			15.37	23.92		
Carbon Dioxide – CO_2			56.50	53.51		
Hydrogen Sulfide – H_2S			2.41			
Methane – CH_4			10.48	5.10		
Ethane – C_2H_6			7.48	10.20		
Propane – C_3H_8			5.57	6.37		
Butane – C_4H_{10}						
Nitrogen – N_2			0.57			
Ammonia – NH_3 (PPM)		0.15	0.10			
Light Oils – (0-100° C @ 1.6 Torr)	77.93				93.98	23.16
Solvent – (100-230°C @ 1.6 Torr)	21.30					73.60
Heavy Oil – (230-255°C @ 1.6 Torr)						2.85
SRL						
Coal (MAF)						
Ash						
Water	0.77	99.85			6.02	0.39
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60	0.938					1.039
Viscosity, cp						

Quantitative

Carbon	83.82		40.40	42.03	78.14	86.40
Hydrogen	10.03	11.12	6.81	5.38	8.52	8.08
Nitrogen	0.22	0.12	0.65		0.30	0.30
Sulfur	0.42		2.27		0.18	1.24
Oxygen (by diff)	5.51	88.76	49.87	52.59	12.86	3.98
Ash						
TOTAL	100	100	100	100	100	100
Number of Sample Avg.	2	2	2	2	2	2

Elemental

*Insufficient sample available. Assumed to be the same as the S-4A oil.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Water	S-4A Oil	S-4A Total	S-7 Btms	Absorbed Gas	
	SAMPLE POINT	Sx-37	Sx-37	Sx-37	Sx-34/39	Calc.	
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2					97.11	
	Hydrogen Sulfide – H_2S					2.48	
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.14		0.01		0.41	
	Light Oils – (0-100° C @ 1.6 Torr)		77.93	73.29	23.16		
	Solvent – (100-230°C @ 1.6 Torr)		21.30	20.03	73.60		
	Heavy Oil – (230-255°C @ 1.6 Torr)				2.85		
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.86	0.77	6.67	0.39		
	Phenol						
	TOTAL	100	100	100	100	100	
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60		0.938		1.039		
	Viscosity, cp						
Elemental	Carbon		83.82	78.82	86.40	26.48	
	Hydrogen	11.11	10.03	10.09	8.08	0.22	
	Nitrogen	0.12	0.22	0.22	0.30	0.34	
	Sulfur		0.42	0.40	1.24	2.33	
	Oxygen (by diff)	88.77	5.51	10.47	3.98	70.63	
	Ash						
	TOTAL	100	100	100	100	100	
	Number of Sample Avg.	2	2	2	2	-	

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MOLE PERCENT

SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Discharge
SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
Hydrogen – H_2	57.00	38.50	43.46	45.22	20.45	13.61
Carbon Monoxide – CO	42.35	18.20	26.24	38.69	14.75	25.68
Carbon Dioxide – CO_2		18.15			34.50	36.56
Hydrogen Sulfide – H_2S		0.60			1.90	
Methane – CH_4		19.20	23.94	12.21	17.60	9.58
Ethane – C_2H_6		3.35	4.14	2.16	6.70	10.22
Propane – C_3H_8		1.05	1.31	0.74	3.40	4.35
Butane – C_4H_{10}						
Nitrogen – N_2	0.65	0.75	0.91	0.98	0.55	
Ammonia – NH_3 (PPM)		0.20			0.15	
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100	100	100
Calc. Mole Wt.	13.18	18.84	14.12	14.94	26.87	30.06
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	3	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Absorbed Gas					
SAMPLE POINT	Calc.					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	95.78					
Hydrogen Sulfide – H_2S	3.17					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	1.05					
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc Mole Wt.	43.40					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.						

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2G
DATE: 9/12/77
TIME: 0700-1900

SAMPLE DESCRIPTION	F-1 Btms	LEC Btms	Feed Solv.	S-8 Btms	S-7 Btms
SAMPLE POINT	Sx-2	Sx-12	Sx-14	Sx-16	Sx-34/39
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5		5
IBP		32.4	40.8		52.5
5%		47.2	75.4		67.3
10%		59.4	85.8		89.6
20%		71.3	105.4		114.2
30%		78.8	129.2		140
40%		86.2	155.2		166.6
50%		95.4	172.2		174.4
60%		107.8	179.5		181.8
70%		125.5	187.8		189.9
80%		152.8	198.2		200.6
90%		180.4	224		226.3
95%		199.2	259.6		260
DRY PT.		199.2			260
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR				732	
IBP				48	
5%				58	
10%				63	
20%				71	
30%				81	
40%				91	
50%				98	
60%				108	
70%				116	
80%				128	
90%				138	
95%					
DRY PT.				147	
ASPHALTENE TEST					
WT % ASH	13.16				
WT % UNCONVERTED COAL	13.08				
WT % PRE-ASPHALTENES	26.96				
WT % ASPHALTENES	22.10				
WT % MALTENES & DIST. OIL	24.70				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		8.7	11.4		11.9
210° F		7.9	8.8		8.6
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)			0.46		0.39
INFRARED RATIO		0.22	0.28		0.31
SP. GRAV. 60/60 F		0.960	1.027		1.040

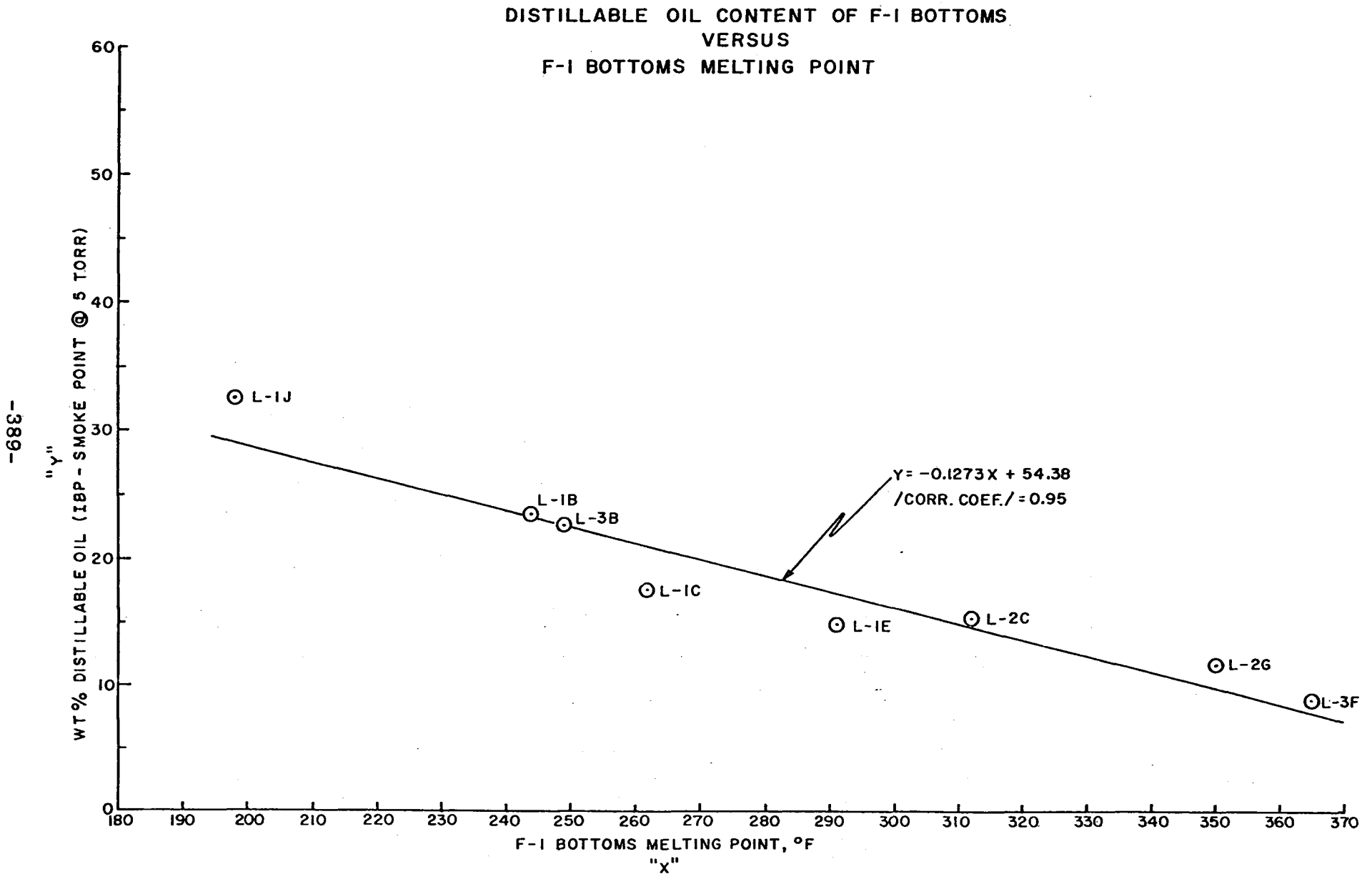
VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2G
DATE: 9/12/77
TIME: 0700-1900

SAMPLE DESCRIPTION	S-4A Oil				
SAMPLE POINT	Sx-37				
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR					
VOLUME PERCENT / TEMPERATURE, °C — IBP					
5%					
10%					
20%					
30%					
40%					
50%					
60%					
70%					
80%					
90%					
95%					
DRY PT.					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR	741				
VOLUME PERCENT / TEMPERATURE, °C — IBP	81				
5%	87				
10%	152				
20%	179				
30%	193				
40%	204				
50%	216				
60%	232				
70%	253				
80%	295				
90%	323				
95%					
DRY PT.	324				
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT% (Raw Sx)	0.77				
INFRARED RATIO					
SP. GRAV. 60/60 F					

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.


DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT
WT % DISTILLABLE OIL (IBP - SMOKE POINT @ 5 TORR)
"Y"
F-1 BOTTOMS MELTING POINT, °F
"X"
Y= -0.1273X + 54.38
/CORR. COEF./ = 0.95
L-1J
L-1B
L-3B
L-1C
L-1E
L-2C
L-2G
L-3F
0
10
20
30
40
50
60
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MATERIAL IN

lbs/hr.

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

Quantitative

STREAM DESCRIPTION	←Feed Gas Recycle Gas	Makeup Gas→	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.54	0.98				1.52
Carbon Monoxide - CO	4.56	10.24				14.80
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	2.37					2.37
Ethane - C_2H_6	0.77					0.77
Propane - C_3H_8	0.36					0.36
Butane - C_4H_{10}						
Nitrogen - N_2	0.16	0.16				0.32
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				24.14		24.14
Solvent - (100-230° C @ 1.6 Torr)				64.54		64.54
Heavy Oil - (230-255° C @ 1.6 Torr)				1.79		1.79
SRL						
Coal (MAF)			28.77			28.77
Ash			2.85			2.85
Water			15.55	0.42		15.97
Phenol						
TOTAL	8.76	11.38	47.17	90.89		158.20

Elemental

Carbon	4.65	4.39	20.25	79.04		108.33
Hydrogen	1.35	0.98	3.09	7.86		13.28
Nitrogen	0.16	0.16	0.26	0.27		0.85
Sulfur			0.29	1.01		1.30
Oxygen (by diff)	2.60	5.85	20.43	2.71		31.59
Ash			2.85			2.85
TOTAL	8.76	11.38	47.17	90.89		158.20

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/24/78

MATERIAL OUT

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

lbs/hr.

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Quantitative	Hydrogen - H_2	0.21	0.54		0.08		
	Carbon Monoxide - CO	1.75	4.56		0.77		
	Carbon Dioxide - CO_2			7.60	2.82		
	Hydrogen Sulfide - H_2S			0.20	0.12		
	Methane - CH_4	0.91	2.37		0.52		
	Ethane - C_2H_6	0.30	0.77		0.37		
	Propane - C_3H_8	0.14	0.36		0.28		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.06	0.16		0.03		
	Ammonia - NH_3			0.03		0.02	
	Light Oil - (0-100° C @ 1.6 Torr)						
	Solvent - (100-230° C @ 1.6 Torr)						
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Cool (MAF)						
	Ash						
	Water					14.19	
	Phenol						
	TOTAL	3.37	8.76	7.83	4.99	14.21	Negl.
Elemental	Carbon	1.79	4.65	2.07	2.02		
	Hydrogen	0.52	1.35	0.02	0.34	1.58	
	Nitrogen	0.06	0.16	0.03	0.03	0.02	
	Sulfur			0.18	0.11		
	Oxygen (by diff)	1.00	2.60	5.53	2.49	12.61	
	Ash						
	TOTAL	3.37	8.76	7.83	4.99	14.21	Negl.

PROJECT LIGNITE

MEASURED MATERIAL BALANCE

Revised: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MATERIAL OUT

lbs/hr.

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms
	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO		0.13				
	Carbon Dioxide - CO_2		0.29				
	Hydrogen Sulfide - H_2S						
	Methane - CH_4		0.03				
	Ethane - C_2H_6		0.06				
	Propane - C_3H_8		0.03				
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	1.50		0.44		16.15	16.05
	Solvent - (100-230°C @ 1.6 Torr)	0.02			2.30	51.32	7.21
	Heavy Oil - (230-255°C @ 1.6 Torr)					1.99	
	SRL				11.21		
	Coal (MAF)				2.40		
	Ash				2.41		
	Water			0.03		0.27	
	Phenol						
	TOTAL	1.52	0.54	0.47	18.32	69.73	23.26
Elemental	Carbon	1.21	0.23	0.37	14.11	60.25	19.68
	Hydrogen	0.20	0.03	0.04	0.87	5.63	2.18
	Nitrogen				0.18	0.21	0.06
	Sulfur				0.20	0.86	0.09
	Oxygen (by diff)	0.11	0.28	0.06	0.55	2.78	1.25
	Ash				2.41		
	TOTAL	1.52	0.54	0.47	18.32	69.73	23.26

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/24/78

Run No: L-2G
Date: 9/12/77
Time: 0700-1900

MATERIAL OUT

lbs/hr.

Temperature: 721°F
Pressure: 2460 psig
LHSV: 1.40
GHSV: 358

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						0.83
Carbon Monoxide - CO						7.21
Carbon Dioxide - CO_2						10.71
Hydrogen Sulfide - H_2S						0.32
Methane - CH_4						3.83
Ethane - C_2H_6						1.50
Propane - C_3H_8						0.81
Butane - C_4H_{10}						
Nitrogen - N_2						0.25
Ammonia - NH_3						0.05
Light Oil - (0-100° C @ 1.6 Torr)						34.14
Solvent - (100-230°C @ 1.6 Torr)						60.85
Heavy Oil - (230-255°C @ 1.6 Torr)						1.99
SRL						11.21
Coal (MAF)						2.40
Ash						2.41
Water						14.49
Phenol						
TOTAL						153.00

Elemental

Carbon						106.38
Hydrogen						12.76
Nitrogen						0.75
Sulfur						1.44
Oxygen (by diff)						29.26
Ash						2.41
TOTAL						153.00

RUN CONDITIONS

RUN NO. L-2H
DATE MADE 9/19/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 748
- INLET 212
- OUTLET 729

DISSOLVERS
- R-1A (1) 777
- (2) 786
- (3) 786
- (4) 785
- R-1B (1)
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 578
- S-2 76
- S-3 488
- S-4A 78
- S-4B 76

PREHEATER E-11
- DOWTHERM 684
- INLET 426
- OUTLET 656

VACUUM FLASH F-1
- OVERHEAD VAPOR 496
- UPPER WALL 604
- LOWER WALL 591
- DOWNCOMER 559
- CONDENSATE ACCUMULATOR, S-7 78

PREHEATER E-13
- DOWTHERM 408
- INLET 75
- OUTLET 152

LIGHT ENDS COLUMN, F-2
- REBOILER 298
- LOWER SECTION 207
- FEED SECTION 210
- OVERHEAD 183
- S-8 72
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2: 2450

SEPARATOR S-3: 240

SEPARATORS S-4A and S-4B: 60

VACUUM FLASH, F-1: 14 Torr

LIGHT ENDS COLUMN, F-2: 0

SOLVENT COLUMN, F-3: NIU

HEAVY ENDS COLUMN, F-4: NIU

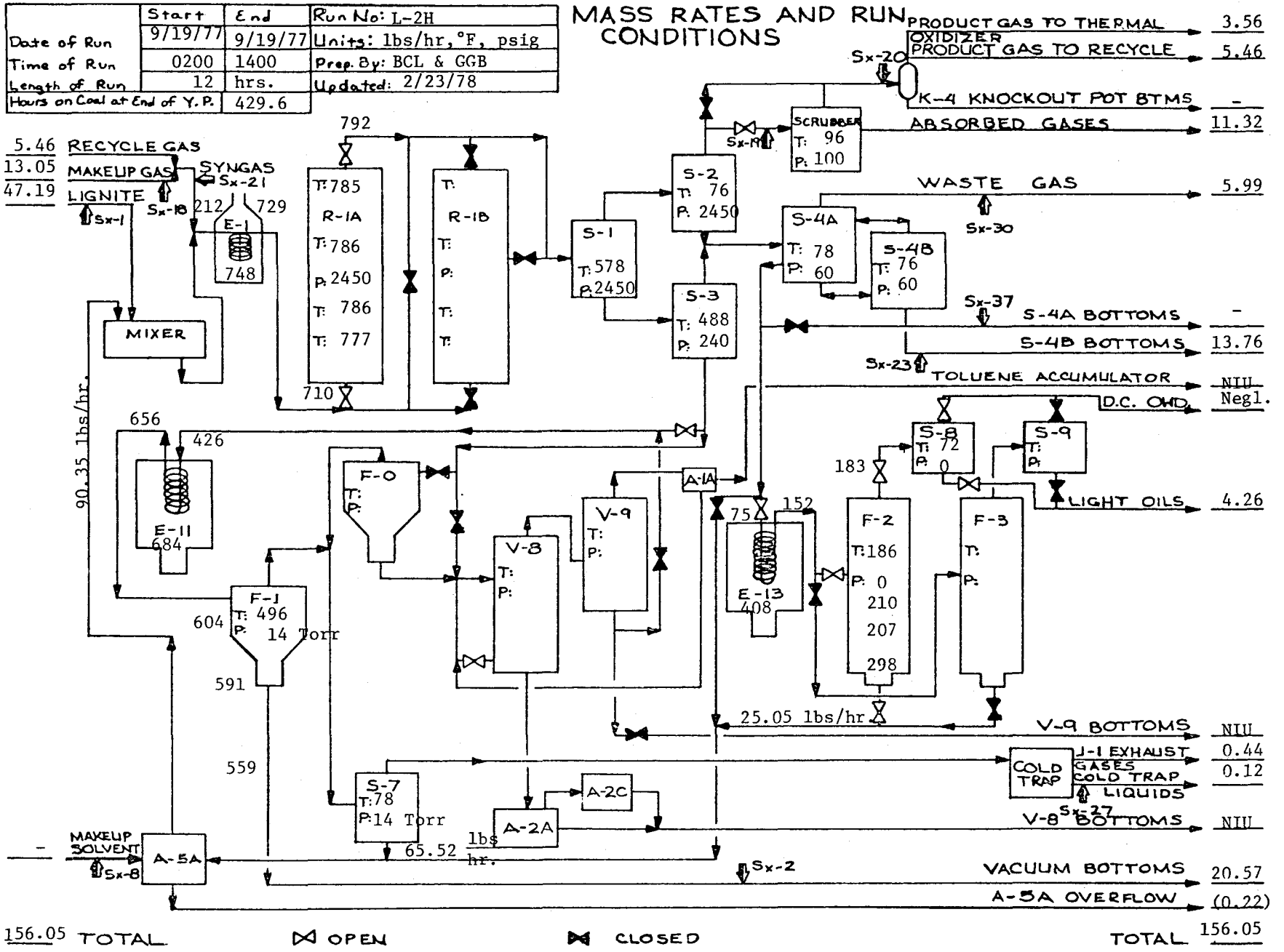
VACUUM FLASH, F-0: NIU

SETTLING TOWER, V-8: NIU

RECOVERY TOWER, V-7: NIU

	Start	End	Run No: L-2H
Date of Run	9/19/77	9/19/77	Units: lbs/hr, °F, psig
Time of Run	0200	1400	Prep. By: BCL & GGB
Length of Run	12	hrs.	Updated: 2/23/78
Hours on Coal at End of Y.P.		429.6	

MASS RATES AND RUN CONDITIONS



Numbers in parentheses are not included in the totals.

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas Rate Adjusted Followed by a Forced Carbon Balance
Revised: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

SUMMARY

lbs/hr.

Temperature: 729°F
Pressure: 2450 psig
LHSV: 1.40
GHSV: 332

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Lignite	
	SAMPLE POINT						
Quantitative	Hydrogen - H_2	1.24	0.86	-0.38			
	Carbon Monoxide - CO	15.23	5.60	-9.63			
	Carbon Dioxide - CO_2		15.77	15.77			
	Hydrogen Sulfide - H_2S		0.28	0.28			
	Methane - CH_4	1.20	2.25	1.05	8.27	28.36	
	Ethane - C_2H_6	0.42	1.04	0.62			
	Propane - C_3H_8	0.19	0.69	0.50			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.23	0.23	-0-			
	Ammonia - NH_3		0.06	0.06			
	Light Oil - (0-100° C @ 1.6 Torr)	35.40	43.96	8.56			
	Solvent - (100-230° C @ 1.6 Torr)	51.50	49.26	-2.24	20.54	70.44	
	Heavy Oil - (230-255° C @ 1.6 Torr)	2.71	2.62	-0.09			
	SRL		14.31	14.31			
	Coal (MAF)	29.16	2.70	-26.46		-90.74	
	Ash	2.94	2.82	-0.12		-0.41	
	Water	15.83	13.60	-2.23		-7.65	
	Phenol						
	TOTAL	156.05	156.05	-0-			
Elemental	Carbon	105.39	105.39	-0-			
	Hydrogen	12.12	12.20	0.08			
	Nitrogen	0.82	0.89	0.07			
	Sulfur	0.89	1.02	0.13			
	Oxygen (by diff)	33.89	33.73	-0.16			
	Ash	2.94	2.82	-0.12			
	TOTAL	156.05	156.05	-0-			

PROJECT LIGNITE
MEASURED & ADJUSTED MATERIAL BALANCE
Revised: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MATERIAL IN

lbs/hr.

Temperature: 729°F
Pressure: 2450 psig
LHSV: 1.40
GHSV: 332

Quantitative

STREAM DESCRIPTION	← Feed Gas → Recycle Gas	Makeup Gas	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.47	0.77				1.24
Carbon Monoxide - CO	3.05	12.18				15.23
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	1.20					1.20
Ethane - C_2H_6	0.42					0.42
Propane - C_3H_8	0.19					0.19
Butane - C_4H_{10}						
Nitrogen - N_2	0.13	0.10				0.23
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				35.40		35.40
Solvent - (100-230° C @ 1.6 Torr)				51.50		51.50
Heavy Oil - (230-255°C @ 1.6 Torr)				2.71		2.71
SRL						
Coal (MAF)			29.16			29.16
Ash			2.94	0.74		2.94
Water			15.09			15.83
Phenol						
TOTAL	5.46	13.05	47.19	90.35		156.05

Elemental

Carbon	2.70	5.22	21.43	76.04		105.39
Hydrogen	0.89	0.77	3.02	7.44		12.12
Nitrogen	0.13	0.10	0.27	0.32		0.82
Sulfur			0.32	0.57		0.89
Oxygen (by diff)	1.74	6.96	19.21	5.98		33.89
Ash			2.94			2.94
TOTAL	5.46	13.05	47.19	90.35		156.05

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas Rate Adjusted followed by Forced Carbon Balance
Revised: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MATERIAL OUT
lbs/hr.

Temperature: 729°F
Pressure: 2450 psig
LHSV: 1.40
GHSV: 332

	STREAM DESCRIPTION	← Vent Gas	Product Gas Recycle Gas	Absorbed Gas →	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Calc	Sx-44
Quantitative	Hydrogen - H_2	0.31	0.47		0.08		
	Carbon Monoxide - CO	1.99	3.05		0.53		
	Carbon Dioxide - CO_2			11.08	4.35		
	Hydrogen Sulfide - H_2S			0.20	0.08		
	Methane - CH_4	0.78	1.20		0.25		
	Ethane - C_2H_6	0.28	0.42		0.32		
	Propane - C_3H_8	0.12	0.19		0.35		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.08	0.13		0.02		
	Ammonia - NH_3			0.04	0.01	0.01	
	Light Oil - (0-100° C @ 1.6 Torr)					2.02	
	Solvent - (100-230° C @ 1.6 Torr)					0.56	
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water					11.17	
	Phenol						
	TOTAL	3.56	5.46	11.32	5.99	13.76	Negl.
Elemental	Carbon	1.76	2.70	3.02	2.14	2.11	
	Hydrogen	0.58	0.89	0.02	0.27	1.49	
	Nitrogen	0.08	0.13	0.03	0.03	0.02	
	Sulfur			0.19	0.08	0.01	
	Oxygen (by diff)	1.14	1.74	8.06	3.47	10.13	
	Ash						
	TOTAL	3.56	2.70	11.32	5.99	13.76	Negl.

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Product Gas Rate Adjusted followed by Forced Carbon Balance

Revised: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MATERIAL OUT

lbs/hr.

Temperature: 729°F
Pressure: 2450 psig
LHSV: 1.40
GHSV: 332

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle S-7 Btms	Solvent→ LEC Btms
Quantitative	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
	Hydrogen - H_2						
	Carbon Monoxide - CO		0.03				
	Carbon Dioxide - CO_2		0.34				
	Hydrogen Sulfide - H_2S						
	Methane - CH_4		0.02				
	Ethane - C_2H_6		0.02				
	Propane - C_3H_8		0.03				
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	2.65		0.02		21.38	17.89
	Solvent - (100-230°C @ 1.6 Torr)	0.06		0.02	0.74	40.72	7.16
	Heavy Oil - (230-255°C @ 1.6 Torr)					2.62	
	SRL				14.31		
	Coal (MAF)				2.70		
	Ash				2.82		
	Water	1.55		0.08		0.80	
	Phenol						
	TOTAL	4.26	0.44	0.12	20.57	65.52	25.05
Elemental	Carbon	2.16	0.16	0.04	15.40	55.54	20.36
	Hydrogen	0.50	0.02	0.01	0.98	5.29	2.15
	Nitrogen				0.23	0.27	0.10
	Sulfur	0.01			0.21	0.46	0.06
	Oxygen (by diff)	1.59	0.26	0.07	0.93	3.96	2.38
	Ash				2.82		
	TOTAL	4.26	0.44	0.12	20.57	65.52	25.05

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas Rate Adjusted followed by a Forced Carbon Balance
Revised: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MATERIAL OUT

lbs/hr.

Temperature: 729°F
Pressure: 2450 psig
LHSV: 1.40
GHSV: 332

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						0.86
Carbon Monoxide - CO						5.60
Carbon Dioxide - CO_2						15.77
Hydrogen Sulfide - H_2S						0.28
Methane - CH_4						2.25
Ethane - C_2H_6						1.04
Propane - C_3H_8						0.69
Butane - C_4H_{10}						
Nitrogen - N_2						0.23
Ammonia - NH_3						0.06
Light Oil - (0-100° C @ 1.6 Torr)						43.96
Solvent - (100-230°C @ 1.6 Torr)						49.26
Heavy Oil - (230-255°C @ 1.6 Torr)						2.62
SRL						14.31
Coal (MAF)						2.70
Ash						2.82
Water						13.60
Phenol						
TOTAL						156.05

Elemental

Carbon						105.39
Hydrogen						12.20
Nitrogen						0.89
Sulfur						1.02
Oxygen (by diff)						33.73
Ash						2.82
TOTAL						156.05

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	LEC Btms	Feed Solvent	S-8 Oil	S-8 Water
	SAMPLE POINT	Sx-1	*Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			71.40	39.18	97.73	
	Solvent – (100-230°C @ 1.6 Torr)		3.59	28.60	57.00	2.20	
	Heavy Oil – (230-255°C @1.6 Torr)				3.00		
	SRL		69.56				
	Coal (MAF)	61.79	13.12				
	Ash	6.24	13.73				
	Water	31.97			0.82	0.07	100
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		84.79				
	Melting Point °F		399				
	Specific Gravity 60/60			0.989	1.026		
	Viscosity, cp						
Elemental	Carbon	45.40	74.86	81.30	84.16	79.57	
	Hydrogen	6.39	4.76	8.57	8.24	12.14	11.11
	Nitrogen	0.58	1.11	0.39	0.35	0.11	
	Sulfur	0.68	1.04	0.24	0.63	0.11	
	Oxygen (by diff)	40.71	4.50	9.50	6.62	8.07	88.89
	Ash	6.24	13.73				
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

*Distillable oil content calculated by following equation: Wt % Distillable oil = -0.1273 (F-1 Btms melting point) + 54.38. See attached graph.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4B Oil
	SAMPLE POINT	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21	*Sx-23
Quantitative	Hydrogen – H_2		5.87	4.30	8.64	6.52	
	Carbon Monoxide – CO		93.34	27.64	55.87	82.88	
	Carbon Dioxide – CO_2			51.96			
	Hydrogen Sulfide – H_2S			0.35			
	Methane – CH_4			9.45	21.94	6.28	
	Ethane – C_2H_6			3.76	7.78	2.17	
	Propane – C_3H_8			1.80	3.39	1.07	
	Butane – C_4H_{10}						
	Nitrogen – N_2		0.79	0.72	2.38	1.08	
	Ammonia – NH_3 (PPM)			0.02			
	Light Oils – (0-100° C @ 1.6 Torr)	62.30					77.14
	Solvent – (100-230°C @ 1.6 Torr)	1.40					21.50
	Heavy Oil – (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water	36.30					1.36
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						0.971
	Viscosity, cp						
Elemental	Carbon	50.73	40.00	37.59	49.39	42.85	80.87
	Hydrogen	11.77	5.87	7.76	16.30	8.71	9.50
	Nitrogen	0.07	0.79	0.74	2.38	1.08	0.36
	Sulfur	0.07		0.33			0.30
	Oxygen (by diff)	37.36	53.34	53.58	31.93	47.36	8.97
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

*Insufficient sample for distillation. Assumed to be the same as the S-4A oil.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4B Water	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	S-4A Oil
	SAMPLE POINT	Sx-23	Sx-23	Sx-30	Sx-32	Sx-33	Sx-37
Quantitative	Hydrogen – H_2			1.28	0.56		
	Carbon Monoxide – CO			8.87	6.22		
	Carbon Dioxide – CO_2			72.63	76.87		
	Hydrogen Sulfide – H_2S			1.32			
	Methane – CH_4			4.13	3.56		
	Ethane – C_2H_6			5.27	5.00		
	Propane – C_3H_8			5.93	7.79		
	Butane – C_4H_{10}						
	Nitrogen – N_2			0.32			
	Ammonia – NH_3 (PPM)	0.12	0.12	0.25			
	Light Oils – (0-100° C @ 1.6 Torr)					20.01	77.14
	Solvent – (100-230°C @ 1.6 Torr)					15.80	21.50
	Heavy Oil – (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.88	99.88			64.19	1.36
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60						0.971
	Viscosity, cp						
Elemental	Carbon			35.78	36.67	31.67	80.87
	Hydrogen	11.12	11.12	4.56	3.87	10.41	9.50
	Nitrogen	0.10	0.10	0.53		0.11	0.36
	Sulfur			1.24		0.36	0.30
	Oxygen (by diff)	88.78	88.78	57.89	59.46	57.45	8.97
	Ash						
	TOTAL	100	100	100	100	100	100
	Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

WEIGHT PERCENT

	SAMPLE DESCRIPTION	S-4A Water	S-4A Total	S-7 Btms	Absorbed Gas		S-4B Btms
	SAMPLE POINT	Sx-37	Sx-37	Sx-34/39	Calc		Calc
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2				97.88		
	Hydrogen Sulfide – H_2S				1.78		
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)	0.17			0.34		0.10
	Light Oils – (0-100° C @ 1.6 Torr)		74.66	32.63			14.63
	Solvent – (100-230°C @ 1.6 Torr)		20.81	62.15			4.08
	Heavy Oil – (230-255°C @ 1.6 Torr)			4.00			
	SRL						
	Coal (MAF)						
	Ash						
	Water	99.83	4.53	1.22			81.19
	Phenol						
	TOTAL	100	100	100	100		100
	Pyridine Solubles (Wt % Ash free)						
	Melting Point °F						
	Specific Gravity 60/60			1.039			
	Viscosity, cp						
Elemental	Carbon		78.27	84.77	26.69		15.34
	Hydrogen	11.12	9.55	8.07	0.16		10.81
	Nitrogen	0.14	0.35	0.42	0.28		0.15
	Sulfur		0.29	0.70	1.68		0.06
	Oxygen (by diff)	88.74	11.54	6.04	71.19		73.64
	Ash						
	TOTAL	100	100	100	100		100
	Number of Sample Avg.	2	2	2	-		-

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Discharge
SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
Hydrogen – H_2	46.60	42.09	53.28	48.33	19.74	9.87
Carbon Monoxide – CO	52.95	19.30	24.61	43.85	9.78	7.90
Carbon Dioxide – CO_2		23.09			50.94	62.10
Hydrogen Sulfide – H_2S		0.20			1.20	
Methane – CH_4		11.55	16.91	5.82	7.96	7.91
Ethane – C_2H_6		2.45	3.20	1.07	5.42	5.93
Propane – C_3H_8		0.80	0.95	0.36	4.16	6.29
Butane – C_4H_{10}						
Nitrogen – N_2	0.45	0.50	1.05	0.57	0.35	
Ammonia – NH_3 (PPM)		0.02			0.45	
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100	100	100
Calc. Mole Wt.	15.88	19.55	12.33	14.81	30.86	35.55
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MOLE PERCENT

Quantitative

SAMPLE DESCRIPTION	Absorbed Gas.					
SAMPLE POINT	Calc.					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	96.86					
Hydrogen Sulfide – H_2S	2.28					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.86					
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc Mole Wt.	43.54					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	–					

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2H
DATE: 9/19/77
TIME: 0200-1400

SAMPLE DESCRIPTION	F-1 Btms	LEC Btms	Feed Solv.	S-8 Oil	Cold Trap Oil
SAMPLE POINT	Sx-2	Sx-12	Sx-14	Sx-16	Sx-33
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR		5	5		
IBP		49.6	54.4		
5%		64.8	73.0		
10%		69.2	80.0		
20%		76.9	94.2		
30%		82.2	103.8		
40%		88.4	121.0		
50%		95.8	145.4		
60%		104.5	166.6		
70%		119.0	179.0		
80%		142.8	191.3		
90%		173.2	226.2		
95%		194.0	260		
DRY PT.		199.8			
(VOLUME PERCENT — TEMPERATURE, °C)					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR				740	736
IBP				52	93
5%				58	97
10%				67	99
20%				78	101
30%				90	207
40%				103	228
50%				114	242
60%				130	300
70%				143	321
80%				158	324
90%				175	
95%				178	
DRY PT.				178	332
(VOLUME PERCENT — TEMPERATURE, °C)					
ASPHALTENE TEST					
WT % ASH	13.73				
WT % UNCONVERTED COAL	13.12				
WT % PRE-ASPHALTENES	30.55				
WT % ASPHALTENES	25.18				
WT % MALTENES & DIST. OIL	17.42				
TOTAL	100.00				
SAYBOLT VISCOSITY, SSU					
100° F		9.5	11.1		
210° F		7.8	8.4		
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)			0.82	0.07	21.57
INFRARED RATIO			0.33		
SP. GRAV. 60/60 F		0.989	1.026		

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

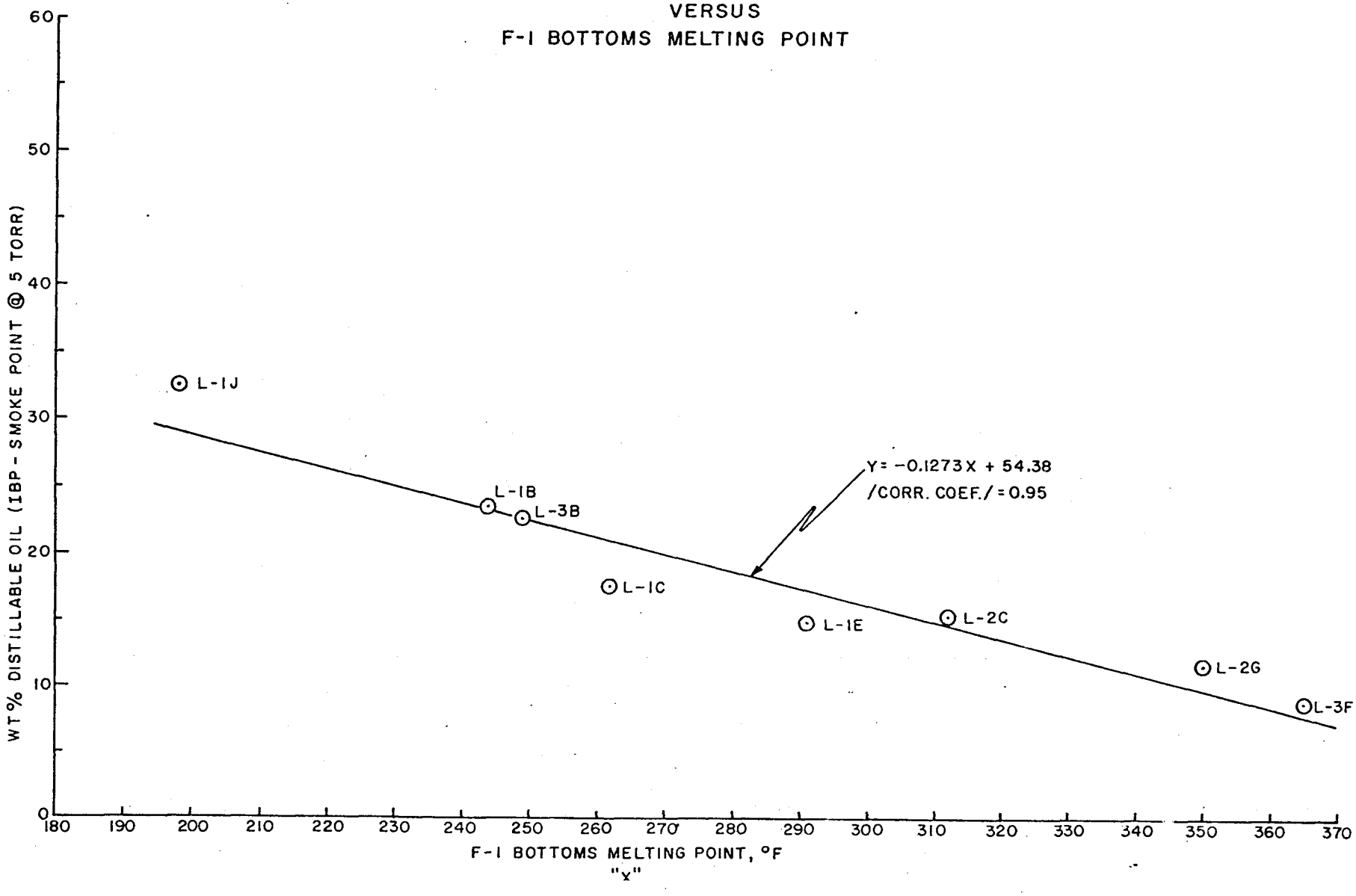
PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2H
DATE: 9/19/77
TIME: 0200-1400

SAMPLE DESCRIPTION	S-7 Btms	S-4A Oil			
SAMPLE POINT	Sx-34/39	Sx-37			
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5				
IBP	57.6				
5%	73.6				
10%	81.7				
20%	98.3				
30%	116.9				
40%	139.2				
50%	159				
60%	173.2				
70%	182.6				
80%	197.9				
90%	239				
95%	260				
DRY PT.					
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR		739			
IBP		91			
5%		91			
10%		182			
20%		197			
30%		204			
40%		214			
50%		223			
60%		238			
70%		258			
80%		289			
90%		336			
95%					
DRY PT.		341			
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F	12.1				
210° F	8.6				
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)	1.22	1.36			
INFRARED RATIO	0.32				
SP. GRAV. 60/60 F	1.039	0.971			

VOLUME PERCENT → TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.

DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT



PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MATERIAL OUT

lbs/hr.

Temperature: 729°F
Pressure: 2450 psig
LHSV: 1.40
GHSV: 332

	STREAM DESCRIPTION	← Product Gas → Vent Gas	Recycle Gas	Absorbed Gas	S-4A Ovhd	S-4B Btms	S-8 Ovhd
	SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Quantitative	Hydrogen - H_2	0.24	0.47		0.08		
	Carbon Monoxide - CO	1.56	3.05		0.53		
	Carbon Dioxide - CO_2			8.61	4.35		
	Hydrogen Sulfide - H_2S			0.16	0.08		
	Methane - CH_4	0.61	1.20		0.25		
	Ethane - C_2H_6	0.22	0.42		0.32		
	Propane - C_3H_8	0.10	0.19		0.35		
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.07	0.13		0.02		
	Ammonia - NH_3			0.03	0.01	0.02	
	Light Oil - (0-100° C @ 1.6 Torr)						
	Solvent - (100-230°C @ 1.6 Torr)						
	Heavy Oil - (230-255°C @ 1.6 Torr)						
	SRL						
	Coal (MAF)						
	Ash						
	Water					13.74	
	Phenol						
	TOTAL	2.80	5.46	8.80	5.99	13.76	Negl.
Elemental	Carbon	1.38	2.70	2.35	2.14		
	Hydrogen	0.46	0.89	0.01	0.27	1.53	
	Nitrogen	0.07	0.13	0.02	0.03	0.01	
	Sulfur			0.15	0.08		
	Oxygen (by diff)	0.89	1.74	6.27	3.47	12.22	
	Ash						
	TOTAL	2.80	2.70	8.80	5.99	13.76	Negl.

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MATERIAL OUT

lbs/hr.

Temperature: 729°F
Pressure: 2450 psig
LHSV: 1.40
GHSV: 332

	STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	← Recycle Solvent → S-7 Btms	LEC Btms
	SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Quantitative	Hydrogen - H_2						
	Carbon Monoxide - CO		0.03				
	Carbon Dioxide - CO_2		0.34				
	Hydrogen Sulfide - H_2S						
	Methane - CH_4		0.02				
	Ethane - C_2H_6		0.02				
	Propane - C_3H_8		0.03				
	Butane - C_4H_{10}						
	Nitrogen - N_2						
	Ammonia - NH_3						
	Light Oil - (0-100° C @ 1.6 Torr)	2.65		0.02		21.38	17.89
	Solvent - (100-230°C @ 1.6 Torr)	0.06		0.02	0.74	40.72	7.16
	Heavy Oil - (230-255°C @ 1.6 Torr)					2.62	
	SRL				14.31		
	Coal (MAF)				2.70		
	Ash				2.82		
	Water	1.55		0.08		0.80	
	Phenol						
	TOTAL	4.26	0.44	0.12	20.57	65.52	25.05
Elemental	Carbon	2.16	0.16	0.04	15.40	55.54	20.36
	Hydrogen	0.50	0.02	0.01	0.98	5.29	2.15
	Nitrogen				0.23	0.27	0.10
	Sulfur	0.01			0.21	0.46	0.06
	Oxygen (by diff)	1.59	0.26	0.07	0.93	3.96	2.38
	Ash				2.82		
	TOTAL	4.26	0.44	0.12	20.57	65.52	25.05

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 2/23/78

Run No: L-2H
Date: 9/19/77
Time: 0200-1400

MATERIAL OUT

lbs/hr.

Temperature: 729°F
Pressure: 2450 psig
LHSV: 1.40
GHSV: 332

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						0.79
Carbon Monoxide - CO						5.17
Carbon Dioxide - CO_2						13.30
Hydrogen Sulfide - H_2S						0.24
Methane - CH_4						2.08
Ethane - C_2H_6						0.98
Propane - C_3H_8						0.67
Butane - C_4H_{10}						
Nitrogen - N_2						0.22
Ammonia - NH_3						0.06
Light Oil - (0-100° C @ 1.6 Torr)						41.94
Solvent - (100-230°C @ 1.6 Torr)						48.70
Heavy Oil - (230-255°C @ 1.6 Torr)						2.62
SRL						14.31
Coal (MAF)						2.70
Ash						2.82
Water						16.17
Phenol						
TOTAL						152.77

Quantitative

Carbon						102.23
Hydrogen						12.11
Nitrogen						0.86
Sulfur						0.97
Oxygen (by diff)						33.78
Ash						2.82
TOTAL						152.77

Elemental

RUN CONDITIONS

RUN NO. L-2I
DATE MADE 9/19-20/77

TEMPERATURE °F

PREHEATER E-1
- SAND BATH 758
- INLET 206
- OUTLET 738

DISSOLVERS
- R-1A (1) 699
- (2) 765
- (3) 777
- (4) 787
- R-1B (1) NIU
- (2)
- (3)
- (4)

REACTOR PRODUCT SEPARATORS
- S-1 578
- S-2 76
- S-3 485
- S-4A 76
- S-4B 69

PREHEATER E-11
- DOWTHERM 683
- INLET 406
- OUTLET 654

VACUUM FLASH F-1
- OVERHEAD VAPOR 492
- UPPER WALL 607
- LOWER WALL 590
- DOWNCOMER 574
- CONDENSATE ACCUMULATOR, S-7 74

PREHEATER E-13
- DOWTHERM 406
- INLET 71
- OUTLET 149

LIGHT ENDS COLUMN, F-2
- REBOILER 302
- LOWER SECTION 208
- FEED SECTION 209
- OVERHEAD 182
- S-8 68
- S-9 -

SOLVENT COLUMN, F-3
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

HEAVY ENDS COLUMN, F-4
- REBOILER NIU
- LOWER SECTION
- FEED SECTION
- OVERHEAD

VACUUM FLASH, F-0
- OVERHEAD NIU
- BOTTOMS

PRECIPITATION TOWER, V-8
- ZONE (1) NIU
- (2)
- (3)

RECOVERY TOWER V-9
- REBOILER NIU
- OVERHEAD

PRESSURE, psig

SEPARATORS S-1 and S-2
2450

SEPARATOR S-3
240

SEPARATORS S-4A and S-4B
62

VACUUM FLASH, F-1
14 Torr

LIGHT ENDS COLUMN, F-2
Atm

SOLVENT COLUMN, F-3
NIU

HEAVY ENDS COLUMN, F-4
NIU

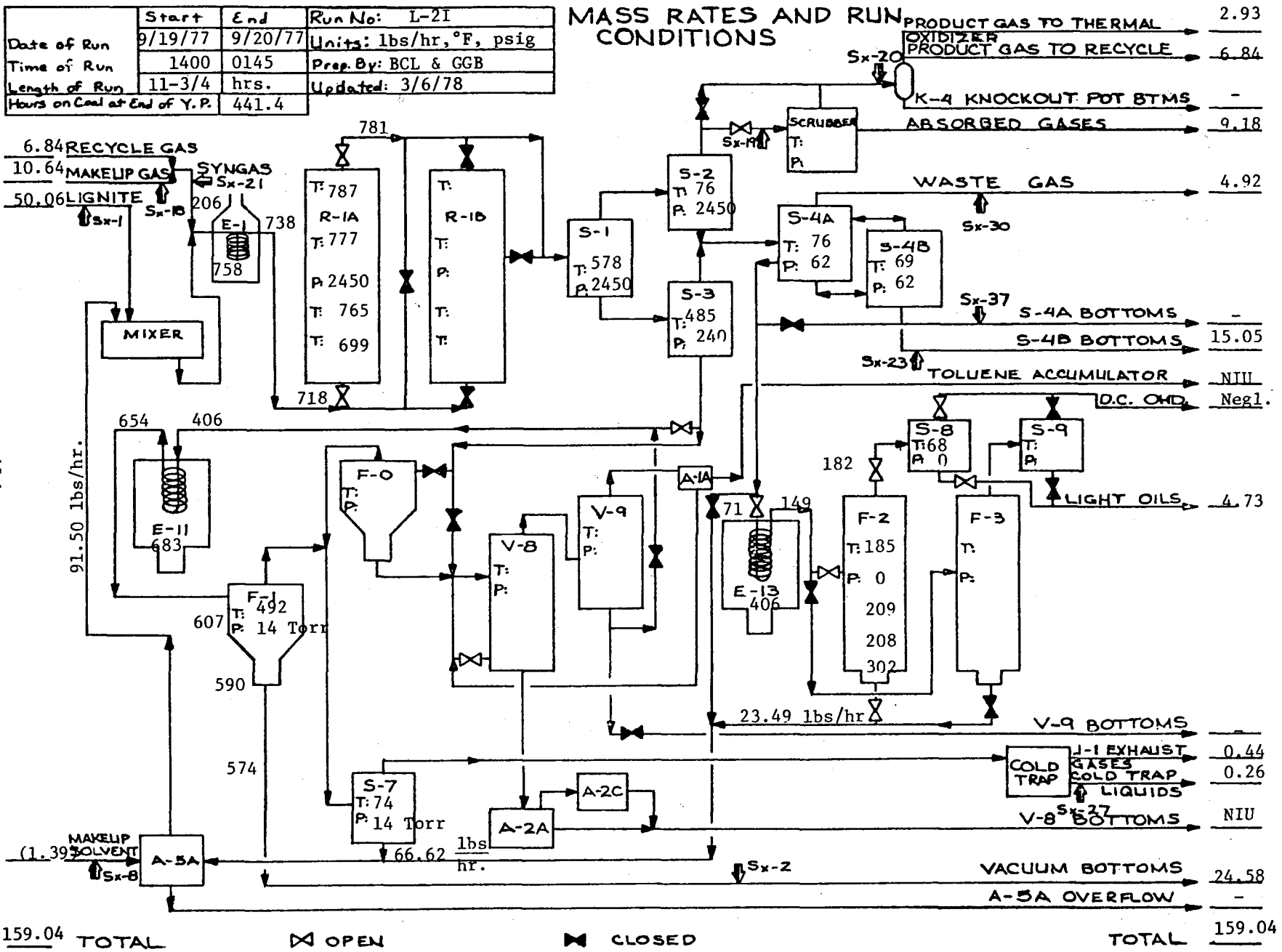
VACUUM FLASH, F-0
NIU

SETTLING TOWER, V-8
NIU

RECOVERY TOWER, V-7
NIU

	Start	End	Run No: L-21
Date of Run	9/19/77	9/20/77	Units: lbs/hr, °F, psig
Time of Run	1400	0145	Prep. By: BCL & GGB
Length of Run	11-3/4	hrs.	Updated: 3/6/78
Hours on Coal at End of Y.P.	441.4		

MASS RATES AND RUN CONDITIONS



PRODUCT GAS TO THERMAL OXIDIZER	2.93
PRODUCT GAS TO RECYCLE	6.84
K-4 KNOCKOUT POT BTMS	-
ABSORBED GASES	9.18
WASTE GAS	4.92
S-4A BOTTOMS	-
S-4B BOTTOMS	15.05
TOLUENE ACCUMULATOR	NIU
D.C. OHD	Negl.
LIGHT OILS	4.73
V-9 BOTTOMS	-
J-1 EXHAUST GASES	0.44
COLD TRAP LIQUIDS	0.26
V-8 BOTTOMS	NIU
VACUUM BOTTOMS	24.58
A-5A OVERFLOW	-
TOTAL	159.04

159.04 TOTAL

⋈ OPEN ⋈ CLOSED

Numbers in parentheses are not included in the totals

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rates Adjusted
Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

SUMMARY

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

lbs/hr.

	STREAM DESCRIPTION	Total In	Total Out	Net Yield		Wt % MAF Coal	
	SAMPLE POINT						
Quantitative	Hydrogen - H_2	1.37	1.05	-0.32			
	Carbon Monoxide - CO	14.39	7.11	-7.28			
	Carbon Dioxide - CO_2		12.84	12.84			
	Hydrogen Sulfide - H_2S		0.24	0.24			
	Methane - CH_4	1.05	1.73	0.68	6.85	22.33	
	Ethane - C_2H_6	0.27	0.60	0.33			
	Propane - C_3H_8	0.18	0.48	0.30			
	Butane - C_4H_{10}						
	Nitrogen - N_2	0.22	0.24	0.02			
	Ammonia - NH_3		0.04	0.04			
	Light Oil - (0-100° C @ 1.6 Torr)	34.60	40.82	6.22			
	Solvent - (100-230°C @ 1.6 Torr)	52.70	50.78	-1.92	23.22	75.68	
	Heavy Oil - (230-255°C @ 1.6 Torr)	3.39	3.47	0.08			
	SRL		18.84	18.84			
	Coal (MAF)	30.68	2.61	-28.07		-91.49	
	Ash	3.03	2.91	-0.12		-0.39	
	Water	17.16	15.28	-1.88		-6.13	
	Phenol						
	TOTAL	159.04	159.04	-0-			
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rates Adjusted
Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MATERIAL IN

lbs/hr.

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

Quantitative

STREAM DESCRIPTION	← Feed Gas Recycle Gas	Gas → Makeup Gas	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.67	0.70				1.37
Carbon Monoxide - CO	4.51	9.88				14.39
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	1.05					1.05
Ethane - C_2H_6	0.27					0.27
Propane - C_3H_8	0.18					0.18
Butane - C_4H_{10}						
Nitrogen - N_2	0.16	0.06				0.22
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				34.60		34.60
Solvent - (100-230° C @ 1.6 Torr)				52.70		52.70
Heavy Oil - (230-255°C @ 1.6 Torr)				3.39		3.39
SRL						
Coal (MAF)			30.68			30.68
Ash			3.03			3.03
Water			16.35	0.81		17.16
Phenol						
TOTAL	6.84	10.64	50.06	91.50		159.04

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas and F-1 Btms Rates Adjusted
Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MATERIAL OUT
lbs/hr.

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

Quantitative

STREAM DESCRIPTION	Product Gas			S-4A	S-4B	S-8
	Vent Gas	Recycle Gas	Absorbed Gas	Ovhd	Btms	Ovhd
SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Hydrogen - H_2	0.29	0.67		0.08		
Carbon Monoxide - CO	1.93	4.51		0.61		
Carbon Dioxide - CO_2			9.00	3.51		
Hydrogen Sulfide - H_2S			0.17	0.07		
Methane - CH_4	0.45	1.05		0.22		
Ethane - C_2H_6	0.11	0.27		0.21		
Propane - C_3H_8	0.08	0.18		0.20		
Butane - C_4H_{10}						
Nitrogen - N_2	0.07	0.16		0.01		
Ammonia - NH_3			0.01	0.01	0.02	
Light Oil - (0-100° C @ 1.6 Torr)						
Solvent - (100-230°C @ 1.6 Torr)						
Heavy Oil - (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water					15.03	
Phenol						
TOTAL	2.93	6.84	9.18	4.92	15.05	Negl.

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE

ADJUSTED MATERIAL BALANCE

Product Gas, Recycle Gas and F-1 Btms Rates Adjusted

Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MATERIAL OUT

lbs/hr.

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

Quantitative

STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	←Recycle Solvent→ S-7 Btms	F-2 Btms
SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Hydrogen - H_2		0.01				
Carbon Monoxide - CO		0.06				
Carbon Dioxide - CO_2		0.33				
Hydrogen Sulfide - H_2S						
Methane - CH_4		0.01				
Ethane - C_2H_6		0.01				
Propane - C_3H_8		0.02				
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)	4.54				19.65	16.63
Solvent - (100-230° C @ 1.6 Torr)	0.19		0.01	0.22	43.90	6.46
Heavy Oil - (230-255°C @ 1.6 Torr)					3.07	0.40
SRL				18.84		
Coal (MAF)				2.61		
Ash				2.91		
Water			0.25			
Phenol						
TOTAL	4.73	0.44	0.26	24.58	66.62	23.49

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
ADJUSTED MATERIAL BALANCE
Product Gas, Recycle Gas, and F-1 Btms Rates Adjusted
Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MATERIAL OUT
lbs/hr.

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.05
Carbon Monoxide - CO						7.11
Carbon Dioxide - CO_2						12.84
Hydrogen Sulfide - H_2S						0.24
Methane - CH_4						1.73
Ethane - C_2H_6						0.60
Propane - C_3H_8						0.48
Butane - C_4H_{10}						
Nitrogen - N_2						0.24
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)						40.82
Solvent - (100-230° C @ 1.6 Torr)						50.78
Heavy Oil - (230-255°C @ 1.6 Torr)						3.47
SRL						18.84
Coal (MAF)						2.61
Ash						2.91
Water						15.28
Phenol						
TOTAL						159.04

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

WEIGHT PERCENT

	SAMPLE DESCRIPTION	Lignite	F-1 Btms	LEC Btms	Feed Solvent	S-8 Oil	S-8 Water
	SAMPLE POINT	Sx-1	*Sx-2	Sx-12	Sx-14	Sx-16	Sx-16
Quantitative	Hydrogen – H_2						
	Carbon Monoxide – CO						
	Carbon Dioxide – CO_2						
	Hydrogen Sulfide – H_2S						
	Methane – CH_4						
	Ethane – C_2H_6						
	Propane – C_3H_8						
	Butane – C_4H_{10}						
	Nitrogen – N_2						
	Ammonia – NH_3 (PPM)						
	Light Oils – (0-100° C @ 1.6 Torr)			70.80	37.81	96.00	
	Solvent – (100-230°C @ 1.6 Torr)		0.90	27.50	57.60	4.00	
	Heavy Oil – (230-255°C @1.6 Torr)			1.70	3.70		
	SRL		76.66				
	Coal (MAF)	61.28	10.60				
	Ash	6.06	11.84				
	Water	32.66			0.89		100
	Phenol						
	TOTAL	100	100	100	100	100	100
	Pyridine Solubles (Wt % Ash free)		87.98				
	Melting Point °F		420				
	Specific Gravity 60/60			0.991			
	Viscosity, cp						
Elemental	Carbon						
	Hydrogen						
	Nitrogen						
	Sulfur						
	Oxygen (by diff)						
	Ash						
	TOTAL						
	Number of Sample Avg.	2	2	2	2	2	-

*Distillable oil calculated using the following equation:
Wt % distillable oil = -0.1273 (F-1 Btms melting point)+ 54.38. See graph

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

WEIGHT PERCENT

SAMPLE DESCRIPTION	S-8 Total	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4B Oil
SAMPLE POINT	Sx-16	Sx-18	Sx-19	Sx-20	Sx-21	*Sx-23
Hydrogen – H_2		6.61	5.27	9.83	7.83	
Carbon Monoxide – CO		92.83	37.16	65.84	82.22	
Carbon Dioxide – CO_2			44.44			
Hydrogen Sulfide – H_2S			0.86			
Methane – CH_4			7.34	15.38	5.39	
Ethane – C_2H_6			3.47	3.95	2.77	
Propane – C_3H_8			0.87	2.62	0.97	
Butane – C_4H_{10}						
Nitrogen – N_2		0.56	0.55	2.38	0.82	
Ammonia – NH_3 (PPM)			0.04			
Light Oils – (0-100° C @ 1.6 Torr)	96.00					80.01
Solvent – (100-230°C @ 1.6 Torr)	4.00					18.50
Heavy Oil – (230-255°C @1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						1.49
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Elemental						
Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

*Insufficient sample for distillation. Assumed to be the same as the S-4A oil.

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

WEIGHT PERCENT

Quantitative

SAMPLE DESCRIPTION	S-4B Water	S-4B Total	S-4A Ovhd	J-1 Discharge	Cold Trap	S-4A Oil
SAMPLE POINT	Sx-23	Sx-23	Sx-30	Sx-32	Sx-33	Sx-37
Hydrogen – H_2			1.60	0.69		
Carbon Monoxide – CO			12.41	13.23		
Carbon Dioxide – CO_2			71.30	73.99		
Hydrogen Sulfide – H_2S			1.36			
Methane – CH_4			4.54	2.91		
Ethane – C_2H_6			4.31	4.41		
Propane – C_3H_8			4.03	4.77		
Butane – C_4H_{10}						
Nitrogen – N_2			0.19			
Ammonia – NH_3 (PPM)	0.12	0.12	0.26			
Light Oils – (0-100° C @ 1.6 Torr)						80.01
Solvent – (100-230°C @ 1.6 Torr)					4.90	18.50
Heavy Oil – (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water	99.88	99.88			95.10	1.49
Phenol						
TOTAL	100	100	100	100	100	100
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	1	2

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

WEIGHT PERCENT

Quantitative

SAMPLE DESCRIPTION	S-4A Water	S-4A Total	S-7 Btms	Absorbed Gas		
SAMPLE POINT	Sx-37	Sx-37	Sx-39	Calc.		
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2				98.02		
Hydrogen Sulfide – H_2S				1.89		
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.14	0.01		0.09		
Light Oils – (0-100° C @ 1.6 Torr)		75.92	29.50			
Solvent – (100-230°C @ 1.6 Torr)		17.56	65.90			
Heavy Oil – (230-255°C @ 1.6 Torr)			4.60			
SRL						
Coal (MAF)						
Ash						
Water	99.86	6.51				
Phenol						
TOTAL	100	100	100			
Pyridine Solubles (Wt % Ash free)						
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	–		

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MOLE PERCENT

SAMPLE DESCRIPTION	Makeup Gas	Product Gas	Recycle Gas	Feed Gas	S-4A Ovhd	J-1 Discharge
SAMPLE POINT	Sx-18	Sx-19	Sx-20	Sx-21	Sx-30	Sx-32
Hydrogen – H_2	49.78	46.95	57.80	53.41	23.22	11.81
Carbon Monoxide – CO	49.92	23.64	27.65	40.04	12.86	16.08
Carbon Dioxide – CO_2		17.99			47.04	57.23
Hydrogen Sulfide – H_2S		0.45			1.16	
Methane – CH_4		8.17	11.30	4.59	8.24	6.19
Ethane – C_2H_6		2.06	1.55	1.26	4.17	5.00
Propane – C_3H_8		0.35	0.70	0.30	2.66	3.69
Butane – C_4H_{10}						
Nitrogen – N_2	0.30	0.35	1.00	0.40	0.20	
Ammonia – NH_3 (PPM)		0.04			0.45	
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230°C @ 1.6 Torr)						
Heavy Oil – (230-255°C @1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100	100	100	100	100	100
Calc Mole Wt.	15.06	17.81	11.76	13.64	29.03	34.03
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.	2	2	2	2	2	2

Elemental

PROJECT LIGNITE
SAMPLE ANALYSIS

Updated: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MOLE PERCENT

SAMPLE DESCRIPTION	Absorbed Gas					
SAMPLE POINT	Calc					
Hydrogen – H_2						
Carbon Monoxide – CO						
Carbon Dioxide – CO_2	97.35					
Hydrogen Sulfide – H_2S	2.43					
Methane – CH_4						
Ethane – C_2H_6						
Propane – C_3H_8						
Butane – C_4H_{10}						
Nitrogen – N_2						
Ammonia – NH_3 (PPM)	0.22					
Light Oils – (0-100° C @ 1.6 Torr)						
Solvent – (100-230° C @ 1.6 Torr)						
Heavy Oil – (230-255° C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water						
Phenol						
TOTAL	100					
Calc. Mole Wt.	43.70					
Melting Point °F						
Specific Gravity 60/60						
Viscosity, cp						

Quantitative

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						
Number of Sample Avg.						

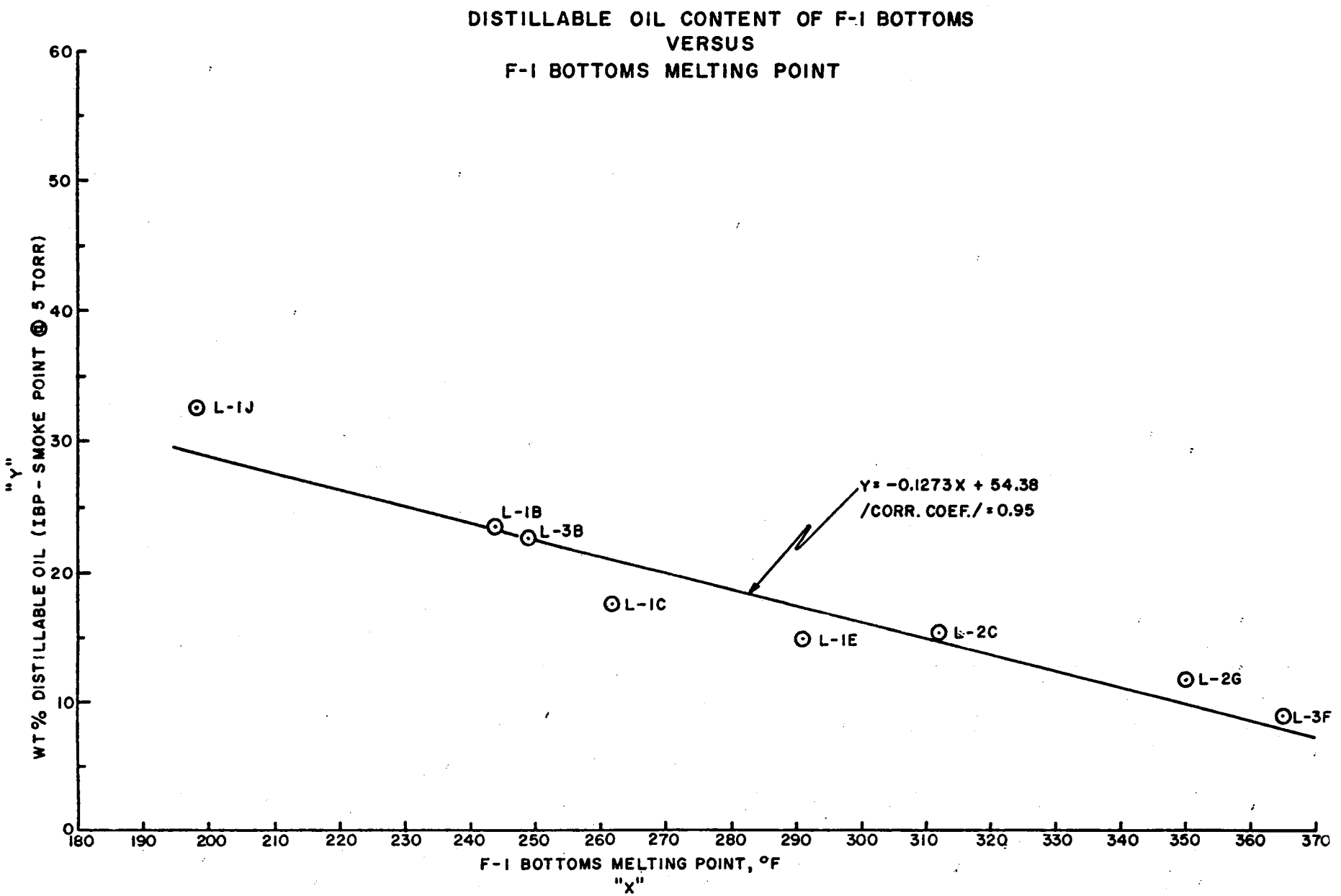
Elemental

PROJECT LIGNITE
SAMPLE ANALYSES
RUN NO: L-2I
DATE: 9/19-20/77
TIME: 1400-0145

SAMPLE DESCRIPTION	LEC Btms	Feed Solv.	S-8 Oil	S-4A Oil	S-7 Btms
SAMPLE POINT	Sx-12	Sx-14	Sx-16	Sx-37	Sx-39
ASTM D-1160 DISTILLATION DATA					
PRESSURE, TORR	5	5			5
IBP	25	26.6			22
5%	68.6	77			81.8
10%	71.3	83			89.8
20%	77.6	93.8			104.5
30%	82.8	106.3			123.0
40%	87.8	125.4			144.8
50%	95.6	150.3			165.0
60%	105.4	169.8			177.2
70%	119.6	182			187.4
80%	142.6	195.2			202.2
90%	172.5	234.5			238.8
95%	188.5	260			
DRY PT.	199.6				238.8
ASTM D-86 DISTILLATION DATA					
BAROMETRIC PRESSURE, TORR			740	739	
IBP			53	92	
5%			58	129	
10%			67	187	
20%			89	197	
30%			104	204	
40%			123	214	
50%			141	226	
60%			160	237	
70%			175	257	
80%			196	274	
90%			236	334	
95%					
DRY PT.			268	338	
ASPHALTENE TEST					
WT % ASH					
WT % UNCONVERTED COAL					
WT % PRE-ASPHALTENES					
WT % ASPHALTENES					
WT % MALTENES & DIST. OIL					
TOTAL					
SAYBOLT VISCOSITY, SSU					
100° F					
210° F					
MISCELLANEOUS					
KF H_2O WT%(Raw Sx)		0.89		1.49	1.15
INFRARED RATIO					
SP. GRAV. 60/60 F	0.991				

VOLUME PERCENT — TEMPERATURE, °C

PREASPHALTENES - PYRIDINE SOLUBLE, BENZENE INSOLUBLE MATERIAL
ASPHALTENES- BENZENE SOLUBLE, N-PENTANE INSOLUBLE MATERIAL
MALTENES- N-PENTANE SOLUBLE MATERIAL NOT RECOVERABLE BY STANDARD DISTILLATION PROCEDURES
DISTILLABLE OIL - RECOVERABLE BY DISTILLATION.


DISTILLABLE OIL CONTENT OF F-1 BOTTOMS
VERSUS
F-1 BOTTOMS MELTING POINT
WT% DISTILLABLE OIL (IBP - SMOKE POINT @ 5 TORR)
"Y"
F-1 BOTTOMS MELTING POINT, °F
"X"
Y = -0.1273X + 54.38
/CORR. COEF./ = 0.95
L-1J
L-1B
L-3B
L-1C
L-1E
L-2C
L-2G
L-3F
0
10
20
30
40
50
60
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MATERIAL IN

lbs/hr.

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

Quantitative

STREAM DESCRIPTION	← Feed Recycle Gas	Gas → Makeup Gas	Lignite	Feed Solvent		Total In
SAMPLE POINT	Sx-20	Sx-18	Sx-1	Sx-14		
Hydrogen - H_2	0.68	0.70				1.38
Carbon Monoxide - CO	4.57	9.78				14.35
Carbon Dioxide - CO_2						
Hydrogen Sulfide - H_2S						
Methane - CH_4	1.07					1.07
Ethane - C_2H_6	0.27					0.27
Propane - C_3H_8	0.18					0.18
Butane - C_4H_{10}						
Nitrogen - N_2	0.17	0.06				0.23
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)				34.60		34.60
Solvent - (100-230°C @ 1.6 Torr)				52.70		52.70
Heavy Oil - (230-255°C @ 1.6 Torr)				3.39		3.39
SRL						
Coal (MAF)			30.68			30.68
Ash			3.03			3.03
Water			16.35	0.81		17.16
Phenol						
TOTAL	6.94	10.54	50.06	91.50		159.04

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MATERIAL OUT

lbs/hr.

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

Quantitative

STREAM DESCRIPTION	← Product Gas		→	S-4A	S-4B	S-8
	Vent Gas	Recycle Gas	Absorbed Gas	Ovhd	Btms	Ovhd
SAMPLE POINT	Sx-20	Sx-20	Calc	Sx-30	Sx-23	Sx-44
Hydrogen - H_2	0.28	0.68		0.08		
Carbon Monoxide - CO	1.84	4.57		0.61		
Carbon Dioxide - CO_2			8.18	3.51		
Hydrogen Sulfide - H_2S			0.16	0.07		
Methane - CH_4	0.43	1.07		0.22		
Ethane - C_2H_6	0.11	0.27		0.21		
Propane - C_3H_8	0.07	0.18		0.20		
Butane - C_4H_{10}						
Nitrogen - N_2	0.07	0.17		0.01		
Ammonia - NH_3			0.01	0.01	0.02	
Light Oil - (0-100° C @ 1.6 Torr)						
Solvent - (100-230°C @ 1.6 Torr)						
Heavy Oil - (230-255°C @ 1.6 Torr)						
SRL						
Coal (MAF)						
Ash						
Water					15.03	
Phenol						
TOTAL	2.80	6.94	8.35	4.92	15.05	Negl.

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE
MEASURED MATERIAL BALANCE
Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MATERIAL OUT

lbs/hr.

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

Quantitative

STREAM DESCRIPTION	S-8 Btms	J-1 Exhaust	Cold Trap	F-1 Btms	← Recycle S-7 Btms	Solvent → F-2 Btms
SAMPLE POINT	Sx-16	Sx-32	Sx-33	Sx-2	Sx-39	Sx-12
Hydrogen - H_2		0.01				
Carbon Monoxide - CO		0.06				
Carbon Dioxide - CO_2		0.33				
Hydrogen Sulfide - H_2S						
Methane - CH_4		0.01				
Ethane - C_2H_6		0.01				
Propane - C_3H_8		0.02				
Butane - C_4H_{10}						
Nitrogen - N_2						
Ammonia - NH_3						
Light Oil - (0-100° C @ 1.6 Torr)	4.54				19.65	16.63
Solvent - (100-230°C @ 1.6 Torr)	0.19		0.01	0.17	43.90	6.46
Heavy Oil - (230-255°C @ 1.6 Torr)					3.07	0.40
SRL				14.63		
Coal (MAF)				2.02		
Ash				2.26		
Water			0.25			
Phenol						
TOTAL	4.73	0.44	0.26	19.08	66.62	23.49

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

PROJECT LIGNITE

MEASURED MATERIAL BALANCE

Revised: 3/6/78

Run No: L-2I
Date: 9/19-20/77
Time: 1400-0145

MATERIAL OUT

lbs/hr.

Temperature: 738°F
Pressure: 2450 psig
LHSV: 1.42
GHSV: 340

Quantitative

STREAM DESCRIPTION						Total Out
SAMPLE POINT						
Hydrogen - H_2						1.05
Carbon Monoxide - CO						7.08
Carbon Dioxide - CO_2						12.02
Hydrogen Sulfide - H_2S						0.23
Methane - CH_4						1.73
Ethane - C_2H_6						0.60
Propane - C_3H_8						0.47
Butane - C_4H_{10}						
Nitrogen - N_2						0.25
Ammonia - NH_3						0.04
Light Oil - (0-100° C @ 1.6 Torr)						40.82
Solvent - (100-230° C @ 1.6 Torr)						50.73
Heavy Oil - (230-255°C @ 1.6 Torr)						3.47
SRL						14.63
Cool (MAF)						2.02
Ash						2.26
Water						15.28
Phenol						
TOTAL						152.68

Elemental

Carbon						
Hydrogen						
Nitrogen						
Sulfur						
Oxygen (by diff)						
Ash						
TOTAL						

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