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FINAL REPORT

on

A NOVEL APPROACH TO COAL GASIFICATION USING CHEMICALLY INCORPORATED CATALYSTS (PHASE II)

APPENDIX A-F

For Period May, 1978 to
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to

United States Department of Energy

by

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APPENDIX A

EXPERIMENTAL APPARATUS, TEST CONDITIONS AND RESULTS OF CATALYTIC COAL TREATMENT

Experimental Apparatus

In this section of the appendix are descriptions of the following experimental apparatus:

(1) Batch and Continuous Treatment Equipment

(2) Batch Solids Fluid Bed (BSFB) Gasifier

(3) Thermogravimetric Analyzer (TGA)

In addition, a description of the Battelle developed agglomerating index (AI) is also included.

Batch Treatment Equipment

The batch experiments on production of BTC are conducted in a "quick-charge", one-gallon autoclave system shown schematically in Figure A-1. In the majority of the experiments, the autoclave is first charged with 3000 g coal of desired size, CaO, and water, and the mixture is brought up to the operating temperature and then NaOH solution may be added through the charging bomb. In some cases, the CaO is added to the preheated autoclave through the charging bomb. On adding the charge to the autoclave, the autoclave temperature drops at first but is back up to the operating temperature in 3 to 5 minutes, at which time the measurement of retention (treatment) time is started. Samples of coal-catalyst slurry can be withdrawn from the autoclave during a run. The samples withdrawn from the autoclave are quickly quenched. The calcium-impregnated (treated) coal is separated from spent catalyst solution and for high sodium treatments, washed under nitrogen atmosphere with distilled water at 35 C.

Continuous Coal Preparation Pilot Plant

A high pressure continuous coal preparation pilot plant is shown schematically in Figure A-2. The facility is composed of the following sections:

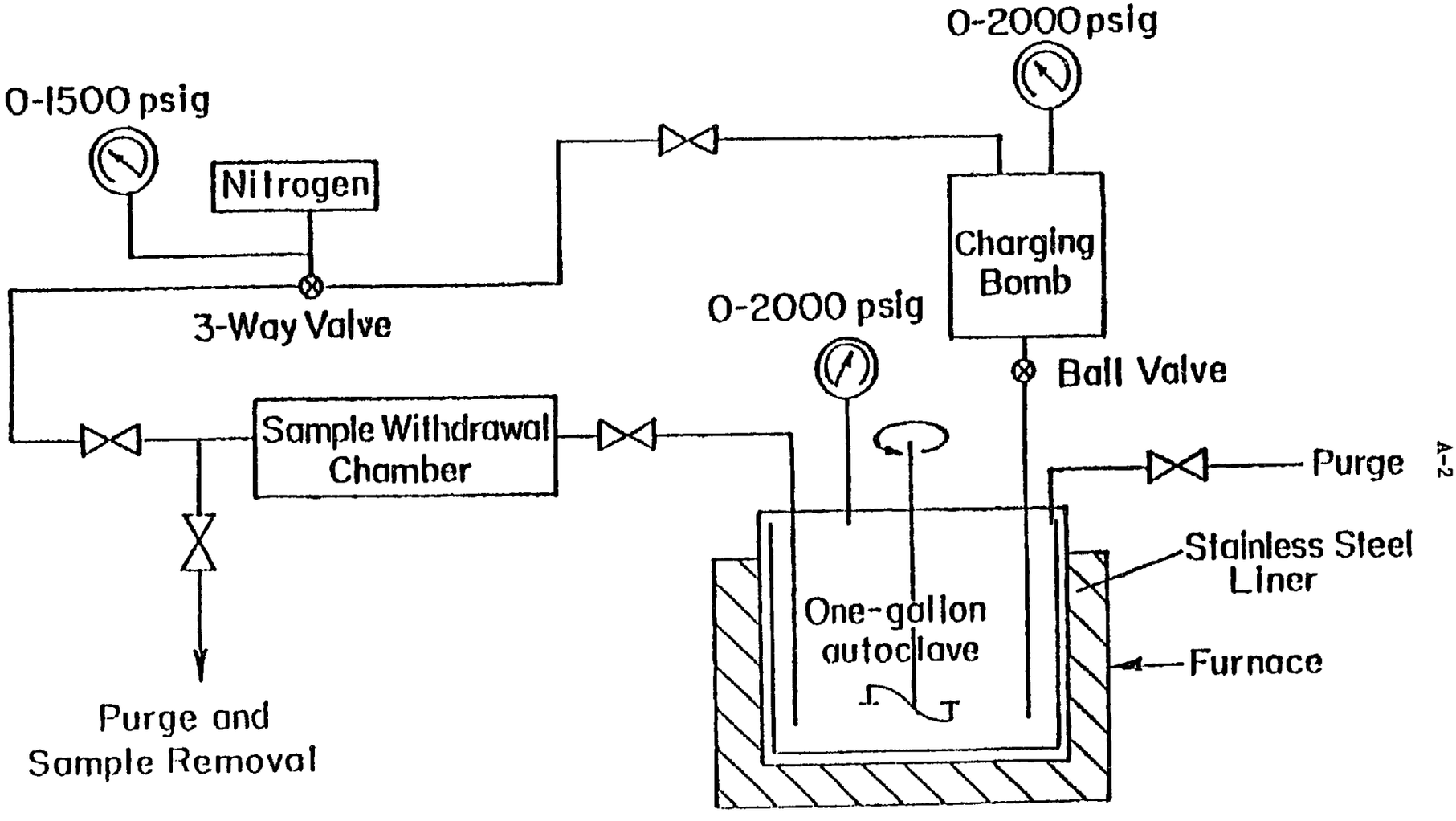

Figure A-1. SCHEMATIC DIAGRAM OF THE ONE-GALLON AUTOCLAVE SYSTEM

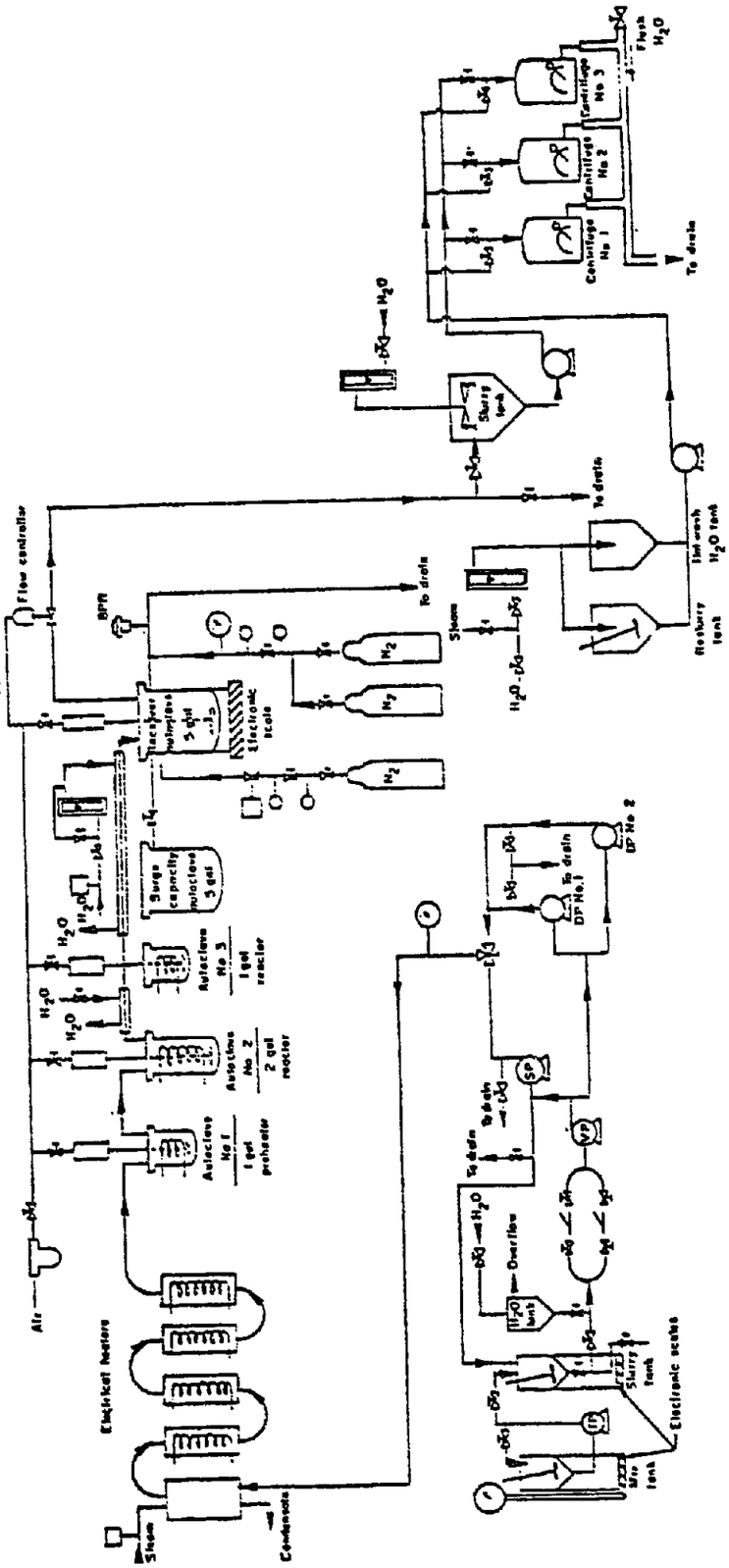

Figure A-2. CONTINUOUS HYDROTHERMAL PILOT PLANT

(1) Coal and reactant slurry preparation,

(2) Slurry pressurization,

(3) Preheating,

(4) Reaction,

(5) Cooling,

(6) Pressure reduction,

(7) Solids/liquid separation, and

(8) Coal drying (not shown in the figure).

Coal was first ground in a Fitz Mill comminuter and separated in a Sweeco vibratory separator. Coal sizes in the range of -20 mesh (the maximum size compatible with the Miniplant) to -200 mesh were prepared in this system. Ground coal and activation reactants were weighed, mixed and pumped to the high pressure pumps. Two high pressure reciprocating pumps, a single and double pump, were available to allow operation over a range of flow rates, i.e., from 5 to 30 gal/hr. The slurry exiting the pumps first passes through a steam preheater and then through four electrical resistance plug-flow heaters before entering the first autoclave, which is also used as a preheater. The slurry exiting the first 1-gal continuously stirred autoclave preheated entered a 2-gal reaction system. The temperature in each preheater and autoclave reactor was maintained at the desired set point by electronic temperature controllers. The maximum operating pressure and temperature are 1000 psig and 275 C. After reaction, the slurry was then fed to one of three basket centrifugal filters. The centrifuge filter cake, typically containing 75-80 percent solids, was fed batchwise to a steam-heated rotary dryer.

Batch-Solids Fluid-Bed Gasifier

A batch-solids fluid-bed (BSFB) gasifier is shown schematically in Figure A-3. The reactor tube is 1-1/2-inch I.D. x 3-inch O.D. x 48 inches long and is fabricated from Haynes 188 Superalloy bar stock. A 36-inch long furnace is used to heat the reactor to temperatures up to 1100 C. The distributor plate, located at the center of the reactor tube, is made of 100-mesh stainless steel tube. The thin-wall tube can be removed easily from the reactor tube for recovery of char from the reactor at the end of a run, and is mounted such that the feed gases cannot flow through the small

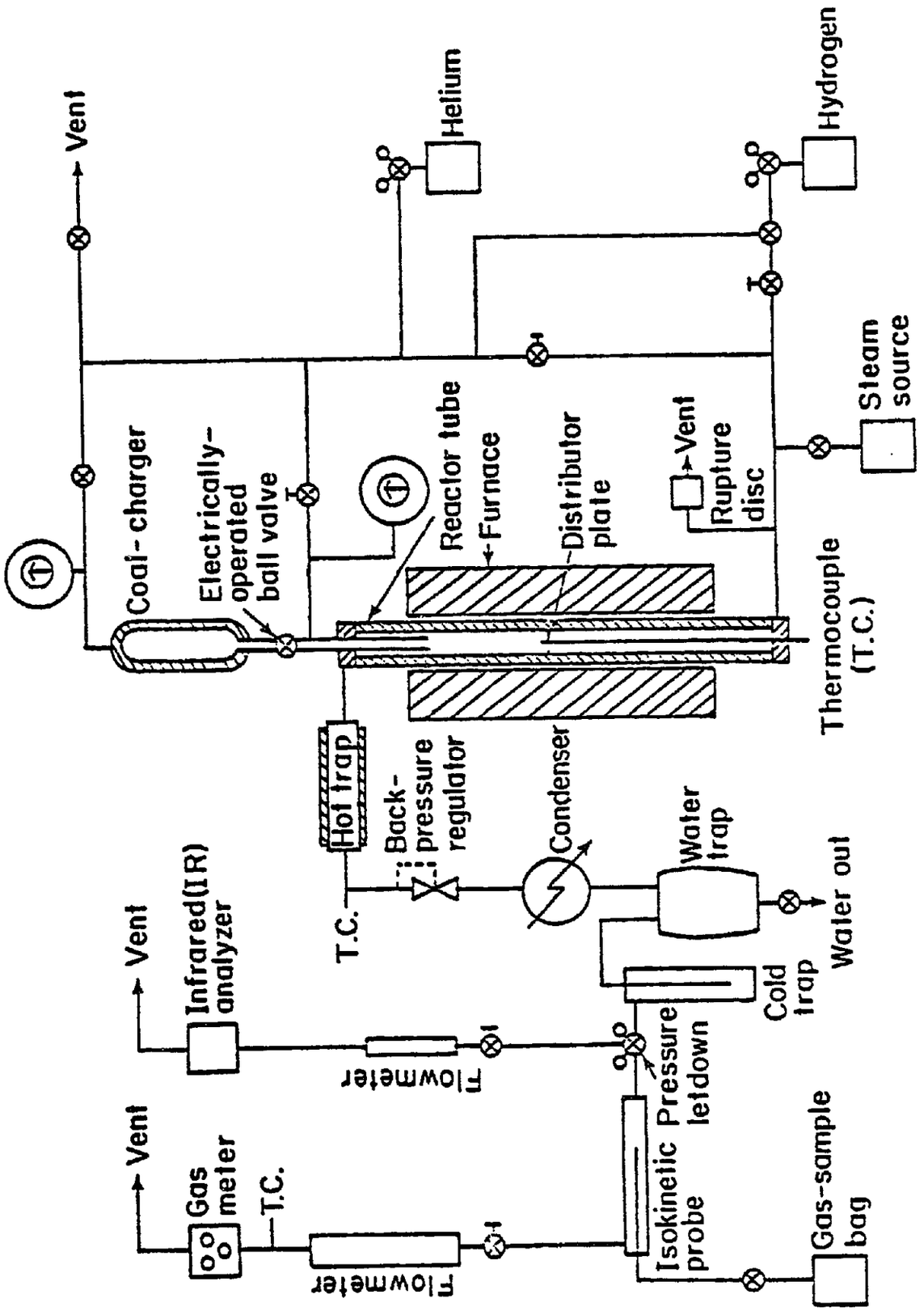

FIGURE A-3. SCHEMATIC OF THE BATCH-SOLIDS FLUID-BED GASIFIER

gap between the thin-wall tube and the reactor tube. A thermocouple is placed in the bed of coal one inch from the distributor plate. The furnace is biased to give a constant temperature zone encompassing the fluid-bed zone.

A 50 g batch of coal can be charged through an electrically-operated ball valve in less than 10 seconds. The portion of the coal-feeding line below the ball valve, called the dip tube, is always purged with helium to prevent condensation of steam, tars, and other condensables. The coal-charges can be pressurized with helium and depressurized regardless of the pressure and the temperature inside the reactor tube.

The rate of flow of various feed gases through the bottom of the reactor is controlled by fine metering valves and the pressure on the upstream and downstream sides of the metering valves.

The reactor is designed to operate at 1000 psig at 1100 C. The pressure in the reactor is precisely controlled with a back-pressure regulator.

The product gas is allowed to pass through, in order, a hot trap, a water condenser, a water trap, and a cold trap prior to gas analysis. The total valume of product gas is determined with a dry gas meter. The product gas is continuously sampled by a infrared detector to determine methane concentration and by an isokinetic probe to collect a gas sample for gas chromatographic analysis to determine the overall gas composition.

Thermobalance (TGA)

The high-pressure thermobalance (TGA) reactor to be used for this study is shown schematically in Figure A-4. The reactor system consists of two zones. The upper zone houses the thermobalance assembly while the lower zone is used for gasification of coal. Ther thermobalance assembly can withstand high pressures but not high temperatures. Therefore, to protect the thermobalance from high temperatures, the upper zone of the reactor is constantly purged with helium during the run. The upper zone can be completely isolated from the lower zone by the use of a ball valve and can be pressurized or depressurized irrespective of the temperature and the pressure in the lower zone. The reactor tube is 3/4-in. I.D., 2-1/2-in. O.D., and 48 inches long and is constructed of Haynes 188 superalloy. The temperature of the basket

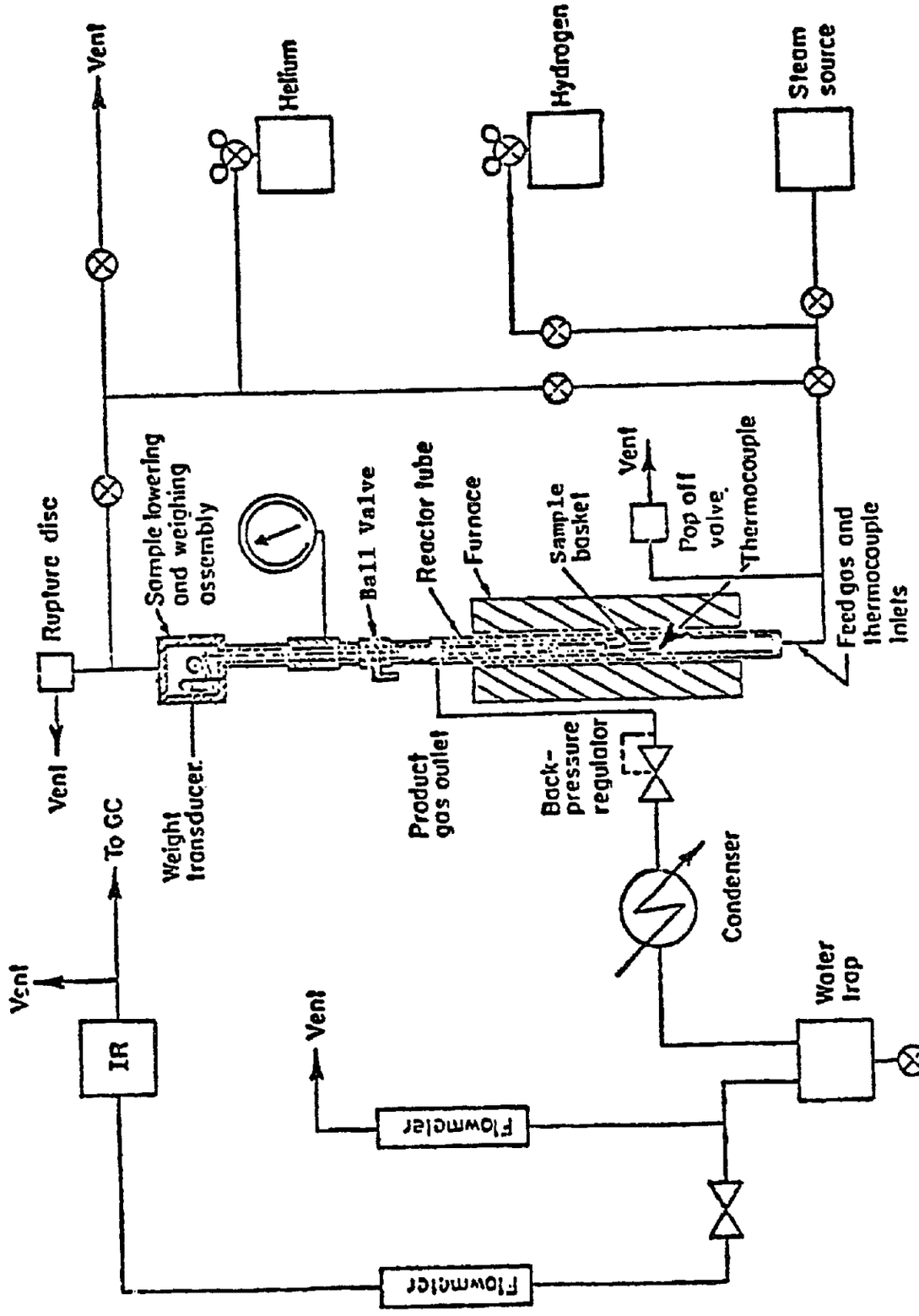

FIGURE A-4. SCHEMATIC OF THERMOBALANCE (TGA) REACTOR SYSTEM

is sensed by a thermocouple placed 1/4 inch below it. A proportional-integral-digital (PDI) controller is used for controlling the temperature of the furnace at a suitable value so that the sample is maintained at the desired temperature. The sample basket is 5-3/4 inches long, having a diamter of 3/8 inch, and is made of 100-mesh stainless steel or nickel screen. The basket is suspended from the end of a 3-mil nichrome hang-down wire.

The sample basket can be raised and lowered at the rate of about 3/4 inch per second using a motor-operated windlass. Thus, it takes less than a minute to lower the sample into the desired position. A dip tube that is constantly purged with helium extends from the upper zone to about 10 inches from the basket. Thus, while lowering the sample basket, only a few seconds are allowed for the sample to contact reactive gases before the transducer starts to indicate the mass of the sample. Similarly, the gasification reaction can be stopped in a matter of a few seconds simply by raising the sample basket a few inches.

A preheater is used to produce steam or to heat hydrogen or other gases to 500 C or higher. An infrared detector (IR) from Mine Safety Appliance Company (Lira 300) is used to continuously monitor the methane concentration of the product gas. A gas chromatograph (GC) from Carle Instrument Company can be used to determine the overall composition of product gases. Other parts of the system include a trap that can be operated at an elevated temperature for capturing tar and solid particles, a back-pressure controller that can be operated up to 500 C, a condenser for steam, a trap for condensed water, several flowmeters, a wet test meter, and a gas collection bag.

During a TGA run, the weight of coal is continuously monitored. From the weight versus time data, the fractional conversion as a function of time can then be determined. The fractional conversion of coal on an MAF basis is defined as

$$X = \frac{W_o - W_t - W_m}{W_o - W_a - W_m}$$

where W_o is the initial sample weight, W_t is the sample weight at any time t, W_a is the weight of ash, and W_m is the weight of moisture of the initial sample. It is assumed that the moisture is quickly released on exposure of the coal sample to the reactor environment.

Development of an Agglomeration Index (AI)

A test to measure the agglomerating tendency of coals had been developed and applied in the Lurgi trials in Westfield, Scotland.* The test consisted of determining, by trial and error, the amount of sand which could be mixed with one gram of coal, coked briefly at 850 C, cooled, and carefully separated such that 1.0 g of nonagglomerated material was produced. The trial and error feature of the test, which required multiple determinations to obtain a result, was considered unattractive for application to this work.

The test was modified by adding a fixed amount of 30 x 50 mesh quartz sand to 1.0 g of -30 mesh coal, coking at 650 C in a crucible, cooling in an inert atmosphere, removing the nonagglomerated material by carefully screening on a 30 mesh screen, and recording the weight of +30 mesh material. Three sand/quartz mixutres were tried, 5:1, 10:1, and 15:1, with 10:1 chosen since the worst agglomerating coals gave a small amount of nonagglomerated material at this ratio. It was necessary to run the samples in duplicate because the resulting agglomerates are weakly bonded and can be easily broken during screening. Repeatability was about $\pm$ 10 percent for the weight retained on the screen or $\pm$ 1 point on the index value explained below. An Agglomeration Index (AI), varying from 1 to 10, was calculated from the following equation:

$$AI = \frac{\text{wt +30 mesh material x 10}}{\text{wt total material after coking}}$$

Thus, the higher the AI value the worse the coal agglomerates. The relationship between AI and Free Swelling Index (FSI) was investigated by plotting the AI and FSI values for treated and untreated coal sample used in this work. It is clear that the agglomerating and swelling tendencies of coal are not directly related. Based on the limited data available, it is possible to have a highly swelling coal (FSI = 9) which has a moderate agglomerating tendency (AI = 3.3) or a moderately swelling coal (FSI = 1.5) with a large agglomerating tendency (AI = 8.5). It appears that if gas is produced when a coal devolatilizes it is highly swelling and if a liquid is produced it is highly agglomerating.

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* Trials of American Coal in a Lurgi Gasifier at Westfield, Scotland, ERDA Report No. 105, Final Report.

Test Conditions

Presented in this appendix are tables and figures covering the following areas:

Table A-1	Treatment conditions for BTC prepared in the Continuous Miniplant
Table A-2	BTC Physical and Chemical Properties
Table A-3	BSFB Hydrogasification Run Summaries
Table A-4	BSFB Steam/H_2 Gasification Run Summaries
Table A-5	Raw Coal Physical and Chemical Properties

TABLE A1. TREATMENT CONDITIONS FOR BTC PREPARED IN THE CONTINUOUS MINIPLANT

BTC No.	Type of Coal	Treatment Temperature, °C	Treatment Pressure, psig	CaO/Coal	NaOH/Coal	Average Residence Time, min		Drying Method(a)	Comments
						Temp	Press		
1	Ill No. 6, Batch 1	262	1026	0.08	0.0	22.5		SD	
2	Ill No. 6, Batch 1	270	1016	0.08	0.0	20.5		SD	
3	Ill No. 6, Batch 1	276	1000	0.05	0.0	17.5		SD	
4	Ill No. 6, Batch 1	272	1000	0.05	0.0	10.1		SD	
5	Ill No. 6, Batch 1	274	1000	0.05	0.0	17.6		SD	
6	Ill No. 6, Batch 1	266	1000	0.05	0.0	9.6		SD	
7	Ill No. 6, River King	273	1041	0.05	0.001	10.1		SD	
8	Ill No. 6, River King	275	1023	0.05	0.003	10.0		SD	
9	Ill No. 6, Batch 1	276	1029	0.05	0.0	14.2		SD	
10	Ill No. 6, Batch 1	279	1041	0.05	0.0	10.2		SD	
11	Ill No. 6, Batch 1	274	1022	0.05	0.0	19.9		SD	
12	Ill No. 6, Batch 1	274	1050	0.05	0.0	12.9		SD	
13	Ill No. 6, Batch 1	279	1017	0.05	0.0	10.4		SD	
14A	Ill No. 6, Batch 2	276	1022	0.10	0.0	28.4		SD	
14B	Ill No. 6, Batch 2	279	1006	0.10	0.0	71.9		VO	
15	Ill No. 6, Batch 2	276	1053	0.05	0.003	31.4		VO/SD	
16	Ill No. 6, Batch 2	277	1052	0.05	0.003	27.4		SD/VO	
17	Ill No. 6, Batch 2	278	1024	0.05	0	28.7		VO	
18-RT	Ill No. 6, Batch 2	28	1020	0.05	0	28.2		SD	
18-100	Ill No. 6, Batch 2	114	1023	0.10	0	28.2		SD	
18-150	Ill No. 6, Batch 2	153	1025	0.10	0	28		VO	
18-225	Ill No. 6, Batch 2	226	1050	0.10	0	27.8		VO	
18-275	Ill No. 6, Batch 2	276	1010	0.10	0	27.8		VO	
19-2	Ill No. 6, Batch 2	32	0	0.10	0	2		VO	
19-15	Ill No. 6, Batch 2	32	0	0.10	0	15		VO	
19-26	Ill No. 6, Batch 2	32	0	0.10	0	26		VO	
19-38	Ill No. 6, Batch 2	31	0	0.10	0	38		VO	
19-51	Ill No. 6, Batch 2	31	0	0.10	0	51		VO	
19-64	Ill No. 6, Batch 2	31	0	0.10	0	64		VO	
19-130	Ill No. 6, Batch 2	30	0	0.10	0	130		VO	
19-210	Ill No. 6, Batch 2	30	0	0.10	0	210		VO	
19-250	Ill No. 6, Batch 2	30	0	0.10	0	250		VO	
20-2	Ill No. 6, Batch 2	30	0	0.05	0	2		VO	
20-16	Ill No. 6, Batch 2	30	0	0.05	0	16		VO	
20-23	Ill No. 6, Batch 2	30	0	0.05	0	23		VO	
20-36	Ill No. 6, Batch 2	30	0	0.05	0	36		VO	
20-47	Ill No. 6, Batch 2	30	0	0.05	0.0	47		VO	
20-60	Ill No. 6, Batch 2	29	0	0.05	0	60		VO	
20-120	Ill No. 6, Batch 2	29	0	0.05	0	120		VO	
20-180	Ill No. 6, Batch 2	29	0	0.05	0	180		VO	
20-240	Ill No. 6, Batch 2	29	0	0.05	0	240		VO	

TABLE A1. (Continued)

BTC No.	Type of Coal	Treatment Temperature, °C	Treatment Pressure, psig	CaO/Coal	NaOH/Coal	Average Residence Time, min		Drying Method[a]	Comments
						Temp	Press		
20-23H	Ill No. 6, Batch 2	25	0	0.05	0	1380		VO	
20-52H	Ill No. 6, Batch 2	25	0	0.05	0	3120		VO	
21A-21B	Ill No. 6, Batch 2	276	1023	0.10	0	11.0		VO	
22	Ill No. 6, Batch 2	275	1044	0.10	0.003	10.6		SD	
23A	Ill No. 6, Batch 2	277	1038	0.10	0.003	11.7		SD	
23B	Ill No. 6, Batch 2	276	1033	0.10	0.003	13.8		SD	
24	Ill No. 6, Batch 2	275	1060	0.10	0.003	11.3		VO	
25A-30	Ill No. 6, Batch 2	25	0	0.10	0.003	30		VO	
25A-60	Ill No. 6, Batch 2	25	0	0.10	0.003	60		VO	
25A-120	Ill No. 6, Batch 2	25	0	0.10	0.003	120		VO	
25B	Ill No. 6, Batch 2	25	500	0.10	0.003	27.5		VO	
25C	Ill No. 6, Batch 2	25	1000	0.10	0.003	27.5		VO	
25D	Ill No. 6, Batch 2	150	1000	0.10	0.003	10		VO	
26A	Ill No. 6, Batch 2	275	1000	0.05	0.003	10		VO	
28B	Ill No. 6, Batch 2	25	0	0.0	0.0	30		SD	
28E	Ill No. 6, Batch 2	25	0	0.10	0.003	30		SD	
29-3	Ill No. 6, Batch 2	23	1030	0.10	0.003	3.5		MSD	
29-6	Ill No. 6, Batch 2	26	1033	0.10	0.003	6.2			
29-11	Ill No. 6, Batch 2	26	1040	0.10	0.003	11.2		MSD	
29-17	Ill No. 6, Batch 2	31	1020	0.10	0.003	17.6		MSD	
29-71	Ill No. 6, Batch 2	25	1031	0.10	0.003	70.9			
30	Ill No. 6, Batch 2	29	0	0.10	0.003	60		MSD	
31-5	Ill No. 6, Batch 2	25	1005	0.10	0.003	5.9			
31-10	Ill No. 6, Batch 2	25	1023	0.10	0.003	10.2		MSD	
32	Ill No. 6, Batch 2	31	1024	0.10	0.003	27.3	27.3	MSD	
33	Ill No. 6, Batch 2	31	1024	0.10	0.0	9.8		MSD	
34A	Pittsburgh No. 8, Montour #4	25	0	0.10	0.01	30		MSD	
34B	Pittsburgh No. 8, Montour #4	273	1000	0.10	0.01	10	31	MSD	
34C	Pittsburgh No. 8, Montour #4	35	0	0	0.0	30		MSD	
35A	Pittsburgh No. 8, Montour #4	25	0	0.15	0.005	133		MSD	
35B	Pittsburgh No. 8, Montour #4	276	1000	0.15	0.005	10	30	VO	
36A	Pittsburgh No. 8, Montour #4	25	0	0.15	0.01	35	35	MSD	
36B	Pittsburgh No. 8, Montour #4	272	1008	0.15	0.01	11	33	MSD	
37	Ill No. 6, Batch 3	38	945	0.10	0.003	32	32	MSD	
38	Ill No. 6, Batch 3	89	508	0.10	0.003	31	31	MSD	
39	Ill No. 6, Batch 3	91	254	0.10	0.003	32	32	MSD	
40	Ill No. 6, Batch 3	92	50	0.10	0.003	31	31	MSD	
41	Ill No. 6, Batch 3	93	994	0.15	0.003	31	31	MSD	
42	Ill No. 6, Batch 3	92	990	0.10	0.01	32	32	MSD	
43	Ill No. 6, Batch 3	92	994	0.10	0.01	30	30	MSD	

TABLE A1. (Continued)

BTC No.	Type of Coal	Treatment Temperature, °C	Treatment Pressure, psig	CaO/Coal	NaOH/Coal	Average Residence Time, min		Drying Method[a]	Comments
						Temp	Press		
44	Ill No. 6, Batch 3	277	998	0.10	0.003	10	30	MSD	
45	Ill No. 6, Batch 3	107	980	0.15	0.01	60	66	MSD	
46	Ill No. 6, Batch 3	276	1004	0.15	0.01	20	64	MSD	
47	Ill No. 6, Batch 3	274	1010	0.15	0.01	20	63	MSD	
48	Ill No. 6, Batch 3	276	1012	0.15	0.003	19	68	MSD	
49	Ill No. 6, Batch 3	277	1010	0.10	0.003	19	69	MSD	
50	Ill No. 6, Batch 3	273	995	0.10	0.003	10	35	MSD	
51	Ill No. 6, Batch 3	45	957	0.10	0.003	27	27	MSD	
51-S	Ill No. 6, Batch 3	45	957	0.10	0.003	27	27	SSD	
52	Ill No. 6, Batch 3	273	960	0.10	0.003	10	30	MSD	
52-S	Ill No. 6, Batch 3	273	960	0.10	0.003	10	30	SSD	
53	Ill No. 6, Batch 3	38	945	0.10	0.003	32	32	MSD	Pelletized
53	Ill No. 6, Batch 3	38	945	0.10	0.003	32	32	MSD	
54	Ill No. 6, Batch 4	42	1005	0.15	0.003	34	34	VO	
55	Ill No. 6, Batch 4	47	1007	0.10	0.003	31	31	VO	
56A	Ill No. 6, Perry Co.	44	999	0.15	0.003	33	33	VO	
57A	Ill No. 6, Perry Co.	41	965	0.10	0.003	32	32	VO	
58A	Ill No. 6, Perry Co.	40	1000	0.05	0.003	33	33	VO	
59A	Ill No. 6, Perry Co.	43	993	0.10	0.0	31	31	VO	
60A	Ill No. 6, Batch 4	44	999	0.15	0.003	32	32	MSD	
61A	Ohio No. 9	42	948	0.15	0.003	31	31	MSD	
62A	Ohio No. 9	273	1052	0.10	0.003	10	30	MSD	
63	Ohio No. 9								Aborted
64A	Kentucky No. 9	37	985	0.15	0.003	25	25	MSD	
65A	Kentucky No. 9	43	993	0.15	0.006	23	23	MSD	
66A	Kentucky No. 9	40	985	0.15	0.01	26	26	MSD	
67	Kentucky No. 9	231	985	0.15	0.01	Valve Stuck		MSD	
68	Illinois No. 6, Batch 4	275	986	0.15	0.006	10	30	MSD	
69	Illinois No. 6, Batch 4	277	1000	0.10	0.15	10	30	MSD	Washed Twice
70A	Indiana No. 5	39	989	0.15	0.003	29	29	MSD	
71A	Indiana No. 5	39	983	0.15	0.01	29	29	MSD	
72	Indiana No. 5	275	998	0.15	0.003	10	30	MSD	
73	Indiana No. 5	273	1000	0.15	0.01	10	30	MSD	
74A	Ill No. 5	39	1009	0.15	0.003	29	29	MSD	
75	Ill No. 5	36	991	0.15	0.01	31	31	MSD	
76A	Ill No. 5	271	993	0.15	0.003	10	30	MSD	
77	Ill No. 5	273	995	0.15	0.01	10	30	MSD	
78A	Ill No. 6, Batch 4	81	50	0.15	0.01	34	34	MSD	
78B	Ill No. 6, Batch 4	25	0	0.15	0.01	30	30	MSD	
79	Ill No. 6, Batch 4	104	102	0.15	0.01	32	32	MSD	
80	Ill No. 6, Batch 4	127	150	0.15	0.01	34	34	MSD	

TABLE A1. (Continued)

BTC No.	Type of Coal	Treatment Temperature, °C	Treatment Pressure, psig	CaO/Coal	NaOH/Coal	Average Residence Time, min		Drying Method[a]	Comments
						Temp	Press		
81	Ill No. 6, Batch 4	117	155	0.15PL	0.01	34	34	MSD	Pebble Lime
82	Ill No. 6, Batch 4	96	992	0.15	0.01	30	30	MSD	
83A	Ill No. 6, Batch 4	41	51	0.05PL	0.0	32	32	MSD	Pebble Lime
83B	Ill No. 6, Batch 4	~60	0	0.05PL	0.0	75	75	VO	Pebble Lime
84A	Ill No. 6, Batch 4	90	50	0.05PL	0.003	34	34	MSD	Pebble Lime
84B	Ill No. 6, Batch 4	~60	0	0.05PL	0.003	84	84	VO	Pebble Lime
85A	Ill No. 6, Batch 4	91	49	0.03PL	0.003	31	31	MSD	Pebble Lime
85B	Ill No. 6, Batch 4	~60	0	0.03PL	0.003	75	75	VO	Pebble Lime
86	Ill No. 6, Batch 4	91	26	0.03	0.003	32	32	MSD	
87	Ill No. 6, Batch 4	93	50	0.05	0.003	30		MSD	
88	Ill No. 6, Batch 4	34	50	0.05	0.003	32	32	MSD	
89	Ill No. 6, Batch 4	36	24	0.05	0.003	30	30	MSD	
90	Ill No. 6, Batch 4	89	0	0.15	0.01	60	60	MSD	
91	Ill No. 6, Batch 4	90	0	0.10	0.003	60	60	MSD	
92	Ill No. 6, Batch 4	90	0	0.05	0.003	60	60	MSD	
93	Ill No. 6, Batch 4	41	1003	0.15	0.003	30	30		Pelletized
94	Ill No. 6, Batch 4	91	0	0.05	0.0	60	60	MSD	
95	Ill No. 6, Batch 4	90	0	0.0	0.01	60	60	MSD	
96A	Ill No. 6, Batch 4	89	0	0.0	0.0	60	60		Variable
97	Ill No. 6, Batch 4	90	50	0.0	0.0	31	31	MSD	
98	Ill No. 6, Batch 4	91	49	0.03	0.0	33	33	MSD	
99	Ill No. 6, Batch 4	91	48	0.02	0.0	31	31	MSD	
100	Ill No. 6, Batch 4	90	49	0.02	0.003	35	35		
101	Ill No. 6, Batch 4	91	51	0.0	0.005	30	30		
102	Ill No. 6, Batch 4	45	0	0.0	0.0	~30	~30	VO	Pellets
103	Kentucky No. 9	275	995	0.15	0.01	10		VO	Pellets
104	Indiana No. 5	81	998	0.15	0.01	26	26	VO	
105	Indiana No. 5	275	932	0.15	0.01	10	29	VO	Pellets
106	Illinois No. 6, Batch 4	91	0	0.02	0.0	60	60	MSD	
107	Illinois No. 6, Batch 4	90	0	0.03	0.0	60	60	MSD	
108	Ill No. 6, Batch 4	91	0	0.04	0.0	60	60	MSD	
109	Ill No. 6, Batch 4	92	49	0.05	0.0	32	32	MSD	
110	Ill No. 6, Batch 4	88	50	0.03	0.003	33	33	MSD	
111	Ill No. 6, Batch 4	42	49	0.03	0.0	33	33	MSD	
112	Ill No. 6, Batch 4	125	53	0.03	0.0	33	33	MSD	
113	Ill No. 6, Batch 4	89	50	0.05	0.003	33	33	MSD	
114	Ill No. 6, Batch 4	91	50	0.02	0.005	32	32	MSD	
115	Ill No. 6, Batch 4	86	1028	0.03	0.0	34	34	MSD	
116	Ill No. 6, Batch 4	91	49	0.10	0.003	33	33	MSD	
117	Ill No. 6, Batch 4	88	246	0.03	0.0	30	30	MSD	
118	Ill No. 6, Batch 4	92	704	0.03	0.0	32	32	MSD	

TABLE A1. (Continued)

BTC No.	Type of Coal	Treatment Temperature, °C	Treatment Pressure, psig	CaO/Coal	NaOH/Coal	Average Residence Time, min		Drying Method[a]	Comments
						Temp	Press		
119	Ill No. 6, Batch 4	181	252	0.03	0.0	30	30	MSD	
120	Ill No. 6, Batch 4	276	980	0.03	0.0	31	31	MSD	
121	Ill No. 6, Batch 4	277	1003	0.0	0.0	34	34	MSD	
122	Ill No. 6, Batch 4	121	1005	0.10	0.003	30	30	MSD	
123	Ill No. 6, Batch 4	178	1000	0.10	0.003	28	28	MSD	
124	Ill No. 6, Batch 4	89	749	0.15	0.01	29	29	MSD	
125	Ill No. 6, Batch 4	29	50	0.10	0.003	32	32	MSD	
126	Ill No. 6, Batch 4	50	50	0.10	0.003	31	31	MSD	
127	Ill No. 6, Batch 4	23	0	0.10	0.003	30	30	MSD	
128	Ill No. 6, Batch 4	83	994	0.10	0.015	30	30	MSD	
129	Ill No. 6, Batch 4	34	1004	0.10	0.015	28	28	MSD	
130	Ill No. 6, Batch 4	83	50	0.10	0.01	33	33	MSD	
131	Ill No. 6, Batch 4	82	50	0.05	0.01	31	31	MSD	
132	Ill No. 6, Batch 4	82	51	0.05	0.02	32	32	MSD	
133	Ill No. 6, Batch 4	85	0	0.10	0.0	30	30	MSD	
134	Ill No. 6, Batch 4	287	988	0.10PL	0.01	10	28	MSD	Pebble Lime
135	Ill No. 6, Batch 4	289	1007	0.15PL	0.01	7	28	MSD	Pebble Lime
136	Ill No. 6, Batch 4	179	52	0.10PL	0.003			MSD	Pebble Lime
137	Ill No. 6, Batch 4								
138	Ill No. 6, Batch 4	178	50	0.05	0.03	11	33	MSD	
139	Ill No. 6, Batch 4								
140	Ill No. 6, Batch 4								
141	Ill No. 6, Batch 4								
142	Ill No. 6, Batch 4	178	53	0.10LS	0.003	10	29	MSD	Limestone
143	Illinois No. 6, Batch 5	90	0	0.10	0.003	10	10	MSD	
144	Illinois No. 6, Batch 5	90	0	0.10	0.003	30	30	MSD	
145	Illinois No. 6, Batch 5	90	0	0.10	0.003	60	60	MSD	
146	Illinois No. 6, Batch 5	90	0	0.10	0.003	120	120	MSD	

(a) Drying Methods
MSD – Modified Steam Dried (0.1% O_2 remainder N_2).
VO – Vacuum Oven with N_2 sweep.
SD – Steam Dried.

TABLE A2. BTC PHYSICAL AND CHEMICAL PROPERTIES[a]

BTC No.	Swelling and Agglomerating[b] Analyses FSI	AI	Chemical Analyses % of Coal, Dry Basis[d] Treatment Chemicals Ca	Na	Proximate VM	Ash	Ultimate C	H	S	O	Higher Heating Value, Btu/lb
1	NR	NR	NR	NR	NR	21.7	62.0	4.5	3.68	6.1	NR
2	NR	NR	NR	NR	NR	15.8	64.2	4.6	4.0	3.6	NR
3	NR	NR	NR	NR	NR	21.6	63.3	4.4	4.4	4.8	NR
4	NR	NR	NR	NR	NR	21.0	63.7	4.9	4.0	5.1	NR
5	NR	NR	NR	NR	NR	19.5	60.6	4.8	4.0	9.7	NR
6	NR	NR	NR	NR	NR	19.3	64.1	4.5	4.2	6.7	NR
7	NR	NR	NR	NR	NR	19.5	65.8	4.3	3.2	6.0	NR
8	NR	NR	NR	NR	NR	20.6	67.6	4.7	3.5	2.2	NR
9	NR	NR	NR	NR	NR	15.8	66.7	4.8	4.1	3.7	NR
10	NR	NR	NR	NR	NR	19.9	63.8	4.5	3.9	1.9	NR
11	NR	NR	NR	NR	NR	18.6	65.4	4.6	3.7	2.0	NR
12	NR	NR	NR	NR	NR	22.1	62.8	4.9	4.3	NR	NR
13	NR	NR	NR	NR	NR	17.1	65.4	3.9	3.1	NR	NR
14A	0	0.2	3.56	0.04	NR	20.3		Not Requested			NR
14B	0	0.3	3.98	0.03	NR	20.0		Not Requested			NR
15	2.0	1.8	2.14	0.09	NR	16.0		Not Requested			NR
16	1.5	3.9	2.00	0.03	NR	13.9		Not Requested			NR
17	1.0	NR	NR	NR	NR	22.6	62.0	4.4	3.7	NR	11,121
18 RT	0	0.3	NR	NR	NR			Not Requested			11,121
18-100	0	0.1	NR	NR	NR			Not Requested			11,121
18-150	0	0.1	NR	NR	NR			Not Requested			11,121
18-225	0	0.1	NR	NR	NR			Not Requested			11,121
18-275	0	0.5	NR	NR	NR			Not Requested			11,121
19-2	1.0	NR	NR	NR	NR			Not Requested			11,121
19-15	1.5	NR	NR	NR	NR			Not Requested			11,121
19-26	1.5	NR	NR	NR	NR			Not Requested			11,121
19-38	1.5	NR	NR	NR	NR			Not Requested			11,121
19-51	1.0	NR	NR	NR	NR			Not Requested			11,121
19-64	1.0	NR	NR	NR	NR			Not Requested			11,121
19-130	1.0	NR	NR	NR	NR			Not Requested			11,121
19-210	1.0	NR	NR	NR	NR			Not Requested			11,121
19-250	1.0	NR	NR	NR	NR			Not Requested			11,121
20-2	1.0	NR	NR	NR	NR			Not Requested			11,121
20-16	1.0	NR	NR	NR	NR			Not Requested			11,121
20-23	1.0	NR	NR	NR	NR			Not Requested			11,121
20-36	1.0	NR	NR	NR	NR			Not Requested			11,121
20-47	1.0	NR	NR	NR	NR			Not Requested			11,121
20-60	1.0	NR	NR	NR	NR			Not Requested			11,121
20-120	1.0	NR	NR	NR	NR			Not Requested			NR
20-180	1.0	NR	NR	NR	NR			Not Requested			NR

TABLE A2. (Continued)

BTC No.	Swelling and Agglomerating(b) Analyses FSI	AI	Chemical Analyses % of Coal, Dry Basis(d) Treatment Chemicals Ca	Na	Proximate VM	Ash	Ultimate C	H	S	O	Higher Heating Value, Btu/lb
20-240	1.0	NR	NR	NR	NR		Not Requested				NR
20-23H	1.0	NR	NR	NR	NR		Not Requested				NR
20-52H	1.0	NR	NR	NR	NR		Not Requested				NR
21A-21B	0.0	NR	4.66	0.02	NR	20.9	64.0	NR	3.6	NR	NR
22	NR	NR	2.89	0.12	NR	18.8	65.7	5.4	3.6	NR	NR
23A	0.0	NR	3.38	0.11	NR	19.2	66.3	5.0	3.5	NR	NR
23B	0.0	NR	2.77	0.10	NR	17.7	66.6	5.4	3.4	NR	NR
24	0.0	NR	NR	NR	NR	17.7	66.6	5.4	3.4	NR	NR
25A	0	NR	NR	NR	NR	17.7	66.6	5.4	3.4	NR	NR
25B	0	NR	NR	NR	NR	17.7	66.6	5.4	3.4	NR	NR
25C	0	NR	4.56	0.16	NR	23.3	62.9	5.8	3.6	NR	NR
25D	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
26A	1.0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
26B	NR	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
27A-10	3	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
27A-10	3	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
27A-20	3	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
27A-60	3	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
27A-120	3	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
27B	4.5	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
27B	4.5	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
27C	3.5	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
28A	3.0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
28B	1.5	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
28C	2.5	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
28D	3.5	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
28E	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
29-3	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
29-6	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
29-11	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
29-17	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
29-51	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
30	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
31-5	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
31-10	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
32	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
33	0	NR	NR	NR	NR	23.3	62.9	5.8	3.6	NR	NR
34A	3.5	NR	5.10	0.08	NR	16.9	NR	NR	NR	NR	NR
34B	2.5	NR	6.03	0.19	NR	20.8	NR	NR	NR	NR	NR
34C	7.0	NR	0.25	0.02	NR	8.1	NR	NR	NR	NR	NR

TABLE A2. (Continued)

BTC No.	Swelling and Agglomerating[b] Analyses FSI	AI	Ash Fusion Temp °F[c] ID	ST	HT	FT	Chemical Analyses % of Coal, Dry Basis[d] Treatment Ca	Chemicals Na	Proximate VM	Ash	Ultimate C	H	S	O	Higher Heating Value, Btu/lb
35A	2.0	NR		Not Requested			8.98	0.06	NR	23.3	NR	NR	NR	NR	NR
35B	2.0	NR		Not Requested			7.54	0.08	NR	21.5	NR	NR	NR	NR	NR
36A	2.0	NR		Not Requested			8.28	0.09	NR	21.3	NR	NR	NR	NR	NR
36B	2.0	NR		Not Requested			6.54	0.12	NR	19.2	NR	NR	1.5	NR	NR
37	0	0.5	2100	2270	2310	2400	6.29	0.20	36.65	26.50	59.01	4.61	3.88	4.80	10,717
38	0	0.5	NR	NR	NR	NR	6.78	0.16	NR	26.80	NR	NR	11.1	NR	NR
39	0	0.7	NR	NR	NR	NR	6.62	0.17	NR	26.80	NR	NR	11.3	NR	NR
40	0	0.4	NR	NR	NR	NR	5.33	0.16*	NR	24.00	NR	NR	10.6	NR	NR
41	0	0.2	2410	2620	2650	2700	6.50	0.18	38.38	26.97	60.14	4.64	3.73	3.42	10,759
42	0	0.2	NR	NR	NR	NR	3.70	0.29	39.29	20.87	64.06	4.74	3.81	5.28	11,500
43	0	0.1	NR	NR	NR	NR	5.04	0.27	39.45	23.15	62.23	4.60	3.70	5.18	11,048
44	0	0.1	NR	NR	NR	NR	6.36	0.21	39.67	19.22	62.25	4.71	3.72	5.11	11,742
45	0	0.2	2330	2500	2550	2600	6.21	0.29	36.84	28.15	58.59	4.40	4.38	2.99	10,532
46	0	0.1	2420	2620	2660	2700	5.83	0.41	37.76	24.55	61.98	4.51	3.59	4.32	11,115
47	0	0.1	NR	NR	NR	NR	6.22	0.15			Not Requested				
48	0	0.1	2480	2600	2650	2700	6.17	0.15	39.20	25.90	61.49	4.59	4.10	2.69	11,097
49	0	0.1	2480	2600	2650	2700	6.58	0.21	40.02	17.20	67.35	4.84	3.74	5.49	12,209
50	0	0.1	2140	2250	2290	2350	3.77	0.15	37.64	19.93	64.56	4.78	3.85	5.63	11,726
51	0	0.23	2140	2270	2310	2370	4.10	0.31	39.07	22.07	63.93	4.75	3.95	3.89	11,448
51-S	0	0.22	2140	2190	2230	2270	4.46	0.25	39.38	24.33	62.64	4.71	3.92	3.15	11,344
52	0	0.55	2180	2210	2235	2265	6.17	0.21	41.77	21.68	63.99	4.73	3.96	4.47	11,612
52-S	0	0.39	2460	2570	2610	2700	4.46	0.25	42.14	22.20	64.01	4.72	3.93	3.76	11,658
53-P	0	0.50	2270	2420	2460	2630	6.22	0.20	39.21	27.31	58.71	4.16	3.85	4.70	10,217
53	0	0.50	2470	2630	2670	2700+	6.39	0.21	38.32	26.21	60.62	4.60	3.97	3.51	10,874
54	0	0.2	2470	2630	2670	2700	6.36	0.21	39.60	26.75	60.40	4.64	3.74	3.46	10,821
55	0	0.3	2290	2470	2520	2630	4.89	0.22	37.38	23.76	62.30	4.66	3.90	4.43	11,270
56-A	0	1.3	2330	2530	2570	2640	5.37	0.75	39.21	22.89	63.59	4.64	3.32	4.37	11,214
57-A	0	2.1	2110	2280	2320	2350	4.35	0.15	37.52	20.55	65.39	4.83	3.27	4.85	11,658
58-A	1.5	3.5	1960	2100	2150	2210	2.79	0.12	37.77	17.14	67.31	4.84	3.34	6.23	11,987
59-A	1.5	3.7	2250	2390	2440	2530	4.81	0.06	37.21	21.87	64.34	4.71	3.30	4.78	11,497
60-A	0	0.1	2430	2590	2630	2700	6.92	0.21	37.74	26.13	61.37	4.57	3.53	3.35	10,912
61-A	1.5	8.1	2130	2260	2300	2360	5.35	0.11	36.80	29.79	60.03	4.56	4.95	NR	10,897
62-A	2.0	8.5	2010	2200	2240	2290	4.52	0.11	36.50	26.80	61.23	4.51	5.21	1.25	11,234
63							Run Aborted								
64-A	1.5	8.3	2560	2700	2700+	2700+	9.31	0.09	35.33	33.41	57.32	4.24	3.94	0.04	10,196
65-A	1.0	7.1	2560	2700	2700+	2700+	8.39	0.12	35.34	33.05	57.27	4.28	4.24	0.07	10,258
66-A	1.0	5.8	2560	2700+	2700+	2700+	8.57	0.14	36.68	32.69	56.23	4.16	4.26	1.54	10,1[illegible]
67	0	2.1	2570	2660	2700+	2700+	9.67	0.29	32.85	33.51	56.92	4.15	3.92	0.38	10,250
68	0	0.113/0.097	2700+	2700+	2700+	2700+	9.67	0.24	37.38	31.31	56.95	4.32	3.40	3.01	10,105
69	0	0.55/0.36	2550	2700	2700+	2700+	5.50	0.66	51.02	24.29	61.81	4.43	3.82	4.65	10,881

TABLE A2. (Continued)

BTC No.	Swelling and Agglomerating(b) Analyses		Ash Fusion Temp °F(c)				Chemical Analyses % of Coal, Dry Basis(d)								Higher Heating Value, Btu/lb
							Treatment	Chemicals	Proximate		Ultimate				
	FSI	AI	ID	ST	HT	FT	Ca	Na	VM	Ash	C	H	S	O	
70-A	2.0	7.9	2440	2580	2620	2700+	6.46	0.12	41.98	24.83	63.82	4.65	3.81	1.63	11,423
71-A	0	4.7	2500	2610	2650	2700+	7.77	0.22	41.75	26.73	61.70	4.72	3.48	2.40	11,123
72	0	5.3	2530	2700+	2700+	2700+	9.44	0.15	43.40	30.04	60.76	4.67	3.33	0.15	10,748
73	0	3.9	2700+	2700+	2700+	2700+	9.63	0.32	45.01	29.23	59.41	4.53	3.47	2.11	10,649
74-A	2.5	7.79/3.26	2400	2550	2600	2670	6.27	0.07	37.24	25.75	64.26	4.64	3.37	0.62	11,616
75	0	8.15/8.13	2470	2680	2700+	2700+	7.54	0.14	39.36	27.46	63.49	4.67	3.56	NR	11,574
76-A	0	7.77/7.76	2700+	2700+	2700+	2700+	9.31	0.13	39.94	28.86	60.95	4.46	3.18	1.34	10,393
77-A	0	2.48/2.56	2700+	2700+	2700+	2700+	10.02	0.32	41.54	29.93	59.13	4.14	2.94	2.50	10,328
78-A	0	0.052/0.031	2520	2700+	2700+	2700+	8.29	0.33	35.90	28.47	58.61	4.49	3.56	3.52	10,482
78-B	0	0.115/0.141	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
79	0	0.063/0.058	2580	2700+	2700+	2700+	8.91	0.32	40.72	28.34	58.82	4.48	3.38	3.70	10,411
80	0	0.039/0.043	2680	2700+	2700+	2700+	11.02	0.32	38.80	32.38	56.18	4.23	3.26	2.68	10,032
81	0	0.050/0.049	2480	2600	2650	2700+	10.19	0.31	37.68	31.26	56.96	4.61	3.37	2.57	10,120
82 Whole	0	0.071	2530	2700+	2700+	2700+	8.61	0.30	37.49	29.81	57.32	4.33	3.53	4.08	10,316
82 LA	2	4.39	2530	2700+	2700+	2700+	5.16	0.27	NR	NR	NR	NR	NR	NR	NR
82 4x6	1.5	5.37	2530	2700+	2700+	2700+	4.69	0.31	NR	NR	NR	NR	NR	NR	NR
82 6x20	0	0.18	2530	2700+	2700+	2700+	7.54	0.32	NR	NR	NR	NR	NR	NR	NR
82 20x50	0	0.034	2530	2700+	2700+	2700+	8.35	0.42	NR	NR	NR	NR	NR	NR	NR
82-50	0	0.057	2530	2700+	2700+	2700+	11.85	0.26	NR	NR	NR	NR	NR	NR	NR
83-A	0	0.70	2070	2250	2290	2360	3.73	0.12	39.17	20.87	63.22	4.85	3.96	5.86	11,526
83-B	0	0.73						Not Requested							
84-A	0	0.36	2130	2270	2310	2360	3.70	0.18	39.26	21.24	63.57	4.77	3.84	5.38	11,452
84-B	0	0.385						Not Requested							
85-A	0	0.63	1990	2090	2130	2200	2.32	0.17	39.54	17.24	65.83	4.92	4.05	6.58	11,728
85-B	1	0.89						Not Requested							
86	0	0.71	2110	2260	2300	2370	3.66	0.16	38.88	21.68	63.98	4.32	4.00	4.73	11,261
87 Whole	2.5	5.32	2030	2140	2200	2240	3.17	0.13	39.01	20.00	64.32	4.77	4.21	5.60	11,546
87 L4	2	7.95	2030	2140	2200	2240	3.37	0.11	NR	NR	NR	NR	NR	NR	NR
87 4x6	1.5	8.05	2030	2140	2200	2240	2.77	0.13	NR	NR	NR	NR	NR	NR	NR
87 6x20	1.5	6.39	2030	2140	2200	2240	3.04	0.18	NR	NR	NR	NR	NR	NR	NR
87 20x50	0	0.27	2030	2140	2200	2240	4.31	0.17	NR	NR	NR	NR	NR	NR	NR
87-50	0	0.13	2030	2140	2200	2240	6.73	0.09	NR	NR	NR	NR	NR	NR	NR
88	0	1.05	2130	2230	2270	2330	4.13	0.22	39.70	17.82	65.61	4.74	3.94	6.42	11,769
89	0	0.34	2090	2220	2260	2320	3.12	0.23	38.85	19.31	64.96	4.81	3.98	5.57	11,543
90	0	0.11/0.10	2570	2700+	2700+	2700+	9.27	0.36	36.82	30.96	57.31	4.60	3.37	2.57	10,467
91	0	0.12/0.15	2470	2700+	2700+	2700+	8.84	0.18	41.19	30.58	57.67	4.28	3.60	2.53	10,199
92	0	0.12/0.12	2260	2390	2420	2500	4.72	0.17	44.12	22.30	63.12	4.52	3.68	5.06	11,029
93	0	0.08/0.06	2530	2700+	2700+	2700+	7.40	0.21	39.59	26.47	58.11	4.49	3.40	6.32	10,169
94	0	0.23/0.20	2280	2390	2420	2500	4.92	0.10	40.05	22.36	62.70	4.79	3.65	5.24	11,108
95	1.5	5.99/6.56	1910	2080	2130	2280	0.78	0.37	38.19	12.09	68.41	4.89	3.78	9.52	12,398

TABLE A2. (Continued)

BTC No.	Swelling and Agglomerating(b) Analyses FSI	AI	Ash Fusion Temp °F(c) ID	ST	HT	FT	Treatment Chemicals Ca	Na	Proximate VM	Ash	Chemical Analyses % of Coal, Dry Basis(d) Ultimate C	H	S	O	Higher Heating Value, Btu/lb
96-A	2.5	7.07/7.37	NR	NR	NR	NR				Not Requested					
96-AA	0	0.056/0.065	NR	NR	NR	NR				Not Requested					
96-B	0	0.096/0.086	1930	2120	2160	2450	0.30	0.06	37.28	9.53	63.97	4.63	3.73	12.13	11,919
96-C	2.5	0.95/7.22	1950	2130	2170	2240	0.39	0.07	39.07	10.75	68.22	4.93	4.13	10.61	12,314
96-D	2.5	8.00/7.80						Not Requested							
97	2.5	7.59/7.88	1990	2110	2140	2330	0.36	0.06	39.44	10.04	69.00	4.98	3.96	10.80	12,439
98	0	0.41/0.29	1940	2060	2100	2150	1.71	0.11	39.67	14.21	66.06	4.80	4.10	9.73	11,987
99	0	0.48/0.48	1960	2070	2110	2160	1.36	0.11	39.41	13.64	66.84	4.96	4.05	9.31	11,949
100	0	0.30/0.28	1960	2000	2040	2070	1.63	0.14	38.65	15.10	64.97	4.56	4.02	10.18	11,692
101	1.5	7.33/7.23	2080	2120	2165	2230	0.43	0.13	39.78	10.18	69.33	4.99	3.83	10.30	12,371
102	1	8.18/8.25	1990	2085	2130	2270	0.40	0.15	41.15	11.88	67.32	4.90	4.06	10.70	12,085
103	0	0.14/0.21	2475	2535	2610	2660	10.66	0.18	37.72	33.90	55.68	3.82	3.53	1.87	9,623
104	0	3.70/3.93	2330	2550	2590	2700+	5.43	0.21	38.44	24.52	62.97	4.63	3.81	2.93	11,297
105	0	0.34/0.27	NR	NR	NR	NR	6.41	0.32	36.69	28.45	58.78	4.10	3.47	3.95	10,339
106	0	0.61/0.50	1940	2100	2130	2250	1.38	0.11	38.76	13.99	67.55	4.93	3.85	8.58	12,061
107	0	0.44/0.22	1960	2090	2130	2260	1.81	0.10	38.27	15.01	66.83	4.93	3.76	8.23	11,933
108	0	0.24/0.25	1960	2040	2130	2240	2.67	0.11	38.55	17.94	65.27	4.83	3.69	7.14	11,704
109	0	0.16/0.11	1990	2040	2085	2125	2.88	0.14	39.13	17.86	64.58	4.80	3.78	7.85	11,590
110	0	0.094/0.064	1950	1985	2035	2080	2.14	0.20	38.32	15.92	65.91	4.74	3.76	8.32	11,730
111	0	0.17/0.12	1955	2010	2040	2075	2.28	0.15	38.40	16.74	65.59	4.74	3.96	7.68	11,724
112	0	0.51/0.41	1970	2005	2040	2075	1.92	0.12	39.44	15.29	66.26	4.89	3.78	8.61	11,856
113	0	0.11/0.08	2095	2130	2155	2180	3.34	0.20	38.52	20.98	63.58	4.69	3.87	6.51	11,480
114	0	0.34/0.26	1990	2020	2050	2080	1.87	0.23	39.02	15.20	66.37	4.86	3.88	8.43	11,830
115	0	0.32/0.40	2020	2050	2080	2110	1.95	0.13	39.31	15.19	66.17	4.88	3.95	8.61	11,844
116	0	0.067/0.042	2330	2520	2560	2700	6.01	0.20	37.69	26.36	60.48	4.43	3.71	3.91	10,798
117	0	0.13/0.10	1750	2060	2100	2170	2.18	0.12	38.58	16.06	66.13	4.80	3.85	7.95	11,761
118	0	0.16/0.14	1940	2040	2080	2130	2.24	0.13	39.11	16.36	65.88	4.86	3.92	7.81	11,763
119	0	0.31/0.23	1970	2100	2130	2130	2.03	0.08	39.03	15.44	65.84	4.73	3.75	9.03	11,883
120	0	0.22/0.23	1980	2100	2130	2180	2.26	0.05	38.46	16.10	66.61	4.73	3.85	7.60	11,928
121	1.5	7.20/6.33	2020	2140	2170	2430	0.30	0.02	38.68	10.13	70.18	4.91	3.88	9.64	12,530
122	0	0.029/0.020	2500	2590	2630	2680	6.04	0.15	38.71	24.57	60.55	4.50	3.40	5.86	10,729
123	0	0.032/0.028	2370	2590	2630	2680	5.85	0.20	38.85	24.30	61.38	4.50	3.59	5.19	10,923
124	0	0.018/0.019	2500	2700+	2700+	2700+	8.65	0.31	37.67	29.39	57.35	4.32	3.47	4.31	10,190
125	0	0.027/0.032	2400	2530	2570	2640	5.34	0.24	38.68	24.09	61.36	4.49	3.54	5.37	10,949
126	0	0.036/0.018	2440	2590	2630	2700	6.47	0.20	37.10	26.30	59.52	4.34	3.52	5.35	10,574
127	0	0.039/0.036	2400	2530	2570	2650	6.86	0.24	38.07	26.60	59.93	4.33	3.40	4.87	10,580
128	0	0.035/0.041	2400	2530	2570	2630	6.62	0.43	37.86	26.31	60.12	4.48	3.32	4.73	10,581
129	0	0.028/0.031	2420	2530	2580	2670	6.27	0.45	37.63	26.72	59.09	4.37	3.27	5.60	10,511
130	0	0.039/0.036	2450	2560	2600	2700	7.32	0.36	37.23	28.20	59.17	4.22	3.44	3.99	10,464
131	0	0.017/0.034	2110	2200	2240	2340	3.81	0.36	37.42	21.74	63.09	4.44	3.55	6.10	11,267

TABLE A2. (Continued)

BTC No.	Swelling and Agglomerating[b] Analyses FSI	AI	Ash Fusion Temp °F[c] ID	ST	HT	FT	Chemical Analyses % of Coal, Dry Basis[d] Treatment Ca	Chemicals Na	Proximate VM	Ash	Ultimate C	H	S	O	Higher Heating Value, Btu/lb
132	0	0.040/0.043	2020	2200	2240	2340	3.88	0.52	36.93	21.91	63.21	4.49	3.36	6.04	11,305
133	0	0.062/0.044	2570	2680	2700+	2700+	7.24	0.17	38.73	26.36	60.66	4.48	3.47	4.25	10,742
134	0	0.029/0.036	2290	2430	2470	2530	5.87	0.41	37.84	26.00	60.56	4.23	3.53	4.95	10,731
135	0	0.024/0.014	2500	2640	2680	7700+	10.07	0.44	36.44	31.40	56.41	4.17	3.16	4.15	9,831
136	0	0.038/0.036	2370	2500	2540	2630	6.76	0.23	38.15	26.88	58.73	4.95	3.76	5.45	10,453
138	0	0.031/0.041	2080	2170	2230	2320	3.95	0.67	39.63	22.60	62.81	4.56	3.56	5.21	11,193
142	2	2.48/3.25	1950	2130	2170	2250	1.44	0.12	39.25	14.99	66.06	4.65	3.90	9.54	11,761
143							Not Analyzed								
144							Not Analyzed								
145							Not Analyzed								
146							Not Analyzed								

(a) NR = Not Requested.
(b) FSI = Free swelling index, AI = Agglomerating index.
(c) ID = Initial deformation temp.
ST = Softening temperature.
HT = Hemispherical temperature.
FT = Fusion temperature.
(d) VM = Volatile matter.

TABLE A-3. BSFB HYDROGASIFICATION RUN SUMMARIES

BTC No.	Run No.	Feed Size	Gasifier Conditions			Char Properties			Hydrogasification Suitability Index[a]	
			Temp., C	Press psig	Superficial Gas Velocity ft/sec	Size Distribution, percent +6	Size Distribution, percent -20	Hardness Crush Press, psig	Quantitative	Qualitative
15	34264-18	20 x 70	899	386	0.38	–	9.9	High	–	B
22	-1	20 x 70	899	391	0.32	–	44.8	Low	–	M
25C	-52	20 x 70	885	387	0.32	–	38.9	7.5	131	M
27B	-82	20 x 70	899	385	0.33	–	2.7	–	–	B
28B	-68	20 x 70	900	385	0.33	–	2.6	>94	9	B
28E	-36	20 x 70	926	385	0.34	–	10.2	–	–	B
32		20 x 70				–	38.2	7.5	131	M
36B	36563-18	-20	896	399	0.33	82.1	11.9	12	100	B
37	35396-2	20 x 70	900	400	0.34	–	8.9	82	27	B
37	-82	-20	900	400	0.33	–	53.7	32	122	M
37	-86	3/16" pellets	908	400	0.33	–	16.0	9	107	M
37	36340-18	-20	898	400	0.33	26.3	62.5	10	152	M
38	36235-66	-20	902	400	0.32	19.7	65.0	6	159	M
38	35396-8	20 x 70	897	400	0.32	–	7.7	77	31	B
39	36235-58	-20	895	400	0.32	37.6	53.0	9	144	M
40	35396-13	20 x 70	895	400	0.33	–	7.7	73	35	B
41	-90	20 x 70	911	400	0.33	–	9.6	38	72	B
41	-66	20 x 70	900	40	2.58	–	66.5	2	165	G
41	35567-22	-20	900	400	0.33	–	47.2	35	112	M
41	36563-10	-20	898	400	0.33	16.5	75.7	<1	175	G
42	36235-46	-20	915	400	0.33	13.9	74.3	2	172	M
42	35396-20	20 x 70	900	400	0.33	–	7.1	75	32	B
43	-24	20 x 70	900	400	0.33	–	12.1	66	46	B
44	-16	20 x 70	900	400	0.33	–	5.5	69	37	B
44	-70	20 x 70	900	40	2.48	–	48.7	–	–	–
44	-74	20 x 70	900	40	2.34	–	42.7	2.5	140	M
44	-78	20 x 70	905	400	0.32	–	5.9	35	54	B
44	36235-42	-20	896	400	0.32	15.0	75.2	4	171	G
45	35396-32	20 x 70	900	400	0.34	–	9.0	50	59	B
46	-28	20 x 70	900	400	0.33	–	23.3	23	100	B
47	-36	20 x 70	900	400	0.33	–	11.5	36	76	B
48	-40	20 x 70	908	400	0.32	–	8.6	45	64	B
48	36235-70	-20	900	400	0.32	10.8	83.8	<1	183	G
49	-54	-20	899	400	0.32	4.3	91.4	<1	190	E
49	35396-44	20 x 70	900	400	0.33	–	11.2	45	66	B
52	-54	20 x 70	900	400	0.33	–	8.4	65	43	B
52	36235-62	-20	902	400	0.33	10.4	82.2	1	181	G

TABLE A-3. (Continued)

BTC No.	Run No.	Feed Size	Gasifier Conditions: Temp., C	Gasifier Conditions: Press psig	Gasifier Conditions: Superficial Gas Velocity ft/sec	Char Properties: Size Distribution, percent +6	Char Properties: Size Distribution, percent -20	Char Properties: Hardness Crush Press, psig	Hydrogasification Suitability Index(a): Quantitative	Hydrogasification Suitability Index(a): Qualitative
52S	35567-6	20 x 70	910	400	0.32	-	8.2	31	77	B
53	35396-94	-20	899	400	0.32	-	16.8	29	88	B
54	36235-30	pellets	881	400		No Increase		Less than Feed	-	E
54	-34	-20	896	400		5.7	90.2	<1	189	E
57A	-50	-20	897	400		59.7	28.6	13	116	M
60A	35340-26	-20	902	400		24.8	66.4	1	165	M
67A	35567-88	-20	908	400	0.14	-	48.0	54	94	B
68	36340-22	-20	898	400		1.3	93.5	<1	193	E
68	36437-42	-20	898	800		1.7	96.6	<1	196	E
69	35844-12	-20	899	400	0.33	0.1	99.8	<1	199	E
73	35567-92	-20	900	400	0.33	79.2	17.4	10	107	M
77A	36437-98	-20	900	400		10.5	81.4	<1	180	G
78A	36340-38	-20	900	400		9.4	84.6	<1	184	G
80	-50	-20	899	400		7.9	93.1	<1	192	E
81	36437-34	-20	899	400		9.5	82.5	<1	182	G
84A	36437-38	-20	899	400		60.3	31.1	19.5	112	M
88	36340-70	-20	899	400		84.6	10.9	55	56	B
90	-10	-20	902	400		12.1	79.4	1	173	G
91	36235-94	-20	899	400		7.9	81.0	<1	180	G
91	36437-90	-20	898	800		3.1	92.9	<1	192	E
92	36340-66	-20	901	400		61.0	31.2	4	127	M
93	36235-38	-20	894	400		7.9	86.1	<1	185	G
94	36340-30	-20	899	400		60.6	28.9	21	108	M
95	-74	-20	898	400		87.2	5.3	17	88	B
107	36437-6	-20	897	400		57.4	32.8	13.5	119	M
107	36563-14	-20	900	400		10.5	81.4	<1	180	G
109	36340-34	-20	899	400		77.0	16.2	28	88	B
112	-98	-20	899	400		85.1	9.9	70	40	B
113	-42	-20	899	400		76.1	18.1	16.5	102	M
115	-46	-20	900	400		85.9	8.8	40.3	69	B
116	36235-74	-20	902	400		13.6	76.5	<1	176	G
116	36437-86	-20	900	800		5.3	90.5	<1	189	G
118	36340-94	-20	901	400		76.7	16.4	39.8	82	B
120	-54	-20	899	400		70.9	21.6	13.7	108	M
122	36235-98	-20	903	400		12.2	78.3	1	177	G
124	36340-14	-20	895	400		10.0	80.1	<1	179	G
125	-2	-20	896	400		10.1	80.8	<1	180	G

TABLE A-3. (Continued)

BTC No.	Run No.	Feed Size	Gasifier Conditions			Char Properties			Hydrogasification Suitability Index[a]	
			Temp., C	Press psig	Superficial Gas Velocity ft/sec	Size Distribution, percent +6	Size Distribution, percent -20	Hardness Crush Press, psig	Quantitative	Qualitative
126	36340-6	-20	899	400		9.2	81.5	1	181	G
127	36437-2	-20	900	400		49.7	42.8	6	137	M
128	-22	-20	903	400		30.3	59.1	2	157	M
129	-26	-20	900	400		15.9	76.1	1	175	G
130	-46	-20	898	800		9.4	82.1	1	181	G
130	36340-86	-20	902	400		30.9	61.0	1	160	M
131	-82	-20	901	400		72.7	21.7	9	113	M
132	-90	-20	901	400		51.9	37.0	2	135	M
133	36437-30	-20	902	400		15.4	74.4	<1	173	G
134	36563-2	-20	898	400		10.2	81.4	1	180	G
135	-6	-20	901	400		7.9	89.9	<1	189	G-E
136	36437-50	-20	898	400		54.8	37.1	17.5	120	M
138	36563-22	-20	897	400		24.7	65.5	12.3	153	M
142	36437-54	-20	900	400		90.7	5.1	62.7	42	B
144	36563-26	-20	898	400		16.5	77.1	<1	176	G
146	-30	-20	898	400		36.9	54.4	6.3	148	M

(a) Hydrogasification Suitability Index
0-100 = Bad (B) 165-189 = Good (G)
100-165 = Marginal (M) 189-200 = Excellent (E)

TABLE A-4. BSFB STEAM/H_2 GASIFICATION RUN SUMMARIES

BTC No.	Run No.	Feed Size	Gasifier Conditions			Char Properties			Steam Gasification Suitability Index(a)	
			Temp, C	Press, psig	Superficial Gas Velocity, ft/sec	Size Distribution, percent +6	Size Distribution, percent -20	Hardness Crash Press, psig	Quantitative	Qualitative
32	35396-62	20 x 100	847	285	0.35	-	12.3	10	102	M
34B	35567-10	-20	870	280	0.37	-	7.1	39	68	B
35B	-14	-20	851	280	0.38	-	11.6	5	107	M
36A	-26	-20	875	280	0.37	-	9.9	41	69	B
36B	-36	-20	870	280	0.39	-	29.8	1	129	M
36B	-34	3/16" x 1/16" pellets	870	280	0.38	-	2.2	34	63	B
37	35396-50	-20	810	285	0.36	-	56.1	4	152	M
37	35567-62	-20	553	500	0.079	-	76.9	2.5	174	G
37	-66	-20	652	500	0.085	-	68.1	19	149	M
37	-70	-20	684	500	0.081	-	59.6	17	143	M
37	-74	-20	655	500	0.098	-	33.2	50	83	B
37	-80	-20	878	285	0.39	-	55.3	4	151	M
37	36437-10	-20	866	87.5		2.4	94.0	<1	193	E
37	-78	-20	865	501		26.4	64.2	<1	163	M
37	-82	-20	860	284		23.4	70.1	<1	169	G
38	36107-70	-20	866	153	0.56	0.0	92.6	<1	192	E
39	36235-14	-20	867	50		1.1	93.6	<1	193	E
61A	35567-50	-20	876	50	0.23	-	15.0	6.3	109	M
62A	-54	-20	859	500	0.22	-	13.5	30.5	83	B
67A	-96	-20	871	280	0.43	41.9	45.1	5	140	M
67A	36107-24	-20	878	197	0.31	2.2	76.1	<1	175	G
67A	-28	-20	868	50.5	1.42	14.7	61.7	<1	160	M
68	36437-14	-20	871	78.5		0.0	98.2	<1	197	E
68	35567-84	-20	867	285	0.24	-	77.4	2	176	G
68	-78	-20	873	500	0.78	-	77.6	3	175	G
68	36437-58	-20	860	801		57.6	36.4	<1	135	M
69	35844-8	-20	878	500	0.22	10.0	87.0	<1	186	G
69	36437-18	-20	868	83		0.0	100.0	<1	199	E
73	35844-1	-20	868	500	0.24	72.7	20.5	14	107	M
73	36107-32	-20	862	48	1.59	42.1	44.9	1	144	M
77A	-36	-20	866	50	1.50	9.3	74.1	<1	173	G
77A	35844-4	-20	866	50	0.21	69.9	26.0	15	111	B
77A	36437-66	-20	865	801		30.6	61.2	<1	160	M
77A	-70	-20	863	501		19.8	69.1	<1	168	G

TABLE A-4. (Continued)

BTC No.	Run No.	Feed Size	Gasifier Conditions			Char Properties			Steam Gasification Suitability Index(a)	
			Temp, C	Press, psig	Superficial Gas Velocity, ft/sec	Size Distribution, percent +6	Size Distribution, percent -20	Hardness Crash Press, psig	Quantitative	Qualitative
78	35844-16	-20	866	500	0.22	48.0	48.1	<1	147	M
78	-20	-20	870	98	1.35	18.1	75.2	<1	174	G
78	36437-74	-20	864	501		8.2	84.7	<1	184	G
78A	-62	-20	859	800		22.2	68.1	<1	167	G
78B	35844-36	-20	872	52	1.41	77.1	20.3	12.5	108	M
78B	-66	-20	876	72	1.04	15.6	73.3	<1	172	G
80	-24	-20	880	130	0.65	11.4	82.0	<1	181	G
81	-28	-20	872	41	1.85	2.0	94.9	<1	194	E
82	-56	-20	869	51	1.87	75.7	12.7	16.5	96	B
82	36107-18	4 x 20	879	88	3.09	46.0	46.0	12	134	M
82	-42	6 x 60	783	57	5.09	3.6	75.2	4.3	171	G
83A	35844-40	-20	863	58	1.53	46.0	30.7	5	126	M
84A	-44	-20	880	72	1.36	18.5	70.4	1	169	G
85A	-48	-20	869	64	1.39	44.7	48.0	1.5	147	M
86	-52	-20	874	64	1.41	7.0	81.0	<1	180	G
87	36107-46	-20	868	48	1.47	1.8	89.1	<1	188	G
88	36340-78	-20	856	83		42.3	48.7	1	148	M
89	35844-58	-20	877	65	1.37	8.5	81.7	<1	181	G
90	-62	-20	867	50	1.49	1.0	93.8	<1	193	E
91	-66	-20	868	74	1.24	0.0	97.9	<1	197	E
92	-74	-20	874	50	1.49	1.0	93.2	<1	192	E
94	-70	-20	876	60	1.30	11.1	77.8	<1	177	G
94	-78	-20	876	63	1.16	6.2	85.8	<1	185	G
95	36235-18	-20	866	52		96.0	1.5	51	50	B
96B	35844-94	-20	882	52	1.48	9.8	86.7	<1	186	G
96C	36107-2	-20	878	52	1.38	92.6	3.7	64	40	B
97	-62	-20	869	48	1.52	92.7	3.6	47	57	B
98	35844-82	-20	878	58	1.30	16.0	72.0	2	170	G
98	36235-2	-20	860	51.4		20.0	20.7	<1	170	G
99	35844-86	-20	876	60	1.28	47.1	44.3	7	137	M
100	-90	-20	874	53	1.40	23.7	71.2	<1	170	G

TABLE A-4. (Continued)

BTC No.	Run No.	Feed Size	Gasifier Conditions			Char Properties			Steam Gasification Suitability Index(a)	
			Temp, C	Press, psig	Superficial Gas Velocity, ft/sec	Size Distribution, percent +6	Size Distribution, percent -20	Hardness Crash Press, psig	Quantitative	Qualitative
101	36107-58	-20	862	50	1.47	81.4	9.6	46	64	B
106	-54	-20	870	50	1.42	33.3	50.0	<1	149	M
106	36235-10	-20	864	59.1		32.8	53.1	1.5	152	M
107	36107-50	-20	871	62.7	1.25	0.0	97.5	<1	197	E
107	36235-22	-20	865	77.2		43.8	50.0	<1	149	M
107	36235-26	-20	866	51.1		12.0	82.0	<1	181	G
109	36107-76	-20	866	50	1.58	11.7	72.7	<1	172	G
111	-84	-20	868	56	1.32	22.5	65.0	<1	164	G
112	-88	-20	859	49	1.50	53.0	36.1	<1	135	M
112	-96	-20	864	50	1.42	62.7	31.3	<1	130	M
114	36235-6	-20	862	50		62.0	31.5	<1	131	M
115	36107-80	-20	867	58	1.23	47.5	41.3	<1	141	M
117	36235-86	-20	866	56		23.8	64.3	<1	163	M
118	-90	-20	866	51		36.8	54.0	<1	153	M
119	-78	-20	864	75		22.9	64.3	<1	163	M
120	-82	-20	867	127		14.5	74.2	1	173	G
Ill No. 6 Batch 3	35396-58	20 x 100	887	285	0.38	-	1.5	63	39	B
Ill No. 6 Batch 4	35844-32	-20	871	47	1.67	86.1	11.2	795	10	B
Pittsburgh Seam	35567-38	-20	874	280	0.30	-	0.9	31	71	B
Ohio, Pittsburgh, No. 8	-42	-50	875	280	0.40	-	3.6	31	73	B
Ohio, Pittsburgh No. 8	-46	-50	878	500	0.17	-	1.6	58	44	B

(a) Steam Gasification Suitability Index
0-100 = Bad (B) 165-189 = Good (G)
100-165 = Marginal (M) 189-200 Excellent (E)

TABLE A-5. RAW COAL PHYSICAL AND CHEMICAL PROPERTIES

Raw Coal Identification	Swelling and Agglomeration Analysis		Ash Fusion Temperatures, F				Chemical Analyses, % of Coal, Dry Basis								Higher Heating Value
							Treatment Chemicals		Proximate		Ultimate				
	FSI	AI	I.D.	S.T.	H.T.	F.T.	Ca	Na	V.M.	Ash	C	H	S	O	Btu/lb
Illinois No. 6															
Peabody No. 10 Mine															
Christian Co., Ill.															
Batch No. 1, Rec'd. /76, BTC-1-6 and 9-13	1.5	NR	Not Requested				NR	NR	NR	13.0	67.92	5.12	11.50	9.70	NR
Batch No. 2, Rec'd. /77, BTC-14-26 and 29-33	2.5	8.4	Not Requested				0.13	0.08	NR	9.64			4.33		13,071
Batch No. 3, Rec'd. 11/79, BTC-37-53[c]	2.5	7.7	1960	2070	2110	2250	0.37	0.13	42.57	12.13	67.73	4.82	4.23	9.33	12,209
Batch No. 4, Rec'd. 2/80, BTC 54-142[a,b]	2.0	8.5	1990	2110	2140	2280	0.54	0.14	39.82	11.43	68.12	4.80	4.20	9.98	12,163
Batch No. 5, Rec'd. / , BTC-143-146	NR	NR	2020	2170	2210	2340	0.40	0.16	39.69	11.24	69.74	4.81	5.00	7.70	12,530
Illinois No. 6															
Captain Mine															
Perry Co., Ill.															
Rec'd 2/80, BTC-56A	3.0	8.8	2000	2200	2240	2430	0.24	0.04	NR	10.33	70.73	4.89	3.70	9.39	12,739
Illinois No. 6															
River King Mine															
Rec'd. /76, BTC-7 and 8	NR	NR	Not Requested				NR	NR	40.5	11.9	70.44	5.47	3.66	7.20	NR
Illinois No. 5[d]															
Eagle No. 2 Mine															
Co., Ill.															
Rec'd. 3/80, BTC-70-74	3.5	9.0	2110	2210	2250	2370	0.74	0.06	38.84	11.83	71.17	4.85	4.08	6.69	12,944

TABLE A-5. (Continued)

Raw Coal Identification	Swelling and Agglomeration Analysis FSI	AI	Ash Fusion Temperatures, F I.D.	S.T.	H.T.	F.T.	Chemical Analyses, % of Coal, Dry Basis Treatment Chemicals Ca	Na	Proximate V.M.	Ash	Ultimate C	H	S	O	Higher Heating Value Btu/lb
Indiana No. 5[e] Old Ben No. 1 Mine Co., Ind. Rec'd. 3/80, BTC-70-73 and 104-105	3.5	9.1	2000	2170	2210	2340	0.32	0.05	40.44	10.5	71.08	4.95	4.51	7.58	13,035
Kentucky No. 9[f] Sinclair No. 2 Mine Co., Kentucky Rec'd. 3/80, BTC-64-67 and 103	2.5	9.0	2000	2120	2160	2330	1.05	0.05	37.07	15.17	67.37	4.58	5.33	6.23	12,196
Ohio No. 9[g] Orange Coal Co. Noble Co., Ohio Rec'd. 3/80, BTC-61-63	2.5	9.5	2010	2300	2370	2510	0.28	0.04	39.77	17.02	65.74	4.70	5.29	6.29	12,066
Montour No. 4 Pittsburgh No. 8 Rec'd. 7/78, BTC-34-36	6.5	NR	Not Requested				0.01	0.02	37.07	8.77	78.96	5.63	1.69		NR
Pittsburgh No. 8 From PETC Rec'd. 8/78 BTC-27 and 28	8	NR	Not Requested				NR	NR				Not Requested			

(a) Excess for Ill. No. 5, Ill. No. 6 (Perry Co.), Indiana No. 5 and Kentucky No. 9 runs noted below.
(b) Gieseler Plastometer values were 2 D.D.P.M. maximum fluidity (M.F.), 398 C Initial Softening Temperature (I.S.T), 401 C Maximum Fluid Temperature (M.F.T.), 419 C Solidification Temperature (S.T.).
(c) Gieseler Plastometer value was ~0 P.O.P.M., no further tests could be conducted. Analysis made 18 mo. after coal sample received.
(d) Gieseler Plastometer values were 618 D.D.P.M. M.F., 380 C I.S.T., 421 C M.F.T., 453 C S.T.
(e) Gieseler Plastometer values were 89 D.D.P.M. M.F., 370 C I.S.T., 421 C M.F.T., 444 C S.T.
(f) Gieseler Plastometer values were 17 D.D.P.M. M.F., 399 C I.S.T., 426 C M.F.T., 444 C S.T.
(g) Gieseler Plastometer values were 1747 D.D.P.M. M.F., 381 C I.S.T., 420 C M.F.T., 449 C S.T.

TABLE A-6. SUMMARY OF BATCH AUTOCLAVE RUNS WITH LOWER CATALYST-TO-COAL RATIOS (TREATMENT TEMPERATURE: 250 C)

Run No.	Sample No.(a),(b)	NaOH-to-Coal Ratio	CaO-to-Coal Ratio	Water-to-Coal Ratio	NaOH Concentration(c), wt %	Treatment Time, minutes	Washing of BTC (at 80C) No. of Washes	Washing of BTC (at 80C) Water-to Dry-Coal Ratio(d)	Properties of BTC: Sodium Content, wt % (MAF)	Properties of BTC: Calcium Content, wt % (MAF)	Properties of BTC: FSI	Hydrogasification at 850 C and 250 psig: t for X = 0.5	Hydrogasification at 850 C and 250 psig: Tendency for Agglomeration
—	Raw Coal: Montour #4 Mine; -48 +65 Mesh								0.02	0.12	8	25(e)	Severe
44	$44A_1$	0.35	0.049	4.0	8.0	11	4	>4	0.36	3.82	—	—	—
44	$44A_2$	0.35	0.049	4.0	8.0	20	4	>4	0.51	3.84	—	20.9	Small
44	44C	0.35	0.049	4.0	8.0	30	4	4	1.35	3.44	0	13.7	Small
46	$46A_1$	0.35	0.08	4.0	8.0	10	4	>4	0.24	6.09	0	1.3	None
46	$46A_2$	0.35	0.08	4.0	8.0	22	4	>4	0.23	--	--	—	—
46	46C	0.35	0.087(f)	4.0	8.0	30	4	4	0.22	7.95	--	—	--
54	$54A_1$	0.10(g)	0.13	2.4	4.0(g)	10	4	>4	—	--	--	—	—
54	$54A_2$	0.10(g)	0.13	2.4	4.0(g)	30	4	>4	--	—	--	—	—
54	54C	0.10(g)	0.13	2.4	4.0(g)	60	4	4	--	--	2-4(e)	--	—
57	$57A_1$	0.10	0.10	2.4	4.0	10	4	>4	0.42	4.50	--	10.1	Small
57	$57A_2$	0.10	0.10	2.4	4.0	30	4	>4	0.49	--	--	3.3	Small
57	$57C_1$	0.10	0.10	2.4	4.0	60	2	4	0.40	--	--	--	--
57	$57C_2$	0.10	0.10	2.4	4.0	60	3	4	0.37	8.28	—	--	—
57	$57C_3$	0.10	0.10	2.4	4.0	60	4	4	0.31	--	--	—	--

(a) Both CaO and NaOH were added to the heated autoclave, containing coal and water, through the charging bomb.

(b) Samples "A_1", and "A_2" were withdrawn from the autoclave and cooled rapidly to 25 C. On the other hand, Samples "C" were quenched to 175 C and then cooled slowly.

(c) Based on total weight of water and and NaOH in the autoclave.

(d) The wash-water-to-coal ratio for Samples "A_1" and "A_2" were greater than 4 because the amount of coal was 10 to 25 g and we needed to recover all the coal from beakers and filter paper.

(e) Estimated.

(f) Some CAO was accidently added through the charging bomb during quenching of the sample.

(g) A major portion of NaOH still remained in the charging bomb and thus the actual NaOH concentration was much less than 4.0 percent.

TABLE A-7. TREATMENT CONDITIONS OF BATCH RUNS WITH ILLINOIS NO. 6 COAL

Sample Number	Particle Size	Time, min.	Temp., C	Catalyst	Catalyst / Coal	Water / Coal	Sample Recovered	FSI	AI	Analyses % in Sample: Moisture	Ash	Ca	Na
New Coal 34044-9	-8+20						34.6	2-1/2	8.6	10.9	8.65	0.14	
	-20+50						38.3	2		11.0	9.40	0.26	
	-50+100						13.9	2-1/2		11.2	8.96	0.24	
	-100						13.3						
34044-16	-8+20	60	278	CaO	0.05	2.0	30.7	1-1/2	8.1	3.22	12.6	0.99	
	-20+50						35.5	2	9.3	2.30	13.0	1.52	
	-50+100						15.6	2(NA)(a)	2.3	2.07	18.1	2.93	
	-100						18.2						
34044-19	-8+20	60	276	CaO	0.10	2.0	30.2	2-1/2	8.1	0.43	12.5	1.05	
	-20+50						37.5	2	3.9	0.53	19.4	3.29	
	-50+100						16.6	NA	0.1	0.73	27.9	7.22	
	-100						15.7						
34044-20	-8+20	60	274	CaO	0.05	2.0	31.8	2-1/2	8.4	0.99	10.2	0.45	0.09
	-20+50			NaOH	0.003		36.4	1-1/2	3.9	0.84	11.5	1.11	0.18
	-50+100						14.8	NA	0.1	1.02	19.4	3.68	0.13
	-100						17.0						
34044-21 (b) (New Coal Grind)	-8+20						37.0						
	-20+50						33.8						
	-50+100						11.2						
	-100						18.0						
34044-22A Dried under N_2	-8+20	60	276	$Ca(NO_3)_2 \cdot 4 H_2O$	0.182(c)	2.0	32.3	1-1/2	8.3	1.72	11.3	0.78	
	-20+50						35.9	1-1/2	3.6	1.43	10.7	0.89	
	-50+100						13.8	NA	0.1	1.54	12.5	1.30	
	-100						18.0						
34044-22B Dried Under Air	-8+20	60	276	$Ca(NO_3)_2 \cdot 4 H_2O$	0.182(c)	2.0	40.9	2-1/2	8.2	0.69	11.1	0.62	
	-20+50						36.5	1-1/2	4.0	1.19	12.0	0.89	
	-50+100						9.9	1	0.0	1.20	14.4	1.23	
	-100						12.7						
34044-26	-8+20	12	277	CaO	0.10	2.0	32.0	2-1/2	8.7	1.62	12.3	0.74	
	-20+50						33.6	2	6.1	1.15	18.0	3.25	
	-50+100						11.6	NA	2.5	1.50	22.0	4.86	
	-100						22.7						
34044-27	-8+20	30	275	CaO	0.10	2.0	31.2	3-1/2	8.0	<0.1	12.8	0.69	
	-20+50						30.2	2-1/2	7.3	0.15	12.2	1.11	
	-50+100						10.3	2	1.4	0.40	15.7	2.55	
	-100						28.3						
34044-28	-20+50	30	276	CaO	0.10	2.0	72.5(e)	NA(d)	3.1	0.42	23.4	4.91	
	-50+100						27.5(e)	(1-1/2)					
34044-30	-8+20	60	25	CaO	0.05	2.0	34.3						
	-20+50						34.8	1-1/2	3.0	2.13	13.7	1.62	
	-50+100						12.4	1	2.9	1.80	16.4	2.87	
	-100						18.5						
34044-31	-20+50	30	277	CaO	0.10	1.0	64.3(e)	NA	2.2	1.55	24.5	5.49	
	-50+100						35.2						
34044-32	-20+100	30	279	CaO	0.05	2.0	(400 psi air)	1-1/2	5.1	1.00	19.0	3.25	

(a) NA = Nonagglomerating. This sample did swell to give a profile similar to FSI = 2.
(b) The samples shown below were prepared starting with this mesh size distribution.
(c) This is equivalent to 0.05 CaO/coal in terms of Ca/coal ratio.
(d) This sample did not agglomerate but the swelling profile was similar to FSI = 1-1/2.
(e) These are the starting amounts of the mesh size fractions.

TABLE A-8. CHEMICAL INCORPORATION OF CATALYST INTO COARSE ILLINOIS NO. 6 COAL

Sample Number 34044-	Preparation Conditions					Particle Size Distribution				FSI			AI		
	Time, min.	Temp., C	Catalyst	Catalyst / Coal	Water / Coal	-8 +20	-20 +50	-50 +100	-100	-8 +20	-20 +50	-50 +100	-8 +20	-20 +50	-50 +100
9	--	(Raw Coal)				34.6	38.3	13.9	13.3	2-1/2	2	2-1/2		8.6	
16	60	278	CaO	0.05	2.0	30.4	35.5	15.6	18.2	1-1/2	2	NA[a]	8.1	9.3	2.3
19	60	276	CaO	0.10	2.0	30.2	37.5	16.6	15.7	2-1/2	2	NA	8.1	3.9	0.1
20	60	274	CaO	0.05	2.0	31.8	36.4	14.8	17.0	2-1/2	1-1/2	NA	8.4	3.9	0.1
21	--	(Raw coal-second grind)	NaOH	0.003		37.0	33.8	11.2	18.0						
22A	60 (Dried under N_2)	276	$Ca(NO_3)_2 \cdot 4\ H_2O$	0.182[b]	2.0	32.3	35.9	13.8	18.0	1-1/2	1-1/2	NA[c]	8.3	3.6	0.1
22B	(Same conditions-dried under air)					40.9	36.5	9.9	12.7	2-1/2	1-1/2	1	8.2	4.0	0.0
26	12	277	CaO	0.10	2.0	32.0	33.6	11.6	22.7	2-1/2	2	NA	8.7	6.1	2.5
27	30	275	CaO	0.10	2.0	31.2	30.2	10.3	28.3	3-1/2	2-1/2	2	8.0	7.3	1.4

(a) NA = Nonagglomerating. This sample did swell to give a profile similar to FSI = 2.

(b) This is equivalent to 0.05 CaO/coal in terms of Ca/coal ratio.

(c) This sample did not agglomerate but the swelling profile was similar to FSI = 1-1/2.

TABLE A-9. DATA ON TREATMENT OF COARSE MONTOUR #4 (PITTSBURGH #8 SEAM) COAL WITH CATALYST USING CATALYST COMPOSITION DETERMINED FOR FINE COAL (NaOH/COAL = 0.35, CaO/COAL = 0.13, WATER/COAL = 4.0)

Batch Treatment Run No.[a]	Sample No.[a]	Treatment Temp, C	Treatment Time, min	Washing of BTC		Temp, C	Properties of Coal					
				No. of Washes	Water-to-Dry Coal Ratio[b]		Sodium Content, wt % (MAF)	Calcium Content, wt % (MAF	Volatile Matter (dry), wt % (MAF)	FSI	Bulk Density, g/cm^3	Heat Content, Btu/lb (MAF)
	2U	-- Untreated coal; -20 + 28 mesh					0.02	0.12[c]	41.9	8[c]	0.65	15,200
2	$2A_1$	265	11	4	>4	25	0.97	--	--	-	--	--
2	$2C^1$	265	60	4	4	25	0.61	5.54	--	-	0.44	--
20	20C	250	20	4	4	80	0.80	11.06	--	-	0.43	--
31	31C	250	22	4	4	80	0.79	9.19	--	0	--	14,937
33	33C	235	20	4	4	80	0.81	8.66	42.6	-	--	15,356
34	34C	250	20	4	4	80	--	4.54	--	-	--	--
	4U	-- Untreated coal; -35 + 48 mesh					0.02[c]	0.12[c]	42.0	8[c]	0.62	14,972
12	$12A_1$	250	11	4	>4	25	0.30	--	--	-	--	--
12	$12A_2$	250	21	4	>4	25	0.35	--	--	-	--	--
12	$12A_3$	250	41	4	>4	25	--	--	--	-	--	--
12	$12A_4$	250	61	4	>4	25	--	--	--	-	--	--
12	12C	250	120	4	4	25	0.41	5.55	--	-	0.45	--
22	22C	250	20	4	4	25	0.55	5.45	--	0	--	--
26	26C	250	20	4	4	25	0.34	14.4	--	-	--	14,437
26	$26C_1$(1)	250	20	3	4	80	0.25	12.80	--	-	--	--
26	$26C_1$(2)	250	20	4	4	80	0.18	11.05	--	-	--	--
26	$26C_1$(3)	250	20	5	4	80	0.15	9.95	--	-	--	--
26	$26C_2$(1)	250	20	3	4	25	0.33	12.16	--	-	--	--
26	$26C_2$(2)	250	20	4	4	25	0.26	11.88	--	-	--	--
26	$26C_2$(3)	250	20	5	4	25	0.20	9.24	--	-	--	--
	6U	-- Untreated coal; -65 + 100 mesh					0.02[c]	0.12[c]	--	8[c]	0.58	--
10[d]	$10A_1$	260	15	4	>4	25	0.16	--	--	-	--	--
10	$10A_2$	260	25	4	>4	25	0.18	--	--	-	--	--
10	$10A_3$	260	60	4	>4	25	--	--	--	-	--	--
10	10C	260	120	4	4	25	0.56	9.95	--	-	0.49	--
	8U	-- Untreated coal; -150 + 200 mesh					0.02[c]	0.12[c]	--	8	0.55	--
14	$14A_1$	250	10	4	>4	25	0.11	--	--	--	--	--
14	$14A_2$	250	20	4	>4	25	0.11	--	--	--	--	--
14	$14A_3$	250	40	4	>4	25	--	--	--	--	--	--
14	$14A_4$	250	60	4	>4	25	--	--	--	--	--	--
14	14C	250	120	4	4	25	0.21	10.67	--	--	--	--
	18U	-- Untreated coal; 0.25 inch to 0.187 inch (4 mesh)					0.02[c]	0.12[c]	--	8[c]	--	--
18	18C	250	120	4	4	25	2.20	9.30	42.7	0	--	14,702

(a) Samples "A_i", where i = 1, 2, 3, etc., were withdrawn from the autoclave and cooled in a few minutes to 25 C. On the other hand, Samples "C" in Runs Nos. 2 to 18 were cooled slowly (in 2 hours), while other "C" samples were obtained after quenching to 175 C followed by slow cooling (in more than 1 hour).

(b) The wash-water-to-dry-coal ratio for Samples "A_i", where i = 1, 2, 3, etc., was greater than 4 because the amount of coal was 10 to 15 grams and it was necessary to recover all the coal from beakers and filter paper.

(c) Expected values based on properties of similar samples.

(d) In Run No. 16, the NaOH-to-coal ratio was 0.41 and the water-to-coal ratio was 4.2.

TABLE A-10. REACTION CONDITIONS AND ANALYSES OF BTC TREATED LUMP COALS

Experiment Number	1	2	3	4	5	6
Coal	Ohio	Ohio	Ohio	Westland	Ohio	Ohio
Starting Mesh Size	1/4 x 3/4	1/4 x 3/4	1/4 x 3/4	-70	1/4 x 3/4	1/4 x 1"
Catalyst/coal	CaO,0.05	MgO·CaO,0.1 NaOH,0.02	MgO·CaO,0.1 NaOH,0.15	CaO,0.1	CaO·MgO,0.1	CaO,0.05
H_2O/coal	1.5	2.0	2.0	2.0	2.0	6.0
Time, min	60	15	15	60	60	30
Temp, C	280	275	310	310	310	325
Atmosphere	N_2	N_2	O_2,30 psi	N_2	N_2	N_2
Stirring Rate, rpm	140	120	120	>300	120	400
Stirring Time, min	60	15	15	60	60	60
Product Size Distribution, % greater than						
-1/4"	--	54.2	12.6		34.6	25.4
4 mesh		66.0	15.0		42.6	
12		71.2	29.7		71.8	60.3
30			63.7		86.1	75.5
FSI[a]	1.5,+1/4,-1/4	3,+4 mesh 1,-4 +12	N.A.,[b]+1/4 N.A.,-12 +30	1.5	N.M.(d), +1/4 1.5,-12 +30	3,+1/4 N.A.,-30
Agglomerating Index[c]	8.5,+1/4 0.8,-1/4	4.5,+4 mesh 2.0,-4 +12	1.0,+1/4 0.4,-12 +30	3.7	7.7,+1/4 0.8,-12 +30	8.8,+1/4 0.3,-30

(a) FSI of raw Ohio coal = 2.5, Westland coal = 7.0.
(b) N.A. = nonagglomerating.
(c) AI of Ohio coal = 8.6, Westland coal = 3.8.
(d) N.M. = not measured.

TABLE A-11. RESULTS OF BTC TREATMENT OF PITTSBURGH SEAM (MONTOUR NO. 4) COAL AT ELEVATED PRESSURES ON STEAM GASIFICATION REACTIVITY[a]

Treatment Press, psi	Raw Coal	0	1000	2000	4000	Vac[b]
Analyses of Treated Coals, wt % of Sample						
Moisture	2.36	0.89	0.87	0.66	0.67	0.44
Ash	8.56	16.1	13.2	15.2	15.6	13.7
Na	0.016	0.026	0.016	0.033	0.022	0.021
Ca	0.010	3.75	2.10	3.15	3.31	1.95
S	0.51	1.07	0.71	0.95	1.05	--
Volatile Matter	36.2				1.254	
C	77.1					
H	5.5					
N	1.4					
S	1.62					
FSI, 20x70 mesh	6-1/2	3	4-1/2	2-1/2	4	4
20x0 mesh		2-1/2	6-1/2	2-1/2	3	
-70 Mesh Material Removed Before Reactivity Tests, %						
		14.8	22.9	15.7	12.4	15.1
Steam Gasification Reactivity Test Results						
Conversion (MAF) at min, %		36.0	37.0	34.7	38.2	37.9
First order rate constant, min^{-1}		0.062	0.056	0.056	0.058	0.054

(a) Treatment conditions: T=25C, $CaO/NaOH/H_2O/Coal = 0.10/0.005/2.0/1.0$ with 10 minute residence time.

(b) Materials degassed under vacuum prior to treatment.

TABLE A-12. SUMMARY OF CATALYST IMPREGNATION EXPERIMENTS WITH ILLINOIS NO. 6 SEAM COAL[a], PEABODY # 10 MINE

Experiment No. 32544-	Sample No. 32544-	CaO/Coal	Water/Coal	Treatment Time, min.	Temperature, C	FSI
Raw Coal	15U	0	0	0	275	3
15	15C	0.13	4.0	120	275	0
17	$17A_1$	0.13	3.0	10	275	0
17	$17A_2$	0.13	3.0	20	275	0
17	$17A_3$	0.13	3.0	30	275	0
17	17C	0.13	3.0	60	275	0
21	$21A_1$	0.08	3.4	10	275	0
21	$21A_2$	0.08	3.4	20	275	0
21	$21A_3$	0.08	3.4	30	275	0
21	21C	0.08	3.4	60	275	0
28[b]	$28A_1$	0.039	3.0	10	275	1.5
28[b]	$28A_2$	0.039	3.0	20	275	0
28[b]	$28A_3$	0.039	3.0	30	275	0
28[b]	28C	0.039	3.0	60	275	0
30[b]	$30A_1$	0.072	2.0	10	275	0
30[b]	$30A_2$	0.072	2.0	20	275	0
30[b]	$30A_3$	0.072	2.0	30	275	0
30[b]	30C	0.072	2.0	60	275	0
32[b]	$32A_1$	0.05	1.5	10	275	0
32[b]	$32A_2$	0.05	1.5	20	275	0
32[b]	$32A_3$	0.05	1.5	30	275	0
32[b]	32C	0.05	1.5	60	275	0
35[b]	35C	0.05	1.1	15	275	0
38	38A	0.055	1.1	10	280	0
38	38C	0.055	1.1	15[b]	280	0
39	39	0.05	1.1	30	23	1.5
40	40A	0.08	1.1	10	280	0
40	40C	0.08	1.1	15[b]	280	0

(a) The temperature variation during a run is normally less than 10 C around the operating temperature. Raw coal particle size was -48+65 mesh.
(b) Removed after quenching to 225 C followed by slow cooling.

TABLE A-13. SUMMARY OF CATALYST IMPREGNATION EXPERIMENTS WITH MONTOUR #4 (PITTSBURGH SEAM NO. 8) COAL USING A CaO-TO-COAL RATIO OF 0.13

Experiment No. 32544-	Sample No. 32544-	Raw Coal Size, mesh	Water/Coal	Quick Charging of CaO	Temp, C	Treatment Time, min	Quick Quenching of Reaction	FSI[a] of BTC	Tendency[b] of Agglomeration During Hydrogasification in TGA
5	$5A_1$	-48+65	4.0	Yes	280	10	Yes	2	
5	$5A_2$	"	4.0	Yes	280	30	Yes	1.5	
5	$5A_3$	"	4.0	Yes	280	60	Yes	1.5	
5	5C	"	4.0	Yes	280	120	Yes	1.5	
7	$7A_1$	"	2.0	Yes	280	10	Yes	2.5	
7	$7A_2$	"	2.0	Yes	280	30	Yes	2.0	
7	$7A_3$	"	2.0	Yes	280	60	Yes	1.5	
7	7C	"	2.0	Yes	280	120	Yes	1.5	Medium
9	9C	"	2.0	Yes	300	120	Yes	1.5	Medium
11	$11A_1$	70%-200	4.0	Yes	275	40	Yes		
11	$11A_2$	"	4.0	Yes	275	70	Yes		
11	11C	"	4.0	Yes	275	150	No	2.0	
13	13C	-48+65	2.0	Yes	325	30[c]	Yes		Medium to Large
14	14C	70%-200	4.0	No	275	120	No	1.5	
16	16C	"	4.0	No	300	120	No	1.5	

(a) FSI of raw coal was 8.0.

(b) The order is: Severe; large; medium; small; none. Raw coal is characterized by "Severe".

(c) The coal particles agglomerated during treatment.

TABLE A-14. DEPENDENCE OF HYDROGASIFICATION ON REACTIVITY OF BTC ON THE TIME OF LEACHING

Gasification Experiment[a] No. 31793-	Sample No. 31689-	Time of Leaching[b], min.	Average Relative Reactivity, R_x for x=0.6	Average Relative Reactivity, R_x for x=0.7
50	$31A_1$	10	17.0	21.8
51	$31A_2$	30	17.9	24.0
55	$31A_3$	60	17.9	23.5
56	$31A_4$	120	17.6	23.1

(a) All hydrogasification experiments were performed at 850 C and 500 psig.

(b) Coal from Montour #4 mine (Batch II) was hydrothermally treated at 250 C using an NaOH to coal ratio of 0.35, a CaO to coal ratio of 0.1, and a water to coal ratio of 4.0.

p

APPENDIX B

DIRECT HYDROGASIFICATION

TABLE B-1. SUMMARY OF CONTINUOUS HYDROGASIFICATION OF BTC

	Run 29	Run 30	Run 31	Run 31	Run 33	Run 34	Run 36	Run 37	Run 41	Run 42	Run 44	Run 46
Feed (i)	BTC-12	BTC-13	BTC-13	BTC-13	BTC-13	BTC-13	BTC-13	BTC-13	BTC-22	BTC-23A	BTC-23B	BTC-25C
Mode of Operation(a)	MB 1	MB 1	MB 1	MB 1	MB 1	MB 1	MB 2	MB 1	MB 2	MB 1	MB 1	MB 1
Temperature, F	1490	1378	1538	1587	1635	1615	1653	1734	1763	1712	1790	1714
Total Pressure, psig	260.4	274.6	508.0	508.0	1008.0	1011.0	1012.0	1015.3	997.3	1000.3	1002.3	1000.3
H_2 Pressure, (c) psi	100.9	128.9	184.6	157.8	242.4	186.4	538.3	201.8	479.9	200.5	227.1	253.8
Material Balance,(b) %												
Overall	100.43	106.87	102.10	102.35	95.52	105.77	101.20	110.98	98.34	100.14	97.12	95.14
Carbon	94.99	97.02	97.26	97.62	94.36	96.91	102.93	96.75	93.91	88.06	92.12	93.48
Hydrogen	98.00	114.27	115.78	116.11	82.93	120.21	93.89	124.15	95.35	111.68	101.34	91.68
Solid Residence Time, min	18.90	19.49	27.53	27.67	22.28	30.12	46.87	34.69	41.13	46.59	42.14	39.85
Gas Residence Time,(c) sec	18.92	18.57	42.21	44.51	87.72	93.94	120.52	90.14	105.77	99.79	90.46	110.36
H_2/C Ratio in Feed, scf/lb	8.72	16.31	13.67	13.67	11.79	14.88	15.48	14.79	12.97	10.52	17.21	18.33
Total Feed Hydrogen Consumption, scf/lb(d)	10.45	20.84	16.69	20.19	33.19	32.57	18.81	28.33	18.64	28.44	33.77	24.59
Feed Hydrogen Consumption for Gas and Liquid Products, scf/lb(e)	0.04	9.70	7.89	11.36	27.63	24.00	18.26	24.83	26.81	17.64	15.70	11.49
Carbon Conversion,(f) %												
Gas	21.29 (23.68)	22.56 (23.90)	27.26 (27.78)	27.18 (27.)	24.11 (24.72)	28.09 (28.52)	27.36 (27.54)	33.75 (33.75)	26.17 (25.81)	37.19 (37.61)	35.07 (35.15)	34.80 (36.65)
Liquid	6.96 (7.84)	11.09 (11.38)	8.29 (13.80)	8.29 (13.30)	1.92 (2.36)	5.75 (9.14)	0.21 (1.58)	6.50 (6.50)	0.22 (0.22)	2.90 (2.95)	1.79 (3.50)	5.76 (6.97)
Carbon Conv. Rate,(g) lb/hr-ft^3												
Gas	12.93	12.29	11.11	11.05	13.02	11.37	6.95	10.96	7.99	10.97	10.76	11.21
Liquid	4.28	5.85	5.52	5.51	1.25	3.65	0.40	2.11	0.068	1.560	1.080	2.13
Product Gas(h)												
CH_4 Conc., mole percent	38.06	32.42	42.20	48.01	58.96	61.50	36.03	62.64	36.08	63.41	60.92	59.89
HHV of Raw Gas, Btu/scf	593	562	624	662	734	749	556	753.5	559.5	761.3	744.5	730.4
HHV of Methanated Gas, Btu/scf	784	663	792	826	887	972	703	935	793	951	915	980

(a) MB 1 indicates moving-bed countercurrent flow and MB 2 moving-bed cocurrent flow.
(b) Material balance = (Output/Input) (100%).
(c) Based on wet gas.
(d) This indicates the total feed hydrogen consumption per unit quantity of carbon converted during steady state period.
(e) This indicates the feed hydrogen consumption for gas and liquid products (excluding water) per unit quantity of carbon converted during steady state period.
(f) The values represent the average carbon conversion during steady state period. The values in parentheses represent carbon conversions to gas products including C_3-C_5 aliphatics and liquid products including benzene and toluene.
(g) During steady state period.
(h) This indicates average values during steady state period.
(i) See Table A-1 in Appendix A for the treatment conditions of each BTC employed.

TABLE B-1. (Continued)

	Run 58	Run 60	Run 62	Run 63	Run 65[1]
Feed[1]	BTC-54P	BTC-60P	BTC-69B	BTC-93P	BTC-105
Mode of Operation[a]	MB 1	MB 1	MB 1	MB 1	MB 1
Temperature, F	1405	1386.9	839.9	926	1440.6
Total Pressure, psig	497	504.9	504	514	505.1
H_2 Pressure, (c) psi	89.7	100.9	700	350.7	700
Material Balance,[b] %					
Overall	102.66	NA	NA	115.56	NA
Carbon	92.59	NA	NA	95.49	NA
Hydrogen	116.22	NA	NA	115.65	NA
Solid Residence Time, min	59.08	41.15	57.26	12.99	63.45
Gas Residence Time,[c] sec	31.84	NA	NA	20.56	NA
H_2/C Ratio in Feed, scf/lb	8.85	24.51	22.93	22.98	9.8
Total Feed Hydrogen Consumption, scf/lb[d]	14.3	NA	NA	79.4	NA
Feed Hydrogen Consumption for Gas and Liquid Products, scf/lb[e]	NA	NA	NA	NA	NA
Carbon Conversion,[f] %					
Gas	35.85 (43.77)	40.53	6.74	22.17 (23.32)	37.82 4.25
Liquid	18.80 (10.88)	.15	12.74	23.91 (22.76)	
Carbon Conv. Rate,[g] lb/hr-ft^3					
Gas	12.49	NA	NA	7.57	NA
Liquid	74.79	NA	NA	8.16	NA
Product Gas[h]					
CH_4 Conc., mole percent	54.84	25.43		6.76	56.11
HHV of Raw Gas, Btu/scf	726.9	504.0	329.0	330.99	719.98
HHV of Methanated Gas, Btu/scf	1006.9	573.0	367.2	332.67	1019.17

(a) MB 1 indicates moving-bed countercurrent flow and MB 2 moving-bed cocurrent flow.
(b) Material balance = (Output/Input) (100%).
(c) Based on wet gas.
(d) This indicates the total feed hydrogen consumption per unit quantity of carbon converted during steady state period.
(e) This indicates the feed hydrogen consumption for gas and liquid products (excluding water) per unit quantity of carbon converted during steady state period.
(f) The values represent the average carbon conversion during steady state period. The values in parentheses represent carbon conversions to gas products including C_3-C_5 aliphatics and liquid products including benzene and toluene.
(g) During steady state period.
(h) This indicates average values during steady state period.
(i) Feedstock: Kentucky No. 9 pellets
(j) See Table A-1 for the treatment conditions of each BTC employed.

TABLE B-2. ULTIMATE ANALYSIS OF TYPICAL RAW COAL AND BTC

Ultimate Analysis, %	Raw Coal	BTC-I[(a)]	BTC-II[(b)]	BTC-III[(c)]
C	68.93	65.17	66.97	61.33
H	5.07	4.67	5.04	4.57
N	1.36	1.26	1.27	1.00
S	4.39	4.07	3.54	3.53
Ca	0.35	2.75	2.42	6.92
Na	--	--	0.11	0.21
Ash	11.77	18.98	19.43	26.13
Balance	8.48	5.85	3.75	3.35
	100.00	100.00	100.00	100.00

(a) BTC-I: BTC-12 and BTC-13, fine particle size, treated only by 5 percent CaO

(b) BTC-II: BTC-22, BTC-23A, BTC-23B and BTC-25C, coarse particle size, treated by 10 percent CaO and 0.3 percent NaOH

(c) BTC-III: BTC-54, 60, 93, coarse particle size treated by 15 percent CaO and $\leq$ 1.0 percent NaOH.

TABLE B-3. TYPICAL PARTICLE SIZE DISTRIBUTION OF BTC

Size, mesh	Weight Percent		
	BTC I	BTC II	BTC III
+40	0	25.40	(a)
-40/+50	0	24.52	
-50/+70	10.57	23.58	
-70/+100	24.04	16.36	
-100/+200	49.38	10.01	
-200/+325	11.92	0.09	
-325	3.54	0.05	
	100.00	100.01	

(a) Feed Size: 3/16 in X 1/2 in long pellets

TABLE B-4. SUMMARY OF CONTINUOUS HYDROGASIFICATION OF CHAR

	Run 32	Run 32	Run 32	Run 35	Run 35	Run 45	Run 45
Feed	Char[1]	Char[1]	Char[1]	Char[j]	Char[j]	Char[k]	Char[k]
Mode of Operation[a]	MB 1	MB 1	MB 1	MB 1	MB 1	MB 1	MB 1
Temperature, F	1510	1697	1771	1481	1687	1753	1863
Total Pressure, psig	499.2	499.2	499.2	1001.0	1001.0	1000.3	1000.3
H_2 Pressure, (c) psi	426.6	371.8	356.2	747.1	601.9	646.7	606.8
Material Balance,[b] %							
Overall	99.78	99.83	99.80	100.21	99.72	90.00	82.32
Carbon	95.87	95.89	95.88	97.36	96.72	83.44	74.68
Hydrogen	109.63	109.64	109.61	121.62	120.36	111.50	95.14
Solid Residence Time, min	42.61	41.88	41.61	55.25	54.95	71.28	70.68
Gas Residence Time,[c] sec	57.50	56.75	53.10	128.07	129.14	113.05	108.56
H_2/C Ratio in Feed, scf/lb	23.11	23.11	23.11	28.31	20.31	36.83	36.83
Total Feed Hydrogen Consumption, scf/lb[d]	58.24	59.63	51.70	38.78	47.71	44.37	62.23
Feed Hydrogen Consumption for Gas and Liquid Products, scf/lb[e]	51.50	55.48	48.16	32.20	43.16	41.82	61.10
Carbon Conversion,[f] %							
Gas	9.07 (9.06)	14.76 (14.74)	17.48 (17.32)	19.07 (19.07)	28.16 (28.14)	28.82 (28.29)	32.08 (32.07)
Liquid	0.04 (0.22)	0.04 (0.22)	0.04 (0.22)	0.10 (0.15)	0.10 (0.15)	0 (0.03)	0 (0.07)
Carbon Conv. Rate,[g] lb/hr-ft^3							
Gas	2.32	3.77	4.44	3.33	4.82	4.28	4.76
Liquid	0.06	0.06	0.06	0.03	0.03	0.005	0.010
Product Gas[h]							
CH_4 Conc., mole percent	13.57	24.14	27.44	22.56	37.14	32.51	36.50
HHV of Raw Gas, Btu/scf	417	486	509	478	577	542.8	570.7
HHV of Methanated Gas, Btu/scf	418	491	514	479	580	551	580

(a) MB 1 indicates moving-bed countercurrent flow and MB 2 moving-bed cocurrent flow.
(b) Material balance = (Output/Input) (100%).
(c) Based on wet gas.
(d) This indicates the total feed hydrogen consumption per unit quantity of carbon converted during steady state period.
(e) This indicates the feed hydrogen consumption for gas and liquid products (excluding water) per unit quantity of carbon converted during steady state period.
(f) The values represent the average carbon conversion during steady state period. The values in parentheses represent carbon conversions to gas products including C_3-C_5 aliphatics and liquid products including benzene and toluene.
(g) During steady state period.
(h) This indicates average values during steady state period.
(i) Char was obtained from hydrogasification of BTC (Runs 29, 30 and 31). Active carbon content in the bed is 70.3 percent of total carbon.
(j) Char was obtained from hydrogasification of BTC (Runs 19, 33 and 34). Active carbon content in the bed is 69.4 percent of total carbon.
(k) Char was obtained from hydrogasification of BTC (Runs 42 and 44). Active carbon content in the bed is 67.2 percent of total carbon.

TABLE B-5. PARTICLE SIZE DISTRIBUTIONS OF HYDROGASIFIED CHAR[a]

Item	Char from BTC I	Char from BTC II	Char from BTC III
Size Distribution (%)			
+40	0	48.80	17.33
-40/+50	1.88	23.32	19.93
-50/+70	20.59	16.32	15.51
-70/+100	20.13	7.20	12.89
-100/+200	28.68	3.72	17.69
-200/+325	13.57	0.19	14.24
-325	5.14	0.46	2.41

TABLE B-6. ULTIMATE ANALYSIS OF FEED CHAR TO SECOND STAGE HYDROGASIFIER

Element	Feed Char		
	Run 32[a]	Run 35[b]	Run 45[c]
C	77.69	72.52	75.76
H	1.10	0.88	0.97
N	0.60	0.49	0.22
S	3.50	3.36	3.45
Ca	4.33	3.74	6.18
Na	NA	NA	0.17
Ash	37.93	31.83	28.10
H_2O	0.25	0.79	0.69
Bal[d]	(21.07)	(9.87)	(9.19)

(a) Graphite content in the char was 21.84 weight percent. The char was from Runs 29, 30, and 31.

(b) Graphite content in the char was 25.53 weight percent. The char was from Runs 19, 33, and 34.

(c) Graphite content in the char was 27.57 weight percent. The char was from Runs 42 and 44.

TABLE B-7. STEADY STATE PRODUCT GAS COMPOSITION, FLOW RATE, AND HEATING VALUE FOR RUNS 29, 30, 31, 33, 34, 37, 42, 44, 58, 60, 62, 63, and 65.

Dry Raw Product Gas Component	Concentration, percent													
	Run 29	Run 30	Run 31A	Run 31B[b]	Run 33	Run 34	Run 37	Run 42	Run 44	Run 46	Run 58	Run 60	Run 62	Run 63	Run 65
H_2	45.76	55.57	43.74	38.09	26.94	22.55	24.73	24.61	27.79	25.47	32.18	69.16	93.07	98.41	31.57
CO_2	4.89	2.67	3.48	4.09	5.90	6.00	3.63	3.02	2.92	4.47	4.13	1.07	2.68	-0.22	4.57
C_2H_4	0.31	0.29	0.16	0.17	0.12	0.12	0.13	0.08	0.07	0.07	0.23	0.00	0.06	0.04	0.17
C_2H_6	1.96	2.13	1.96	1.99	2.21	2.03	1.14	1.03	1.04	0.98	2.90	0.76	0.42	0.72	2.04
N_2	0.67	1.14	0.82	0.77	0.62	0.45	0.64	0.55	0.48	0.56	0.37	0.21	0.56	0.08	0.38
CH_4	38.06	32.42	42.20	48.01	58.96	61.50	62.92	63.81	61.25	60.10	54.97	25.43	1.84	-0.12	56.10
CO	6.77	4.26	6.13	5.34	3.59	5.61	5.30	5.89	5.48	7.40	4.21	3.26	0.30	0.10	4.18
H_2S[a]	1.58	1.52	1.50	1.53	1.65	1.75	1.51	1.01	0.97	0.97	1.00	0.11	1.07	0.99	0.98
	100.00	100.00	99.99	99.99	99.99	100.01	100.00	100.00	100.00	100.02	99.99	100.00	100.00	100.00	99.99
Product Gas Flow Rate, scfh	135.54	154.39	11.454	103.64	113.58[d]	76.36	99.57	97.02	99.33	93.66	93.70	316.90	173.00	285.20	76.20
Carbon Conversion to Gas Products	21.29	22.56	27.26	27.18	24.11	28.09	34.90	37.19	35.07	34.80[e]	35.85	40.43	6.44	22.17	37.82
Heating Value without Methanation[b] Btu/SCF	593.00	562.00	624.00	662.00	797.00	813.00	796.00	795.00	776.00	NA[f]	766.00	510.00	342.00	334.00	362.00
Heating Value after Methanation[c] Btu/SCF	784.00	663.00	792.00	826.00	887.00	972.00	935.00	951.00	915.00	980.00	869.00	556.00	344.00	334.00	865.00

(a) The concentration was assumed
(b) After CO shift and sour gas removal, heating values are at 60 F.
(c) H_2S and CO_2 in the product gas would be removed prior to methanation.
(d) This includes a lead estimated at 38.8 scfh based on the pressure drop of around 35 psi/hr.
(e) Carbon content in the feed BTC was assumed at 65 percent.
(f) Not available.

TABLE B-8. ULTIMATE ANALYSES OF LIQUID PRODUCTS

Liquid Product	Quantity lb/lb BTC	Weight Percent	Composition, percent by weight C	H	N	S	Ash	Balance[a]
Run 29								
Oil	0.0466	30.42	82.4	7.5	1.0	2.18	0.05	6.92
Tar	0.0110	7.30	41.5	8.6	3.1	5.43	2.3	39.07
Aqueous	0.0931	61.78	3.6	NA[b]	NA	NA	NA	NA
	0.1507	100.00						
Run 30								
Oil	0.0815	41.33	80.4	7.7	1.2	1.36	0.05	9.34
Tar	0.0178	9.03	15.0	10.3	3.5	2.24	4.2	64.76
Aqueous	0.0979	49.65	3.4	NA	NA	NA	NA	NA
	0.1972	100.01						
Run 31								
Oil	0.0893	44.21	84.4	7.1	1.1	1.14	0.05	6.23
Tar	0.0234	11.58	23.2	9.0	4.1	1.34	5.4	56.98
Aqueous	0.0893	44.21	3.4	NA	NA	NA	NA	NA
	0.2020	100.00						
Run 34								
Oil	0.0369	27.11	85.0	7.25	1.50	0.93	0.02	5.30
Tar	0.0121	8.89	47.7	7.69	3.60	2.65	6.91	31.45
Aqueous	0.0871	64.00	3.95	NA	NA	NA	NA	NA
	0.1361	100.00						
Run 42								
Oil	0.0221	16.13	86.3	7.0	<0.1	2.6	<0.01	4.1
Aqueous	0.1149	83.87	0.62	NA[b]	NA	NA	NA	NA
	0.1370	100.00						
Run 44								
Oil	0.0138	10.57	84.9	6.9	<0.1	1.8	<0.01	6.4
Aqueous	0.1167	89.43	0.48	NA	NA	NA	NA	NA
	0.1305	100.00						
Run 46								
Oil[c]	0.0422	31.10	84.53	6.7	0.79	2.14	<0.01	5.84
Aqueous	0.0935	68.90	NA	NA	NA	NA	NA	NA
	0.1357	100.00						

(a) This indicates the contents of water, oxygen, and other trace elements. For tar samples, the major portion of the balance would be water.

(b) Not analyzed.

(c) Moisture content and heating value of this oil was analyzed at 0.5 percent and 15,998 Btu/lb, respectively.

TABLE B-9. BTX PRODUCTION FROM HYDROGASIFICATION OF BTC

Item	Run 17	Run 34[a]	Run 39	Run 42	Run 44	Run 46
Temperature, F	1614	1615	1604	1712	1791	1656
Pressure, psig	259	1011	1006	1001	1003	1000
H_2/Coal Ratio, scf/lb	6.67	9.59	10.65	10.51	11.30	11.37
Coal Processed, lb	44.555	25.77	4.82	43.53	43.13	26.51
Liquid Product, lb	4.478	3.507	0.276	5.967	5.631	3.598
Liquid Product Ratio, lb/lb coal fed	0.1005	0.1361	0.0573	0.1371	0.1306	0.1357
Carbon Conversion to Liquid Product, %	5.28	9.14	NA	2.95	3.50	6.97
Oil Phase, %	19.53	27.09	19.2	16.14	10.61	31.13
BTX Conc in Oil, wt %						
Benzene	58.0	6.1	25	6.9	29	12.6
Toluene	NA[a]	2.5	18	4.3	6	4.4
Xylene	NA	0.7	12	2.5	2	
BTX Production in Liquid, lb/lb coal	0.0114	0.0034	0.0061	0.0030	0.0051	0.0081
Product Gas Flow Rate, scfh	82.4	76.3	~100	97.02	99.33	93.66
BTX Conc in Gas, vol %						
Benzene	0.09	0.05	NA	0.38	0.34	0.15
Toluene	NA	NA	NA	0.01	0.01	<0.01
Xylene	NA	NA	NA	NA	<0.01	<0.01
BTX Production in Gas, lb/lb coal	0.0016	0.0004	NA	0.0084	0.0073	0.0030
Total BTX Production, lb/lb coal	0.0130	0.0038	0.0061[c]	0.0114	0.0124	0.0111

(a) The oil phase separation from aqueous phase was conducted in an open environment and the liquid products were exposed to open air for 3 days. Loss of BTX would be considerable during the period.

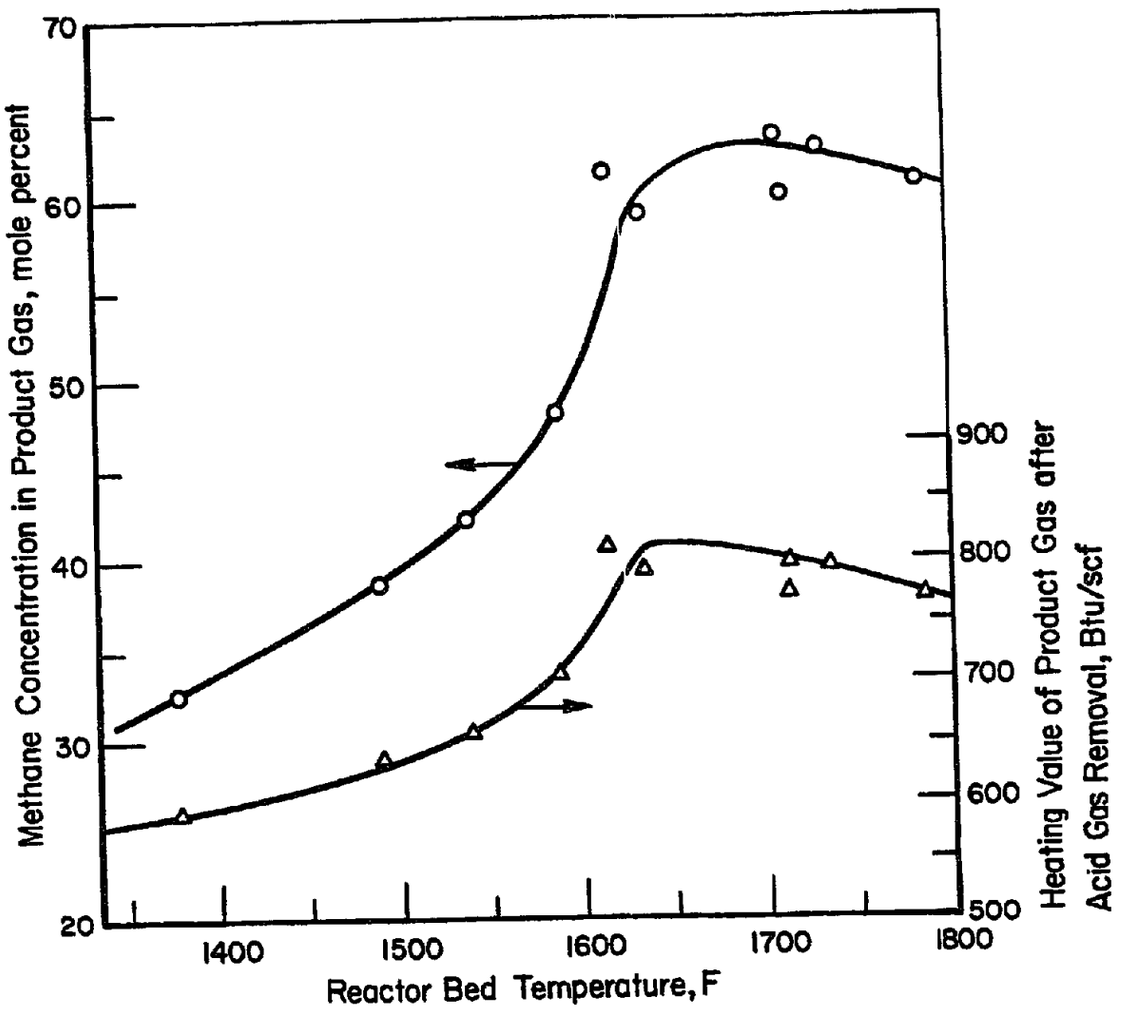


FIGURE B-1. EFFECT OF REACTOR BED TEMPERATURE IN METHANE CONCENTRATION AND HEATING VALUE OF PRODUCT GAS FOR HYDROGASIFICATION OF BTC

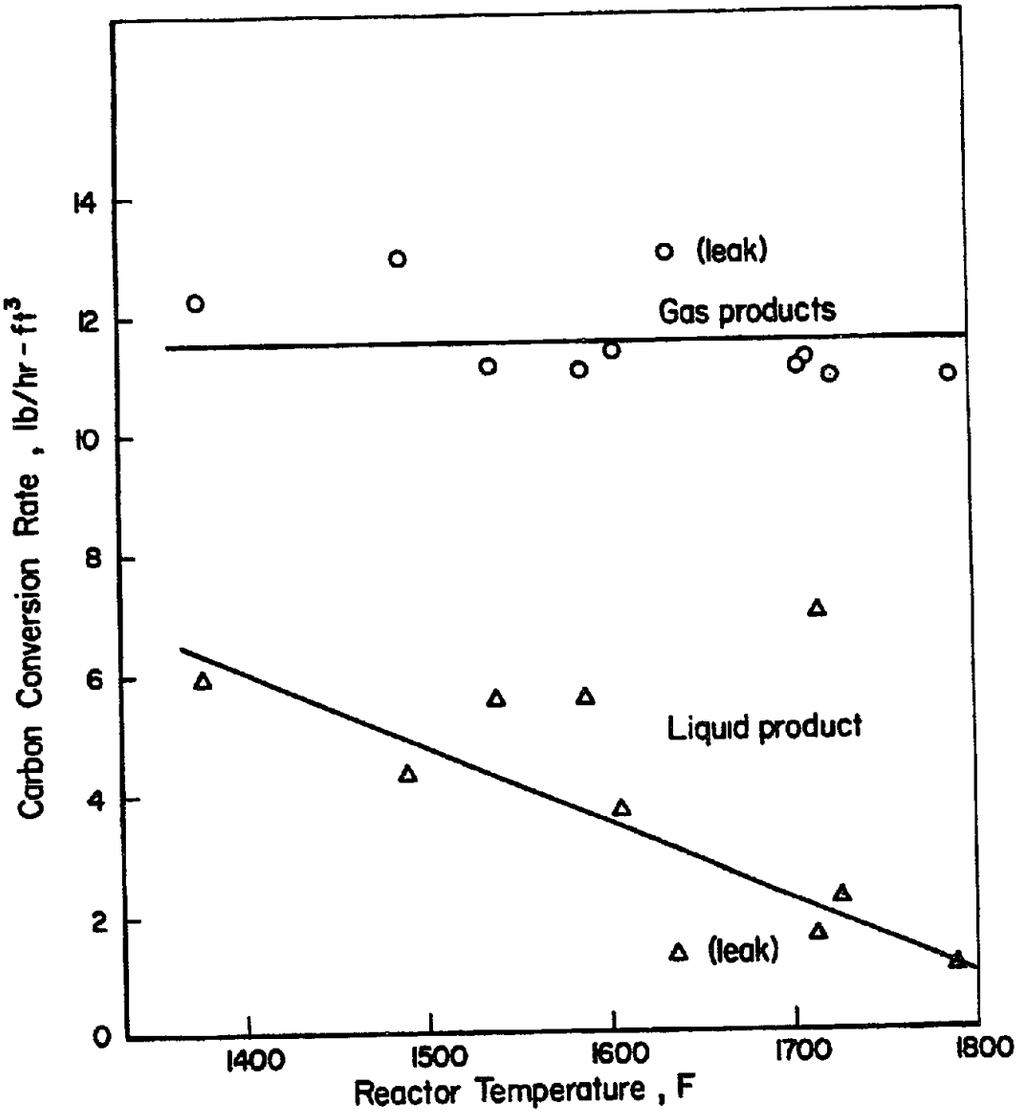


FIGURE B-2. CARBON CONVERSION RATE DURING STEADY STATE AS A FUNCTION OF REACTOR TEMPERATURE FOR HYDROGASIFICATION OF BTC

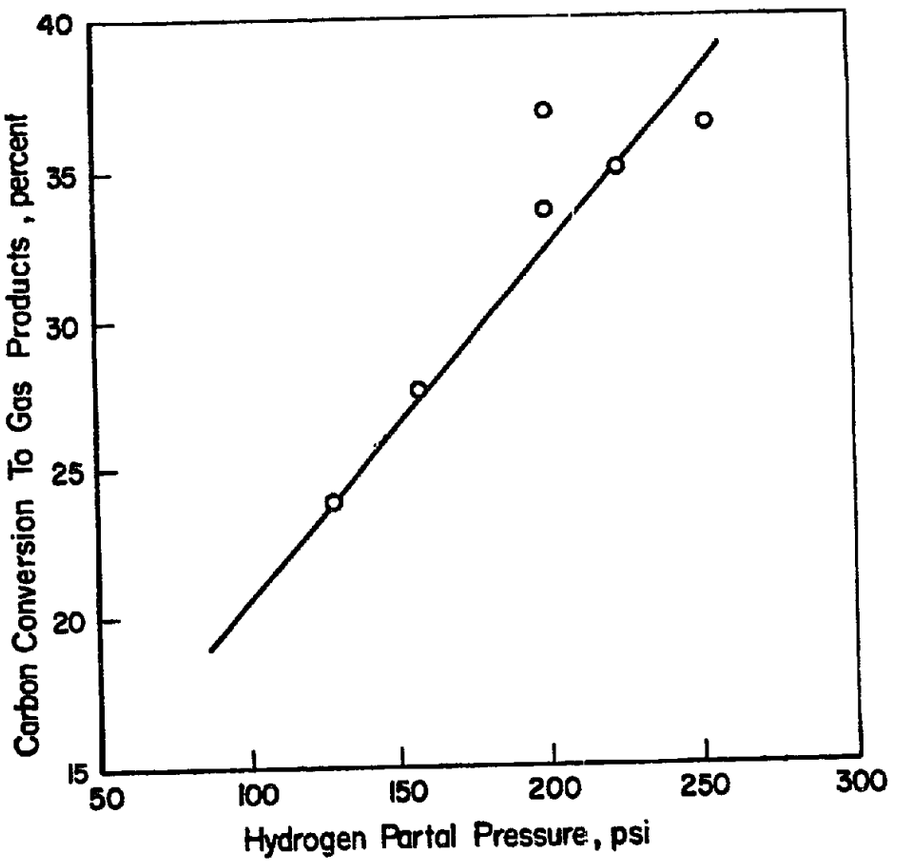


FIGURE B-3. EFFECT OF HYDROGEN PARTIAL PRESSURE ON CARBON CONVERSION TO GAS PRODUCTS FOR HYDROGASIFICATION OF BTC

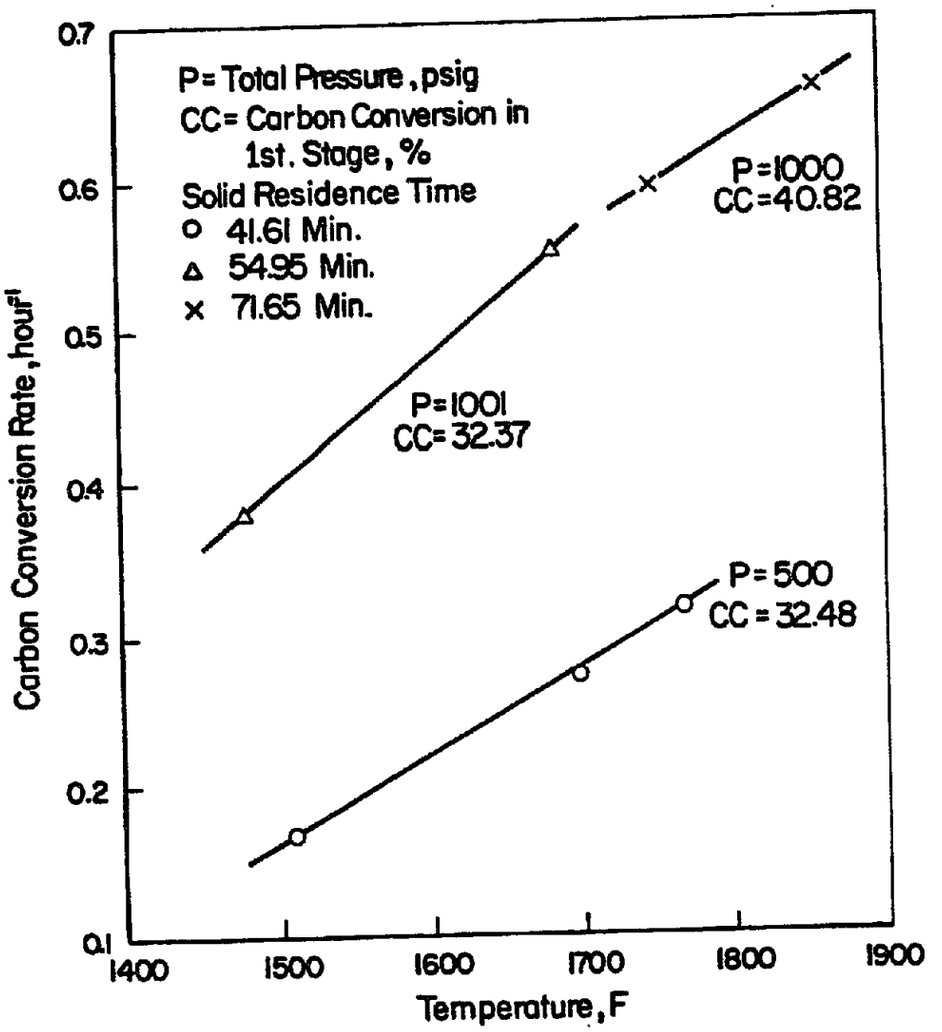


FIGURE B-4. CARBON CONVERSION RATE AS A FUNCTION OF REACTOR TEMPERATURE FOR HYDROGASIFICATION OF CHAR

APPENDIX C

SUMMARY OF TEST RUNS FOR HYDROGASIFICATION OF HTC

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 29.3310024 12.01.77 FIFTEENTH MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1157.
BEG. OF STEADY-STATE	1230.
END OF STEADY-STATE	1400.
END OF COAL FEED	1542.
END OF RUN	1745.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.500 FEED TIME = 3.750 TOTAL RUN TIME = 5.800

CONDITIONS -

PRESSURE	275. PSIA
TEMPERATURE	1491. F AVERAGE , 1786. F MAXIMUM
BED DEPTH	4.50 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	TOTAL RUN LB C	TOTAL RUN LB H
INPUTS -								
COAL		15.299	1.	10.172	0.749	57.371	38.146	2.809
H2 STREAM	96.0	0.513	0.0335	.003	0.509	1.924	.000	1.910
TOTAL						59.295	38.146	4.720
OUTPUTS -								
SS DRY GAS	135.4	4.533	0.2963	2.408	0.946	6.799	3.613	1.419
WATER		1.584	0.1035		0.177	5.939		0.665
LIQ. PROD.		0.918	0.0600	0.797	0.080	3.442	2.989	0.300
CHAR		9.113	0.5957	6.685	0.140	34.174	25.071	0.525
OTHER GAS						9.194	4.562	1.717
TOTAL						59.549	36.235	4.625
MATERIAL BALANCES (PCT.)						100.43	94.99	98.00

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	176.7 SCFH OR 35.4 ACFH
COAL RESIDENCE TIME	18.98 MIN.
GAS RESIDENCE TIME	18.92 SEC.
SUPER. GAS VELOCITY	0.238 FT/SEC
MAF CONVERSION	54.47 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	34.28	21.43	23.68
CARBON CONV. RATE (LB/HR/FT3)	18.72	11.70	12.93

C-1

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	30.53	37.65	24.04	70.14
C2H4	0.25	0.31	0.39	1.14
C2H6	1.57	1.94	2.48	7.22
CO	5.43	6.70	4.28	12.48
CO2	3.92	4.84	3.09	9.01
H2	36.71	45.26		
N2	0.54	0.66		
H2S	1.27	1.56		
C3-C7	0.88	1.09		
H2O	18.89			

MOLECULAR WEIGHT OF DRY C2- GAS = 12.48
HIGH HEATING VALUE OF DRY C2- GAS = 593.1 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	66.49	67.62	80.79	78.45	78.64	115.83	74.36	74.64	103.38
H	4.71	4.79	5.72	1.20	1.20	1.77	1.49	1.50	2.07
S	4.30	4.37	5.22	2.89	2.89	4.25	3.38	3.39	4.70
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.27	1.29	1.54	0.51	0.51	0.75	0.54	0.54	0.75
ASH	16.03	16.30		32.03	32.10		27.69	27.80	
H2O	1.67			0.23			0.38		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	0.3	20.9
- 40+ 50	0.9	12.3
- 50+ 70	17.2	17.5
- 70+100	27.3	15.5
-100+200	46.5	26.4
-200+325	5.9	5.8
-325	1.7	1.6

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	41.50	68.11	70.78
H	8.60	14.11	14.67
S	5.43	8.91	9.26
N	3.10	5.09	5.29

ASH	2.30	3.77
H2O	39.07	

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	20.23	5.08
C2H4	0.14	.00
C2H6	0.96	0.27
CO	2.83	0.56
CO2	2.01	0.60
H2	69.87	87.02
N2	2.23	4.65
H2S	1.11	1.19
C3-C7	0.63	0.63

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.34	0.11
C3H8	0.40	0.07
N-C4H10	0.09	0.05
C6H6	0.24	0.31
C7H9	0.02	0.09
TOTAL	1.09	0.63

C-3

OTHER PARAMETERS -

LETDOWN PRESSURE	29.3 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.2 PSIA AND 68. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0163 CM
MINIMUM FLUIDIZATION VELOCITY	0.0355 FT/SEC
GAS DENSITY AT MIN. FLUID. VEL.	34.89 LB/FT3
GAS DENSITY AT ACTUAL VELOCITY	25.87 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 4.836 , P = 0.279

PARTIAL PRESSURES (PSI) - H2 = 100.9 H2O = 51.4 CO = 14.9

VOLUMES (SCF) - VIN = 291.996 COR = 32.620 VFIN = 2.652 VH2O = 3.522

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 30-33100 — 16 TH MOVING-BED HYDROGASIFICATION RUN

TIMES —

STARTUP	1236.
BEG. OF STEADY-STATE	1310.
END OF STEADY-STATE	1515.
END OF COAL FEED	1539.
END OF RUN	1800.

TIME INTERVALS (HR.) — STEADY-STATE TIME = 2.083 FEED TIME = 3.050 TOTAL RUN TIME = 5.400

CONDITIONS —

PRESSURE	289. PSIA
TEMPERATURE	1379. F AVERAGE , 1558. F MAXIMUM
BED DEPTH	4.50 FT

YIELDS AND MATERIAL BALANCES —

	STEADY-STATE PERIOD — MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS —								
COAL		14.836	1.	9.577	0.589	45.251	29.210	1.796
H2 STREAM	156.2	3.835	0.0563	.003	0.829	2.546	.000	2.528
TOTAL						47.797	29.210	4.325
OUTPUTS —								
SS DRY GAS	154.2	4.303	0.2900	2.289	1.074	8.965	4.768	2.239
WATER		1.739	0.1206		0.200	5.456		0.610
LIQ. PROD.		1.274	0.0859	1.090	0.127	3.986	3.325	0.397
CHAR		5.327	0.5613	5.724	0.192	25.398	17.457	0.585
OTHER GAS						7.374	2.790	1.121
TOTAL						51.078	28.339	4.942
MATERIAL BALANCES (PCT.)						106.87	97.02	114.27

CALCULATED PARAMETERS —

WET PRODUCT GAS RATE	200.8 SCFH OR 36.1 ACFH
COAL RESIDENCE TIME	19.49 MIN.
GAS RESIDENCE TIME	18.57 SEC.
SUPER. GAS VELOCITY	0.242 FT/SEC
MAF CONVERSION	57.97 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	40.24	25.87	23.90
CARBON CONV. RATE (LB/HR/FT3)	20.63	13.30	12.29

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	26.03	32.04	29.52	73.37
C2H4	0.23	0.29	0.53	1.31
C2H6	1.71	2.11	3.88	9.64
CO	3.42	4.21	3.88	9.64
CO2	2.14	2.64	2.43	6.04
H2	44.61	54.92		
N2	0.92	1.13		
H2S	1.22	1.50		
C3-C7	0.95	1.17		
H20	18.78			

MOLECULAR WEIGHT OF DRY C2- GAS = 10.25
HIGH HEATING VALUE OF DRY C2- GAS = 562.6 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	64.55	65.43	79.12	76.17	76.37	113.47	69.02	69.63	89.28
H	3.82	3.87	4.68	1.55	1.55	2.31	3.05	3.08	3.95
S	3.73	3.78	4.57	2.81	2.82	4.19	3.52	3.55	4.55
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.24	1.25	1.52	0.57	0.57	0.85	1.08	1.09	1.40
ASH	17.07	17.30		32.61	32.70		21.81	22.00	
H20	1.34			0.25			0.88		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	0.2	19.7
- 40+ 50	0.3	15.6
- 50+ 70	9.2	20.6
- 70+100	21.1	13.7
-100+200	46.9	21.6
-200+325	12.9	5.3
-325	9.4	3.5

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	15.00	42.57	46.32
H	10.30	29.23	33.18
S	2.24	6.36	7.22
N	3.50	9.93	11.28

ASH	4.20	11.32
H2O	64.76	

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	14.28	14.60
C2H4	0.06	0.03
C2H6	0.60	0.15
CO	1.23	0.38
CO2	0.65	0.17
H2	75.27	69.88
N2	6.57	13.63
H2S	1.03	0.84
C3-C7	0.33	0.33

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.48	0.06
C3H8	0.55	0.06
N-C4H10	0.04	0.02
C6H6	0.13	0.19
TOTAL	1.17	0.33

OTHER PARAMETERS -

LETDOWN PRESSURE	25.8 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 69. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0165 CM
MINIMUM FLUIDIZATION VELOCITY	0.0060 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	34.92 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	25.87 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 4.868 , P = 0.308

PARTIAL PRESSURES (PSI) - H2 = 128.9 H2O = 53.6 CO = 9.9

VOLUMES (SCF) - VIN = 318.813 COR = 29.347 VFIN = 1.838 VH2O = 2.797

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 31.3310052 12.16.77 SEVENTEENTH MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1242.
BEG. OF STEADY-STATE	1329.
END OF STEADY-STATE	1440.
END OF COAL FEED	1740.
END OF RUN	2050.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.183 FEED TIME = 4.967 TOTAL RUN TIME = 8.133

CONDITIONS -

PRESSURE	522. PSIA
TEMPERATURE	1538. F AVERAGE , 1804. F MAXIMUM
BED DEPTH	4.50 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD					TOTAL RUN		
	MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	LB	LB C	LB H
INPUTS -								
COAL		11.572	1.	7.450	0.474	57.473	37.001	2.356
H2 STREAM	101.8	0.544	0.0470	.000	0.540	2.702	.000	2.684
TOTAL						60.175	37.001	5.040
OUTPUTS -								
SS DRY GAS	114.5	3.743	0.3234	2.069	0.831	4.429	2.449	0.983
WATER		1.296	0.1120		0.145	6.435		0.720
LIQ. PROD.		1.186	0.1025	1.028	0.106	5.892	5.105	0.524
CHAR		5.882	0.5083	4.019	0.097	29.213	19.962	0.480
OTHER GAS						15.478	8.471	3.128
TOTAL						61.445	35.987	5.836
MATERIAL BALANCES (PCT.)						102.11	97.26	115.79

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	146.6 SCFH OR 15.9 ACFH
COAL RESIDENCE TIME	27.53 MIN.
GAS RESIDENCE TIME	42.21 SEC.
SUPER. GAS VELOCITY	0.107 FT/SEC
MAF CONVERSION	56.91 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	46.05	29.51	27.78
CARBON CONV. RATE (LB/HR/FT3)	18.42	11.80	11.11

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	34.11	41.91	34.67	75.29
C2H4	0.13	0.16	0.25	0.57
C2H6	1.58	1.95	3.22	6.99
CO	4.96	6.09	5.04	10.94
CO2	2.81	3.46	2.86	6.21
H2	35.36	43.44		
N2	0.66	0.81		
H2S	1.24	1.52		
C3-C7	0.56	0.69		
H2O	18.60			

MOLECULAR WEIGHT OF DRY C2- GAS = 12.28
HIGH HEATING VALUE OF DRY C2- GAS = 623.8 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	64.38	65.08	78.50	74.52	74.59	98.57	71.39	71.62	99.28
H	3.98	4.02	4.85	1.20	1.20	1.59	1.96	1.97	2.73
S	3.65	3.69	4.45	2.56	2.66	3.52	3.37	3.38	4.69
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.28	1.29	1.56	0.33	0.33	0.44	0.56	0.56	0.78
ASH	16.92	17.10		24.30	24.32		27.77	27.86	
H2O	1.07			0.10			0.32		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	0.9	16.3
- 40+ 50	0.1	16.6
- 50+ 70	10.4	22.8
- 70+100	24.0	15.0
-100+200	49.9	21.6
-200+325	11.9	5.6
-325	3.5	2.1

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	23.28	53.90	61.64
H	9.00	20.91	23.91
S	1.54	3.11	3.55
N	4.10	9.53	10.89

ASH	5.40	12.55
H2O	56.96	

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	21.69	2.95
C2H4	0.06	.00
C2H6	0.76	0.09
CO	2.59	0.20
CO2	1.50	0.42
H2	70.29	92.38
N2	1.24	2.04
H2S	1.08	1.13
C3-C7	0.80	0.80

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.22	0.22
C3H8	0.28	0.35
C6H6	0.19	0.23
TOTAL	0.69	0.80

C9

OTHER PARAMETERS -

LETDOWN PRESSURE	27.6 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 72. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0168 CM
MINIMUM FLUIDIZATION VELOCITY	0.0057 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	35.00 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	28.51 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 4.960 , P = 0.532

PARTIAL PRESSURES (PSI) - H2 = 184.6 H2O = 96.5 CO = 25.9

VOLUMES (SCF) - VIN = 527.375 COR = 29.181 VFIN = 3.728 VH2O = 4.499

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 31.3310052 12.16.77 SEVENTEENTH MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1242.
BEG. OF STEADY-STATE	1705.
END OF STEADY-STATE	1730.
END OF COAL FEED	1740.
END OF RUN	2050.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 0.417 FEED TIME = 4.967 TOTAL RUN TIME = 8.133

CONDITIONS -

PRESSURE	522. PSIA	
TEMPERATURE	1587. F AVERAGE ,	1804. F MAXIMUM
BED DEPTH	4.50 FT	

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	LB/HR	LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		11.572	1.	7.450	0.474	57.473	37.001	2.356
H2 STREAM	101.8	0.544	0.0470	.000	0.540	2.702	.000	2.684
TOTAL						60.175	37.001	5.040
OUTPUTS -								
SS DRY GAS	103.6	3.620	0.3128	2.059	0.785	1.508	0.858	0.327
WATER		1.296	0.1120		0.145	6.435		0.720
LIQ. PROD.		1.188	0.1026	1.029	0.106	5.899	5.112	0.525
CHAR		5.892	0.5083	4.019	0.097	29.213	19.962	0.480
OTHER GAS						18.536	10.190	3.800
TOTAL						61.591	36.121	5.852
MATERIAL BALANCES (PCT.)						102.35	97.62	116.11

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	135.9 SCFH OR 15.1 ACFH
COAL RESIDENCE TIME	27.67 MIN.
GAS RESIDENCE TIME	44.51 SEC.
SUPER. GAS VELOCITY	0.101 FT/SEC
MAF CONVERSION	56.91 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	46.05	29.86	27.63
CARBON CONV. RATE (LB/HR/FT3)	18.42	11.94	11.05

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	38.10	47.68	35.80	77.74
C2H4	0.13	0.17	0.25	0.55
C2H6	1.58	1.98	2.97	6.44
CO	4.24	5.30	3.98	8.65
CO2	3.25	4.06	3.05	6.62
H2	30.23	37.83		
N2	0.61	0.76		
H2S	1.21	1.52		
C3-C7	0.55	0.69		
H2O	20.09			

MOLECULAR WEIGHT OF DRY C2- GAS = 13.15
HIGH HEATING VALUE OF DRY C2- GAS = 662.2 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	64.38	65.08	78.50	74.52	74.59	98.57	71.39	71.62	99.28
H	3.98	4.02	4.85	1.21	1.20	1.59	1.96	1.97	2.73
S	3.65	3.69	4.45	2.66	2.66	3.52	3.37	3.38	4.69
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.28	1.29	1.56	0.33	0.33	0.44	0.56	0.56	0.78
ASH	16.92	17.10		24.30	24.32		27.77	27.86	
H2O	1.07			0.11			0.32		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	0.0	16.3
- 40+ 50	0.1	16.6
- 50+ 70	10.4	22.8
- 70+100	24.0	15.0
-100+200	49.9	21.6
-200+325	11.9	5.6
-325	3.5	2.1

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	23.20	53.30	61.64
H	9.00	20.91	23.91
S	1.34	3.11	3.56
N	4.10	9.53	10.89

ASH	5.40	12.55
H2O	56.96	

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	23.60	2.95
C2H4	0.07	.00
C2H6	0.88	0.09
CO	2.97	0.20
CO2	1.68	0.42
H2	57.72	92.38
N2	1.20	2.04
H2S	1.08	1.13
C3-C7	0.80	0.80

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.22	0.22
C3H8	0.28	0.35
C6H6	0.19	0.23
TOTAL	0.69	0.80

OTHER PARAMETERS -

LETDOWN PRESSURE	27.6 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 72. =

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0168 CM
MINIMUM FLUIDIZATION VELOCITY	0.0056 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	35.00 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	28.65 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 4.747 , P = 0.499

PARTIAL PRESSURES (PSI) - H2 = 157.8 H2O = 104.2 CO = 22.1

VOLUMES (SCF) - VIN = 527.375 COR = 29.181 VFIN = 3.728 VH2O = 4.499

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 33.3310085 01.19.78 NINETEENTH MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1905.
BEG. OF STEADY-STATE	2040.
END OF STEADY-STATE	2152.
END OF COAL FEED	2137.
END OF RUN	2420.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.200 FEED TIME = 2.533 TOTAL RUN TIME = 5.250

CONDITIONS -

PRESSURE	1022. PSIA
TEMPERATURE	1635. F AVERAGE , 2115. F MAXIMUM
BED DEPTH	5.00 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		16.759	1.	10.903	0.598	42.456	27.622	1.514
H2 STREAM	128.6	0.687	0.0410	.000	0.682	1.741	.000	1.729
TOTAL						44.197	27.622	3.243
OUTPUTS -								
SS DRY GAS	113.5	4.569	0.2726	2.695	0.936	5.483	3.235	1.123
WATER		0.778	0.0464		0.087	1.972		0.221
LIQ. PROD.		0.294	0.0176	0.257	0.023	0.745	0.651	0.059
CHAR		11.267	0.6723	7.716	0.160	28.544	19.547	0.406
OTHER GAS						5.474	2.632	0.880
TOTAL						42.219	26.064	2.689
MATERIAL BALANCES (PCT.)						95.52	94.36	82.93

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	146.6 SCFH OR 8.5 ACFH
COAL RESIDENCE TIME	22.29 MIN.
GAS RESIDENCE TIME	87.72 SEC.
SUPER. GAS VELOCITY	0.057 FT/SEC
MAF CONVERSION	48.10 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	29.23	21.24	24.72
CARBON CONV. RATE (LB/HR/FT3)	15.40	11.19	13.02

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	51.90	58.44	23.58	80.65
C2H4	0.11	0.12	0.10	0.33
C2H6	1.95	2.19	1.77	6.05
CO	3.16	3.56	1.44	4.91
CO2	5.19	5.85	2.36	8.07
H2	23.71	26.70		
N2	0.55	0.61		
H2S	1.45	1.64		
C3-C7	0.78	0.88		
H2O	11.19			

MOLECULAR WEIGHT OF DRY C2- GAS = 15.04
HIGH HEATING VALUE OF DRY C2- GAS = 734.0 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	65.06	65.68	80.69	81.23	81.38	108.93	69.62	69.70	106.24
H	3.46	3.49	4.29	1.15	1.15	1.54	1.15	1.15	1.75
S	3.89	3.93	4.82	2.25	2.26	3.33	4.62	4.63	7.05
O	-.00	.00	.00	-.03	.00	.00	-.00	.30	.00
N	1.27	1.28	1.58	0.15	0.16	0.21	0.44	0.44	0.67
ASH	18.42	18.60		25.25	25.30		34.36	34.40	
H2O	0.95			0.18			0.11		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	.0	44.0
- 40+ 50	0.1	7.4
- 50+ 70	11.3	9.9
- 70+100	25.6	9.6
-100+200	49.2	18.5
-200+325	10.4	6.9
-325	3.3	3.7

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	48.10	65.84	78.52
H	7.20	9.85	11.75
S	2.86	3.91	4.67
N	3.10	4.24	5.06

ASH	11.80	16.15
H2O	26.94	

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	6.11	4.74
C2H4	.00	.00
C2H6	0.15	0.07
CO	0.11	.00
CO2	0.38	0.24
H2	91.47	93.12
N2	0.61	0.66
H2S	1.04	1.06
C3-C7	0.11	0.11

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.22	0.02
C3H8	0.56	0.04
N-C4H10	0.05	.00
C6H6	0.03	0.05
TOTAL	0.88	0.11

OTHER PARAMETERS -

LETDOWN PRESSURE	39.0 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.1 PSIA AND 76. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0171 CM
MINIMUM FLUIDIZATION VELOCITY	0.0355 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	35.06 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	30.07 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 5.465 , P = 1.182

PARTIAL PRESSURES (PSI) - H2 = 242.4 H2O = 113.4 CO = 32.3

VOLUMES (SCF) - VIN =1083.920 COR = 45.029 VFIN = 2.440 VH2O = 2.993

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 34.33770.1.02.03.78 TWENTIETH MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1504.
BEG. OF STEADY-STATE	1750.
END OF STEADY-STATE	1936.
END OF COAL FEED	1935.
END OF RUN	2209.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 0.767 FEED TIME = 2.517 TOTAL RUN TIME = 5.933

CONDITIONS -

PRESSURE	1026. PSIA
TEMPERATURE	1605. F AVERAGE , 1813. F MAXIMUM
BED DEPTH	4.00 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD					TOTAL RUN		
	MATERIAL			C	H			
	SCFH	LB/HR	LB/LB CL	LB/HR	LB/HR	LB	LB C	LB H
INPUTS -								
COAL		10.241	1.	6.602	0.318	25.774	16.614	0.800
H2 STREAM	99.9	0.534	0.0521	.000	0.530	1.343	.000	1.334
TOTAL						27.117	16.614	2.134
OUTPUTS -								
SS DRY GAS	76.3	3.210	0.3134	1.883	0.625	2.461	1.444	0.479
WATER		1.012	0.0988		0.113	2.546		0.285
LIQ. PROD.		9.685	0.0659	0.604	0.056	1.724	1.519	0.141
CHAR		5.280	0.5156	3.429	0.053	13.288	8.631	0.133
OTHER GAS						8.663	4.507	1.528
TOTAL						28.683	16.100	2.565
MATERIAL BALANCES (PCT.)						105.77	96.91	120.21

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	111.4 SCFH OR 6.3 ACFH
COAL RESIDENCE TIME	30.12 MIN.
GAS RESIDENCE TIME	93.94 SEC.
SUPER. GAS VELOCITY	0.043 FT/SEC
MAF CONVERSION	74.42 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	48.05	35.81	28.52
CARBON CONV. RATE (LB/HR/FT3)	19.16	14.28	11.37

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	49.57	61.30	38.18	79.45
C2H4	0.10	0.12	0.15	0.31
C2H6	1.64	2.02	2.52	5.24
CO	4.52	5.59	3.48	7.25
CO2	4.84	5.98	3.72	7.75
H2	18.18	22.48		
N2	0.36	0.45		
H2S	1.41	1.74		
C3-C7	0.26	0.32		
H2O	19.14			

MOLECULAR WEIGHT OF DRY C2- GAS = 15.98
HIGH HEATING VALUE OF DRY C2- GAS = 748.7 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	64.46	64.82	80.69	79.91	80.01	134.55	65.48	65.55	112.45
H	3.04	3.06	3.81	0.61	0.61	1.03	0.82	0.82	1.41
S	4.04	4.06	5.06	2.88	2.88	4.85	4.84	4.84	8.31
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.23	1.24	1.54	0.15	0.15	0.25	0.27	0.27	0.46
ASH	19.55	19.56		40.48	40.53		41.67	41.71	
H2O	0.56			0.13			0.10		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	0.2	39.7
- 40+ 50	0.9	9.9
- 50+ 70	26.5	14.0
- 70+100	28.4	9.3
-100+200	39.1	18.5
-200+325	4.2	6.2
-325	0.7	2.2

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	47.70	69.58	77.38
H	7.69	11.22	12.48
S	2.65	3.87	4.30
N	3.60	5.25	5.84

ASH	6.91	10.08
H2O	31.45	

HYDROGEN STREAM COMPOSITION -

	MOL. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	9.36	1.50
C2H4	0.01	.00
C2H6	0.29	0.02
CO	0.88	.00
CO2	0.75	0.15
H2	87.09	96.66
N2	0.36	0.43
H2S	1.04	1.02
C3-C7	0.23	0.23

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.13	.00
C3H8	0.13	.00
N-C4H10	0.01	.00
C6H6	0.05	0.21
C7H8	.00	0.02
TOTAL	0.32	0.23

OTHER PARAMETERS -

LETDOWN PRESSURE	34.6 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 68. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0180 CM
MINIMUM FLUIDIZATION VELOCITY	0.0063 FT/SEC
PED DENSITY AT MIN. FLUID. VEL.	35.27 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	31.05 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 4.472 , P = 0.942

PARTIAL PRESSURES (PSI) - H2 = 186.4 , H2O = 195.7 CO = 46.4

VOLUMES (SCF) - VIN = 1367.532 COR = 37.717 VFIN = 2.877 VH2O = 3.201

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 36.3377035 02.27.78 FIRST COCURRENT STAGNANT-BED EXPERIMENT

TIMES - STARTUP 1555.
BEG. OF STEADY-STATE 2020.
END OF STEADY-STATE 2122.
END OF COAL FEED 2120.
END OF RUN 2430.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.033 FEED TIME = 5.417 TOTAL RUN TIME = 8.583

CONDITIONS - PRESSURE 1025. PSIA
TEMPERATURE 1653. F AVERAGE , 1711. F MAXIMUM
BED DEPTH 6.25 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		10.028	1.	6.533	0.482	54.316	35.387	2.613
H2 STREAM	101.2	0.541	0.0539	.000	0.537	2.928	.000	2.908
TOTAL						57.244	35.387	5.521
OUTPUTS -								
SS DRY GAS	124.4	3.442	0.3433	1.799	0.832	3.557	1.859	0.860
WATER		0.049	0.0049		0.006	0.267		0.030
LIQ. PROD.		0.112	0.0112	0.103	0.009	0.607	0.559	0.047
CHAR		6.106	0.6090	4.149	0.087	33.076	22.472	0.474
OTHER GAS						20.421	11.534	3.773
TOTAL						57.928	36.424	5.183
MATERIAL BALANCES (PCT.)						101.20	102.93	93.89

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	132.7 SCFH OR 7.7 ACFH
COAL RESIDENCE TIME	46.87 MIN.
GAS RESIDENCE TIME	120.92 SEC.
SUPERF. GAS VELOCITY	0.052 FT/SEC
MAF CONVERSION	51.22 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	36.50	37.85	27.54
CARBON CONV. RATE (LB/HR/FT3)	9.22	9.56	6.95

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	35.73	36.01	28.74	78.75
C2H4	.00	.00	.00	.00
C2H6	0.05	0.05	0.08	0.22
CO	6.41	6.46	5.15	14.12
CO2	3.13	3.16	2.52	6.91
H2	52.45	52.86		
N2	0.47	0.47		
H2S	0.93	0.94		
C3-C7	0.05	0.05		
H2O	0.78			

MOLECULAR WEIGHT OF DRY C2- GAS = 10.51
HIGH HEATING VALUE OF DRY C2- GAS = 556.0 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	65.15	65.74	80.83	73.62	75.12	102.68	70.55	71.33	111.28
H	4.71	4.75	5.84	1.00	1.02	1.39	0.98	0.99	1.55
S	3.88	3.92	4.81	2.65	2.70	3.70	3.58	3.62	5.65
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.20	1.21	1.49	0.67	0.68	0.93	0.42	0.42	0.66
ASH	18.58	18.57		26.33	26.84		35.50	35.69	
H2O	0.90			2.00			1.10		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	0.1	21.5
- 40+ 50	0.5	13.4
- 50+ 70	19.6	19.1
- 70+100	24.3	13.3
-100+200	44.9	23.3
-200+325	9.1	7.3
-325	2.4	2.3

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	40.00	66.67	75.33
H	7.00	11.67	13.18
S	2.50	4.17	4.71
N	3.60	6.00	6.78

ASH	6.90	11.50
H2O	40.00	

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	18.95	14.01
C2H4	.00	.00
C2H6	0.62	.00
CO	3.15	2.77
CO2	1.47	1.93
H2	75.30	80.09
N2	0.52	0.61
H2S	0.43	0.44
C3-C7	0.16	0.16

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C6H6	0.05	0.16
TOTAL	0.05	0.16

OTHER PARAMETERS -

LETDOWN PRESSURE	39.8 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.5 PSIA AND 78. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0161 CM
MINIMUM FLUIDIZATION VELOCITY	0.0160 FT/SEC
RED DENSITY AT MIN. FLUID. VEL.	34.82 LB/FT3
RED DENSITY AT ACTUAL VELOCITY	30.28 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 10.382 , P = 2.303

PARTIAL PRESSURES (PSI) - H2 = 538.3 H2O = 8.0 CO = 65.7

VOLUMES (SCF) - VIN =1353.057 COR = 43.436 VFIN = 3.411 VH2O = 4.175

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 37-3377057 07-06-78 TWENTY SECOND MOVING-BED HYDROGASIFICATION RUN

TIMES - STARTUP 2024.
BEG. OF STEADY-STATE 2256.
END OF STEADY-STATE 2411.
END OF COAL FEED 2347.
END OF RUN 2710.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.250 FEED TIME = 3.383 TOTAL RUN TIME = 6.767

CONDITIONS - PRESSURE 1030. PSIA
TEMPERATURE 1734. F AVERAGE , 2073. F MAXIMUM
BED DEPTH 5.00 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	LB/HR	LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		10.500	1.	6.720	0.555	35.525	22.736	1.879
H2 STREAM	99.4	0.531	0.0506	.000	0.528	1.798	.000	1.785
TOTAL						37.323	22.736	3.664
OUTPUTS -								
SS DRY GAS	95.7	3.731	0.3554	2.268	0.793	4.664	2.835	0.991
WATER		1.330	0.1267		0.149	4.499		0.503
LIQ. PROD.		0.478	0.0456	0.437	0.037	1.618	1.479	0.125
CHAR		5.309	0.5056	2.933	0.104	17.963	9.941	0.351
OTHER GAS						12.676	7.743	2.577
TOTAL						41.420	21.997	4.549
MATERIAL BALANCES (PCT.)						110.98	96.75	124.15

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	137.1 SCFH OR 8.3 ACFH
COAL RESIDENCE TIME	34.69 MIN.
GAS RESIDENCE TIME	90.14 SEC.
SUPER. GAS VELOCITY	0.055 FT/SEC
MAF CONVERSION	70.25 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	56.23	46.52	33.75
CARBON CONV. RATE (LB/HR/FT3)	18.27	15.10	10.96

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	49.84	62.64	47.60	84.59
C2H4	0.10	0.13	0.20	0.35
C2H6	0.90	1.13	1.72	3.06
CO	4.20	5.28	4.01	7.12
CO2	2.88	3.61	2.75	4.88
H2	19.59	24.62		
N2	0.51	0.64		
H2S	1.20	1.50		
C3-C7	0.35	0.44		
H20	20.44			

MOLECULAR WEIGHT OF DRY C2- GAS = 14.75
HIGH HEATING VALUE OF DRY C2- GAS = 753.5 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	64.00	64.51	80.49	67.23	67.49	111.84	65.00	65.32	100.76
H	5.20	5.24	6.54	1.32	1.33	2.20	2.00	2.01	3.10
S	3.61	3.64	4.54	3.40	3.41	5.66	3.50	3.52	5.43
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.22	1.23	1.53	0.35	0.36	0.60	0.50	0.50	0.78
ASH	19.70	19.86		39.50	39.65		35.00	35.17	
H20	0.79			0.39			0.49		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	1.3	22.9
- 40+ 50	1.9	8.3
- 50+ 70	20.2	14.5
- 70+100	23.6	14.2
-100+200	42.6	27.3
-200+325	8.7	9.6
-325	1.7	3.6

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC	MF	MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	16.78	4.11
C2H4	0.02	.00
C2H6	0.26	0.07
CO	1.16	0.20
CO2	0.96	0.34
H2	79.63	34.13
N2	0.53	0.41
H2S	0.35	0.32
C3-C7	0.42	0.42

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.12	.00
C3H8	0.13	0.06
N-C4H10	0.01	.00
C6H6	0.15	0.30
C7H8	.00	0.06
TOTAL	0.44	0.42

OTHER PARAMETERS -

LETDOWN PRESSURE 52.3 PSIA
DRY GAS MEASUREMENT CONDITIONS 24.3 PSIA AND 80. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR 82.00 LB/FT3
AVERAGE PARTICLE DIAMETER 0.0143 CM
MINIMUM FLUIDIZATION VELOCITY 0.0238 FT/SEC
BED DENSITY AT MIN. FLUID. VEL. 34.28 LB/FT3
BED DENSITY AT ACTUAL VELOCITY 29.33 LB/FT3
REDUCED CONDITIONS OF EFFLUENT GAS - T = 4.745 , P = 0.931

PARTIAL PRESSURES (PSI) - H2 = 201.7 H2O = 209.5 CO = 43.2

VOLUMES (SCF) - VIN = 985.539 COR = 52.508 VFIN = 6.566 VH2O = 7.239

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN #1.34192.1 08.01.78 TWENTY.SEVENTH.HYDROGASIFICATION.RUN.CO.CURRENT

TIMES - STARTUP 1405.
BEG. OF STEADY-STATE 1830.
END OF STEADY-STATE 2015.
END OF COAL FEED 2020.
END OF RUN 2430.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.750 FEED TIME = 6.250 TOTAL RUN TIME =10.417

CONDITIONS - PRESSURE 1012. PSIA
TEMPERATURE 1763. F AVERAGE , 1852. F MAXIMUM
BED DEPTH 6.00 FT.

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		11.707	1.	7.694	0.647	73.167	48.095	4.041
H2 STREAM	99.8	0.534	0.0456	.000	0.530	3.335	.000	3.312
TOTAL						76.502	48.095	7.353
OUTPUTS -								
SS DRY GAS	128.4	3.848	0.3287	1.985	0.844	6.735	3.475	1.476
WATER		0.237	0.0203		0.027	1.482		0.166
LIQ. PROD.		0.018	0.0016	0.017	0.001	0.114	0.105	0.009
CHAR		7.012	0.5990	4.632	0.099	43.824	28.947	0.620
OTHER GAS						23.081	12.632	4.740
TOTAL						75.236	45.159	7.011
MATERIAL BALANCES (PCT.)						98.34	93.91	95.35

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE 136.1 SCFH OR 8.5 ACFH
COAL RESIDENCE TIME 41.13 MIN.
GAS RESIDENCE TIME 105.77 SEC.
SUPER. GAS VELOCITY 0.057 FT/SEC
MAF CONVERSION 52.63 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	39.93	33.50	25.81
CARBON CONV. RATE (LB/HR/FT3)	12.33	10.38	7.99

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	34.76	36.08	29.38	73.82
C2H4	.09	.00	.00	.00
C2H6	0.28	0.29	0.47	1.19
CO	9.25	9.60	7.82	19.64
CO2	2.52	2.62	2.13	5.35
H2	47.42	49.23		
N2	0.62	0.64		
H2S	1.39	1.44		
C3-C7	0.10	0.10		
H2O	3.67			

MOLECULAR WEIGHT OF DRY C2- GAS = 11.39
HIGH HEATING VALUE OF DRY C2- GAS = 559.5 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	65.72	66.33	81.89	70.39	71.67	102.94	69.03	69.51	112.94
H	5.42	5.47	6.75	1.04	1.06	1.52	1.09	1.10	1.78
S	3.56	3.59	4.44	3.34	3.40	4.88	6.23	6.27	10.19
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.23	1.24	1.53	0.57	0.58	0.83	0.26	0.26	0.43
ASH	18.93	19.00		29.84	30.38		38.19	38.46	
H2O	0.92			1.75			0.69		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	33.1	46.8
- 40+ 50	26.1	16.3
- 50+ 70	21.7	15.5
- 70+100	12.7	10.9
-100+200	6.3	9.7
-200+325	0.1	0.8
-325	0.1	.0

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC	MF	MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	18.70	11.59
C2H4	.00	.00
C2H6	0.15	0.11
CO	4.14	2.44
CO2	1.23	0.96
H2	74.84	83.96
N2	0.60	0.61
H2S	0.33	0.31
C3-C7	0.02	0.02

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C5H6	0.10	0.02
TOTAL	0.10	0.02

OTHER PARAMETERS -

LETDOWN PRESSURE 25.3 PSIA
DRY GAS MEASUREMENT CONDITIONS 25.0 PSIA AND 80. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR 82.00 LB/FT3
AVERAGE PARTICLE DIAMETER 0.0260 CM
MINIMUM FLUIDIZATION VELOCITY 0.0135 FT/SEC
BED DENSITY AT MIN. FLUID. VEL. 36.83 LB/FT3
BED DENSITY AT ACTUAL VELOCITY 32.31 LB/FT3
REDUCED CONDITIONS OF EFFLUENT GAS - T = 9.298 , P = 1.880

PARTIAL PRESSURES (PSI) - H2 = 480.2 H2O = 37.1 CO = 93.6

VOLUMES (SCF) - VIN = 966.470 COR = 25.065 VFIN = 7.551 VH2O = 8.473

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 42.3419221 08.08.78 TWENTY EIGHT4 MOVING-BED HYDROGASIFICATION RUN

TIMES - STARTUP 1436.
BEG. OF STEADY-STATE 1813.
END OF STEADY-STATE 1925.
END OF COAL FEED 1916.
END OF RUN 24.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.200 FEED TIME = 4.667 TOTAL RUN TIME =*4.200

CONDITIONS - PRESSURE 1015. PSIA
TEMPERATURE 1712. F AVERAGE , 2184. F MAXIMUM
BED DEPTH 5.08 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	STEADY-STATE PERIOD - MATERIAL LB/HR	STEADY-STATE PERIOD - MATERIAL LB/LB CL	STEADY-STATE PERIOD C LB/HR	STEADY-STATE PERIOD H LB/HR	TOTAL RUN LB	TOTAL RUN LB C	TOTAL RUN LB H
INPUTS -								
COAL		9.329	1.	6.134	0.515	43.534	28.624	2.404
H2 STREAM	98.1	0.524	0.0562	.003	0.520	2.446	.000	2.429
TOTAL						45.980	28.624	4.833
OUTPUTS -								
SS DRY GAS	97.0	3.718	0.3985	2.307	0.805	4.461	2.768	0.966
WATER		1.145	0.1228		0.128	5.344		0.598
LIQ. PROD.		0.361	0.0387	0.328	0.027	1.683	1.531	0.127
CHAR		4.161	0.4461	2.521	0.068	19.420	11.766	0.317
OTHER GAS						15.135	9.141	3.389
TOTAL						46.043	25.236	5.398
MATERIAL BALANCES (PCT.)						100.14	88.36	111.68

CALCULATED PARAMETERS -

NET PRODUCT GAS RATE	125.3 SCFH OR 7.6 ACFH
COAL RESIDENCE TIME	46.59 MIN.
GAS RESIDENCE TIME	99.79 SEC.
SUPF. GAS VELOCITY	0.051 FT/SEC
MAF CONVERSION	68.21 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	58.90	41.61	37.61
CARBON CONV. RATE (LB/HR/FT3)	17.18	12.14	10.97

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	51.20	63.41	50.15	85.15
C2H4	0.06	0.08	0.13	0.21
C2H6	0.83	1.02	1.62	2.75
CO	4.73	5.85	4.63	7.86
CO2	2.42	3.00	2.37	4.03
H2	19.75	24.45		
N2	0.44	0.55		
H2S	0.81	1.00		
C3-C7	0.51	0.63		
H2O	19.26			

MOLECULAR WEIGHT OF DRY C2- GAS = 14.54
HIGH HEATING VALUE OF DRY C2- GAS = 761.3 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	65.75	66.36	81.93	70.39	71.67	102.94	69.03	69.51	112.94
H	5.42	5.47	6.75	1.04	1.06	1.52	1.09	1.10	1.78
S	3.56	3.59	4.44	3.34	3.40	4.88	6.23	6.27	10.19
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.23	1.24	1.53	0.57	0.58	0.83	0.26	0.26	0.43
ASH	18.83	19.00		29.84	30.38		38.19	38.46	
H2O	0.92			1.78			0.69		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	25.4	64.2
- 40+ 50	24.5	14.5
- 50+ 70	23.6	10.2
- 70+100	16.4	6.0
-100+200	10.0	4.7
-200+325	0.1	0.2
-325	0.1	0.2

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC MF MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	17.94	2.13
C2H4	0.02	.00
C2H6	0.29	.00
CO	1.56	0.25
CO2	0.80	0.41
H2	78.37	96.10
N2	0.53	0.63
H2S	0.22	0.23
C3-C7	0.25	0.25

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.08	.00
C3H8	0.13	0.02
N-C4H10	0.03	.00
C6H6	0.38	0.22
C7H8	0.01	0.01
TOTAL	0.63	0.25

OTHER PARAMETERS -

LETDOWN PRESSURE	25.3 PSIA
OPY GAS MEASUREMENT CONDITIONS	24.2 PSIA AND 84. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0308 CM
MINIMUM FLUIDIZATION VELOCITY	0.0180 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	38.61 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	34.45 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 4.834 , P = 0.948

PARTIAL PRESSURES (PSI) - H2 = 200.4 H2O = 194.2 CO = 48.0

VOLUMES (SCF) - VIN = 970.716 COR = 25.863 VFIN = 5.493 VH2O = 6.342

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 44.3419255 08.22.78 THIRTIETH MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1356.
BEG. OF STEADY-STATE	1640.
END OF STEADY-STATE	1820.
END OF COAL FEED	1820.
END OF RUN	2350.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.667 FEED TIME = 4.400 TOTAL RUN TIME = 9.900

CONDITIONS -

PRESSURE	1017. PSIA
TEMPERATURE	1790. F AVERAGE , 2160. F MAXIMUM
BED DEPTH	5.38 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		9.801	1.	6.438	0.537	43.126	28.325	2.364
H2 STREAM	110.8	0.592	0.0604	.000	0.588	2.605	.000	2.587
TOTAL						45.731	28.325	4.951
OUTPUTS -								
SS DRY GAS	99.3	3.663	0.3737	2.263	0.814	6.105	3.771	1.356
WATER		1.219	0.1244		0.136	5.363		0.600
LIQ. PROD.		0.249	0.0254	0.225	0.019	1.096	1.002	0.083
CHAR		4.511	0.4603	3.204	0.363	19.849	14.116	0.277
OTHER GAS						11.999	7.204	2.701
TOTAL						44.412	26.093	5.018
MATERIAL BALANCES (PCT.)						97.12	92.12	101.34

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	133.7 SCFH OR 8.4 ACFH
COAL RESIDENCE TIME	42.14 MIN.
GAS RESIDENCE TIME	90.46 SEC.
SUPER. GAS VELOCITY	0.056 FT/SEC
MAF CONVERSION	64.15 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	50.16	38.75	35.15
CARBON CONV. RATE (LB/HR/FT3)	15.36	11.86	10.76

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	49.21	50.92	42.75	85.22
C2H4	0.06	0.07	0.10	0.19
C2H6	0.94	1.03	1.45	2.89
CO	4.40	5.45	3.82	7.62
CO2	2.35	2.90	2.04	4.06
H2	22.33	27.64		
N2	0.39	0.48		
H2S	0.78	0.96		
C3-C7	0.44	0.54		
H2O	19.21			

MOLECULAR WEIGHT OF DRY C2- GAS = 14.00
HIGH HEATING VALUE OF DRY C2- GAS = 744.5 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	65.68	66.55	80.94	78.83	79.77	109.00	73.07	73.34	103.60
H	5.32	5.40	6.56	0.88	0.89	1.22	1.34	1.34	1.90
S	3.33	3.38	4.10	3.47	3.51	4.80	2.73	2.71	3.83
O	-.00	.00	.00	-.00	.00	.00	-.03	.00	.05
N	1.20	1.22	1.48	0.13	0.19	0.26	0.34	0.34	0.48
ASH	17.40	17.56		26.50	26.82		29.10	29.21	
H2O	1.45			1.13			0.37		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	25.9	53.3
- 40+ 50	24.7	16.4
- 50+ 70	23.1	13.3
- 70+100	15.6	8.6
-100+200	10.4	7.7
-200+325	0.2	0.4
-325	0.2	0.3

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC	MF	MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	14.72	5.12
C2H4	0.01	.00
C2H6	0.25	0.06
CO	1.34	0.44
CO2	0.68	0.27
H2	82.20	93.35
N2	0.41	0.37
H2S	0.21	0.22
C3-C7	0.18	0.18

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.07	.00
C3H8	0.12	0.03
C6H6	0.34	0.14
C7H8	0.01	0.01
TOTAL	0.54	0.18

OTHER PARAMETERS -

LETDOWN PRESSURE	42.3 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 80. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0276 CM
MINIMUM FLUIDIZATION VELOCITY	0.0143 FT/SEC
RED DENSITY AT MIN. FLUID. VEL.	37.30 LB/FT3
RED DENSITY AT ACTUAL VELOCITY	32.73 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 5.094 , P = 0.962

PARTIAL PRESSURES (PSI) - H2 = 227.0 H2O = 194.3 CO = 44.8

VOLUMES (SCF) - VIN = 997.128 COR = 44.308 VFIN = 5.390 VH2O = 6.133

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 46-3419301 10.17.78 HYDROGASIFICATION OF BTC.25C COUNTER.CURRENT FLOW

TIMES - STARTUP 1409.
BEG. OF STEADY-STATE 1610.
END OF STEADY-STATE 1653.
END OF COAL FEED 1653.
END OF RUN 2130.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 0.717 FEED TIME = 2.733 TOTAL RUN TIME = 7.350

CONDITIONS - PRESSURE 1015. PSIA
TEMPERATURE 1714. F AVERAGE , 2075. F MAXIMUM
BED DEPTH 4.75 FT

YIELDS AND MATERIAL BALANCES -

	- - - - - STEADY-STATE PERIOD - - - - -					- - - TOTAL RUN - - -		
	- - - MATERIAL - - - -			C	H			
	SCFH	LB/HR	LB/LB CL	LB/HR	LB/HR	LB	LB C	LB H
INPUTS -								
COAL		9.699	1.	6.012	0.569	26.510	16.434	1.556
H2 STREAM	113.2	0.589	0.0607	.003	0.585	1.610	.000	1.599
TOTAL						28.120	16.434	3.154
OUTPUTS -								
SS DRY GAS	93.6	3.706	0.3821	2.204	0.745	2.656	1.579	0.534
WATER		0.076	1.0078		0.009	0.208		0.023
LIQ. PROD.		0.660	0.0680	0.584	0.047	1.803	1.597	0.127
CHAR		4.728	0.4875	2.603	0.086	12.924	7.131	0.235
OTHER GAS						9.162	5.055	1.972
TOTAL						26.753	15.362	2.892
MATERIAL BALANCES (PCT.)						95.14	93.48	91.68

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	105.9 SCFH	OR	6.4 ACFH
COAL RESIDENCE TIME	39.85 MIN.		
GAS RESIDENCE TIME	110.36 SEC.		
SUPER. GAS VELOCITY	0.043 FT/SEC		
MAF CONVERSION	75.93 PCT.		

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	56.61	40.37	36.65
CARBON CONV. RATE (LB/HR/FT3)	17.31	12.34	11.21

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	58.98	59.89	45.93	81.14
C2H4	0.07	0.07	0.11	0.19
C2H6	0.96	0.98	1.50	2.65
CO	7.26	7.37	5.66	9.99
CO2	4.39	4.45	3.42	6.03
H2	25.00	25.38		
N2	0.55	0.56		
H2S	0.95	0.97		
C3-C7	0.34	0.35		
H2O	1.51			

MOLECULAR WEIGHT OF DRY C2- GAS = 15.80
HIGH HEATING VALUE OF DRY C2- GAS = 730.4 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	61.99	62.88	82.01	72.18	72.58	119.80	63.77	64.34	123.56
H	5.71	5.79	7.55	0.93	0.94	1.54	1.74	1.76	3.37
S	3.51	3.56	4.64	5.07	5.10	8.41	5.37	5.12	9.82
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	1.21	1.23	1.60	0.19	0.18	0.30	0.26	0.26	0.50
ASH	23.00	23.33		39.20	39.42		47.50	47.93	
H2O	1.41			0.55			0.89		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 40	19.6	44.3
- 40+ 50	24.0	18.1
- 50+ 70	22.6	13.9
- 70+100	22.7	12.6
-100+200	11.0	9.4
-200+325	0.1	0.4
-325	0.1	0.8

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC	MF	MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	10.51	1.70
C2H4	0.01	.00
C2H6	0.15	.00
CO	1.22	0.17
CO2	0.62	.00
H2	86.41	96.97
N2	0.55	0.63
H2S	0.32	0.32
C3-C7	0.22	0.22

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	0.04	.00
C3H8	0.15	-.00
N-C4H10	0.01	-.00
C6H6	0.15	0.22
TOTAL	0.35	0.22

OTHER PARAMETERS -

LETDOWN PRESSURE	31.8 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 75. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0252 CM
MINIMUM FLUIDIZATION VELOCITY	0.0122 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	36.65 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	32.76 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 7.474 , P = 1.689

PARTIAL PRESSURES (PSI) - H2 = 253.9 H2O = 15.3 CO = 73.7

VOLUMES (SCF) - VIN =1019.944 COR = 33.522 VFIN = 3.822 VH2O = 4.383

DATA FROM CONTINUOUS GASIFICATION UNIT WORKUP DATE 04-08-80

RUN 59.5419394 J3-25-80 HYDROGASIFICATION OF PELLETIZED BTC-54 (3/16 DIA.

TIMES - STARTUP 1342.
BEG. OF STEADY-STATE 1650.
END OF STEADY-STATE 2110.
END OF COAL FEED 2114.
END OF RUN 2320.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 5.333 FEED TIME = 7.533 TOTAL RUN TIME = 9.633

CONDITIONS - PRESSURE 462. PSIA
TEMPERATURE 1405. F AVERAGE, 1452. F MAXIMUM
BED DEPTH 4.00 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD: MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN: LB	LB C	LB H	
INPUTS -									
COAL		11.995	1.	5.769	.606	90.370	43.459	4.562	
H2 STREAM	106.3	.565	.0471	0.000	.564	4.254	0.000	4.248	→ H2 stream has to be 3% high to balance → really 142 SCFH
TOTAL						94.624	43.459	8.810	
OUTPUTS -									
SS DRY GAS	93.7	3.422	.2852	2.068	.758	18.249	11.030	4.043	
WATER		3.040	.2569		.345	23.203		2.596	
LIQ. PROD.		.391	.0326	.200	.032	2.948	1.539	.242	
CHAR		5.164	.4305	2.616	.050	38.900	19.708	.379	
OTHER GAS						13.842	7.993	2.979	
TOTAL						97.143	40.240	10.239	
MATERIAL BALANCES (PCT.)						102.66	92.59	116.22	

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	104.1 SCFH OR 18.7 ACFH
COAL RESIDENCE TIME	59.08 MIN.
GAS RESIDENCE TIME	31.84 SEC.
SUPER. GAS VELOCITY	.126 FT/SEC
MAF CONVERSION	64.37 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	54.65	43.77	35.85
CARBON CONV. RATE (LB/HR/FT3)	19.04	15.25	12.49
SPECIFIC CARBON CONV. RATE (1/HR)	.228	.182	.149

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	33.15	54.84	43.17	78.99
C2H4	.14	.23	.36	.66
C2H6	1.76	2.90	4.57	8.36
CO	2.54	4.20	3.31	6.05
CO2	2.49	4.12	3.24	5.93
H2	19.41	32.11		
N2	.22	.37		
H2S	.69	1.14		
C3-C7	.14	.23		
H2O	39.55			

MOLECULAR WEIGHT OF DRY C2- GAS = 13.35
HIGH HEATING VALUE OF DRY C2- GAS = 726.9 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	48.09	56.15	70.88	58.00	58.51	92.31	55.97	56.23	92.76
H	3.44	4.02	5.07	.72	.73	1.15	.86	.86	1.43
S	2.95	3.45	4.35	.52	.52	.83	3.42	3.44	5.67
O	4.24	4.95	6.25	0.00	0.00	0.00	0.00	0.00	0.00
N	.74	.86	1.09	.45	.45	.72	.34	.34	.56
ASH	17.78	20.75		36.30	36.62		39.19	39.38	
H2O	24.37			.87			.47		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- 40 + 50	95.0	89.0
- 50 + 60	5.0	11.0

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	9.28	49.11	50.35
H	1.36	7.20	7.38
S	1.27	6.73	6.90
O	4.78	25.29	25.94
N	1.84	9.74	9.98
ASH	.47	2.49	
H2O	81.10		

HYDROGEN STREAM COMPOSITION -

	MOL. PCT.
H2	99.90
N2	.01

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	23.12	6.55
C2H4	.22	.02
C2H6	1.31	.35
CO	1.74	.45
CO2	2.03	1.59
H2	70.36	88.93
N2	1.18	1.69
H2S	.02	.03
C3-C7	.1[illegible]	.17

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	.07	.02
C3H8	.04	.01
C6H6	.12	.14
TOTAL	.23	.17

OTHER PARAMETERS -

LETDOWN PRESSURE 39.0 PSIA
DRY GAS MEASUREMENT CONDITIONS 24.5 PSIA AND 69. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR 144.14 LB/FT3
AVERAGE PARTICLE DIAMETER .0395 CM
MINIMUM FLUIDIZATION VELOCITY .3612 FT/SEC
BED DENSITY AT MIN. FLUID. VEL. 91.59 LB/FT3
BED DENSITY AT ACTUAL VELOCITY 71.34 LB/FT3
REDUCED CONDITIONS OF EFFLUENT GAS - T = 3.002 , P = .291

PARTIAL PRESSURES (PSI) - H2 = 89.7 H2O = 182.5 CO = 11.7

VOLUMES (SCF) - VIN = 465.444 COR = 44.453 VFIN = 2.635 VH2O = 3.654

END-OF-FILE ENCOUNTERED, FILENAME - INPUT
ERROR NUMBER 55 DETECTED BY INPC= AT ADDRESS 000152
CALLED FROM CNGAS AT LINE 32

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/08/80

RUN 63.3538530 06.25.80 HYDROGASIFICATION OF BTC.93 PELLETS (3/16" DIA)

TIMES - STARTUP 1334.
BEG. OF STEADY-STATE 1445.
END OF STEADY-STATE 1845.
END OF COAL FEED 1940.
END OF RUN 2230.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 4.000 FEED TIME = 6.100 TOTAL RUN TIME = 8.933

CONDITIONS - PRESSURE 514. PSIA
TEMPERATURE 926. F AVERAGE , 1127. F MAXIMUM
BED DEPTH 4.08 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	LB/HR	LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		11.105	1.	5.651	.559	67.740	34.473	3.410
H2 STREAM	310.6	1.660	.1494	0.000	1.648	10.124	0.000	10.054
TOTAL						77.864	34.473	13.463
OUTPUTS -								
SS DRY GAS	285.2	3.764	.3389	1.253	1.607	15.056	5.012	6.426
WATER		3.968	.3574		.444	24.207		2.709
LIQ. PROD.		1.320	.1188	1.031	.113	8.050	6.291	.692
CHAR		5.251	.4726	3.047	.119	32.030	18.588	.726
OTHER GAS						10.633	3.027	5.018
TOTAL						89.976	32.917	15.570
MATERIAL BALANCES (PCT.)						115.56	95.49	115.65

CALCULATED PARAMETERS -

NET PRODUCT GAS RATE 380.1 SCFH OR 29.0 ACFH
COAL RESIDENCE TIME 12.99 MIN.
GAS RESIDENCE TIME 20.56 SEC.
SUPER. GAS VELOCITY .195 FT/SEC
MAF CONVERSION 53.35 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	46.08	23.32	22.17
CARBON CONV. RATE (LB/HR/FT3)	15.73	7.96	7.57
SPECIFIC CARBON CONV. RATE (1/HR)	.535	.271	.258

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	5.27	6.76	24.69	53.59
C2H4	.12	.15	1.09	2.37
C2H6	.74	.95	5.91	15.00
CO	.68	.87	3.16	6.87
CO2	2.18	2.80	11.22	22.18
H2	68.23	87.48		
N2	.09	.12		
H2S	.33	.43		
C3-C7	.37	.47		
H2O	22.00			

MOLECULAR WEIGHT OF DRY C2- GAS = 4.85
HIGH HEATING VALUE OF DRY C2- GAS = 374.9 BTU/SCF

COAL, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	COAL (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	50.89	57.25	78.28	68.67	69.18	93.63	54.55	54.75	89.48
H	3.79	4.26	5.82	1.69	1.70	2.30	2.22	2.23	3.64
S	2.95	3.32	4.53	2.11	2.13	2.88	3.17	3.18	5.20
O	6.35	7.14	9.76	0.00	0.00	0.00	0.00	0.00	0.00
N	1.01	1.14	1.55	.73	.74	1.00	.96	.96	1.57
ASH	23.81	26.79		25.92	26.11		38.61	38.75	
H2O	11.11			.74			.37		

COAL AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	COAL	CHAR
- + 20	98.0	61.8
- 20 + 50	2.0	13.9

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
C	78.01	80.42	80.46
H	7.13	7.28	7.28
S	1.50	1.53	1.53
O	9.22	9.41	9.41
N	1.29	1.32	1.32
ASH	.05	.85	
H2O	2.80		

HYDROGEN STREAM COMPOSITION -

	MOL. PCT.
H2	99.95
N2	.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	2.02	2.02
C2H4	.10	.02
C2H6	.48	.28
CO	.35	.20
CO2	1.83	1.37
H2	92.40	94.48
N2	.35	.45
H2S	.35	.35
C3-C7	.84	.84

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C3H6	.10	.27
C3H8	.18	.31
1-C4H8	.03	.03
N-C4H10	.08	.07
C5H10	.05	.05
C6H6	.03	.11
TOTAL	.47	.84

OTHER PARAMETERS -

LETDOWN PRESSURE	127.0 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.2 PSIA AND 83. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	42.70 LB/FT3
AVERAGE PARTICLE DIAMETER	.0271 CM
MINIMUM FLUIDIZATION VELOCITY	.0149 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	19.34 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	14.52 LB/FT3
REDUCED CONDITIONS OF EFFLUENT GAS -	T = 4.121 , P = .567

PARTIAL PRESSURES (PSI) - H2 = 350.7 H2O = 112.6 CO = 3.5

VOLUMES (SCF) - VIN = 255.425 COR = 83.053 VFIN = 13.795 VH2O = 16.197

p

APPENDIX D

SUMMARY OF TEST RUNS FOR HYDROGASIFICATION OF CHAR

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 32.3310068 01.05.78 EIGHTEENTH MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1257.
BEG. OF STEADY-STATE	1450.
END OF STEADY-STATE	1530.
END OF COAL FEED	2200.
END OF RUN	2430.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 0.667 FEED TIME = 9.050 TOTAL RUN TIME =11.550

CONDITIONS -

PRESSURE	513. PSIA
TEMPERATURE	1513. F AVERAGE , 1855. F MAXIMUM
BED DEPTH	4.00 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		7.765	1.	6.033	0.088	70.277	54.598	0.793
H2 STREAM	97.9	0.523	0.0674	.000	0.519	4.734	.000	4.701
TOTAL						75.011	54.598	5.494
OUTPUTS -								
SS DRY GAS	88.2	0.978	0.1259	0.384	0.530	0.652	0.256	0.353
WATER		0.123	0.0159		0.014	1.116		0.125
LIQ. PROD.		0.001	0.0001	0.001	0.000	0.006	0.006	0.000
CHAR		6.809	0.8768	5.204	0.089	61.620	47.097	0.803
OTHER GAS						11.451	4.987	4.741
TOTAL						74.844	52.345	6.023
MATERIAL BALANCES (PCT.)						99.78	95.87	109.63

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	95.5 SCFH OR 10.4 ACFH
COAL RESIDENCE TIME	42.16 MIN.
GAS RESIDENCE TIME	57.59 SEC.
SUPER. GAS VELOCITY	0.070 FT/SEC
MAF CONVERSION	1.79 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	~~13.74~~ 14.57	~~9.60~~ 13.66	~~6.36~~ 9.66
CARBON CONV. RATE (LB/HR/FT3)	5.01	3.50	2.32

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	13.19	13.56	13.54	98.55
C2H4	.00	.00	.00	.00
C2H6	0.05	0.05	0.10	0.73
CO	0.09	0.09	0.09	0.65
CO2	0.01	0.01	0.01	0.07
H2	83.08	85.41		
N2	0.31	0.32		
H2S	0.51	0.52		
C3-C7	0.05	0.05		
H2O	2.72			

MOLECULAR WEIGHT OF DRY C2- GAS = 4.21
HIGH HEATING VALUE OF DRY C2- GAS = 414.5 BTU/SCF

Feed ~~COAL~~, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	Char ~~COAL~~ (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	77.69	77.88	125.67	78.52	78.73	109.34	78.99	79.16	107.98
H	1.10	1.10	1.76	0.98	0.98	1.36	1.77	1.77	2.42
S	3.50	3.51	5.66	1.99	2.00	2.77	2.64	2.65	3.61
O	-.00	.00	.00	-.03	.00	.00	-.00	.00	.00
N	0.60	0.60	0.97	0.21	0.21	0.29	0.40	0.40	0.55
ASH	37.93	38.03		27.92	28.00		26.64	26.70	
H2O	0.25			0.27			0.21		

Feed ~~COAL~~ AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	Feed ~~COAL~~	CHAR
- + 40	16.5	28.3
- 40+ 50	15.4	7.8
- 50+ 70	21.0	12.0
- 70+100	15.1	12.9
-100+200	23.7	26.7
-200+325	5.9	9.2
-325	2.3	3.0

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC MF MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	12.39	1.52
C2H4	.00	.00
C2H6	0.01	.00
CO	0.15	.00
CO2	0.01	0.06
H2	85.81	94.89
N2	1.29	3.18
H2S	0.33	0.35
C3-C7	.00	.00

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C6H6	0.05	.00
TOTAL	0.05	.00

OTHER PARAMETERS -

LETDOWN PRESSURE	44.3 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 70. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	90.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0149 CM
MINIMUM FLUIDIZATION VELOCITY	0.0398 FT/SEC
PED DENSITY AT MIN. FLUID. VEL.	37.83 LB/FT3
PED DENSITY AT ACTUAL VELOCITY	32.95 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 14.997 , P = 1.505

PARTIAL PRESSURES (PSI) - H2 = 426.6 H2O = 14.0 CO = 0.4

VOLUMES (SCF) - VIN = 535.552 COR = 47.324 VFIN = 4.028 VH2O = 4.951

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 32.3310068 01.05.78 EIGHTEENTH MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1257.
BEG. OF STEADY-STATE	1610.
END OF STEADY-STATE	1830.
END OF COAL FEED	2200.
END OF RUN	2430.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.833 FEED TIME = 9.050 TOTAL RUN TIME =11.550

CONDITIONS -

PRESSURE	513. PSIA
TEMPERATURE	1697. F AVERAGE , 1855. F MAXIMUM
BED DEPTH	4.00 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	C LB	H LB
INPUTS -								
COAL		7.765	1.	6.033	0.088	70.277	54.598	0.793
H2 STREAM	97.9	0.523	0.0674	.000	0.519	4.734	.000	4.701
TOTAL						75.011	54.598	5.494
OUTPUTS -								
SS DRY GAS	81.1	1.227	0.1580	0.625	0.531	2.250	1.145	0.974
WATER		0.123	0.0159		0.014	1.116		0.125
LIQ. PROD.		0.002	0.0002	0.002	0.000	0.015	0.014	0.001
CHAR		6.809	0.8768	5.204	0.089	61.620	47.097	0.803
OTHER GAS						9.885	4.098	4.120
TOTAL						74.886	52.354	6.024
MATERIAL BALANCES (PCT.)						99.83	95.89	109.64

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	88.4 SCFH OR 10.5 ACFH
COAL RESIDENCE TIME	41.33 MIN.
GAS RESIDENCE TIME	56.75 SEC.
SUPF. GAS VELOCITY	0.070 FT/SEC
MAF CONVERSION	1.79 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	~~13.74~~ 14.57	~~9.60~~ 13.67	~~10.35~~ 14.74
CARBON CONV. RATE (LB/HR/FT3)	5.01	3.50	3.77

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	23.42	24.13	13.61	99.06
C2H4	.00	.00	.00	.00
C2H6	0.02	0.02	0.02	0.16
CO	0.17	0.18	0.10	0.74
CO2	0.01	0.01	0.01	0.04
H2	72.42	74.61		
N2	0.46	0.47		
H2S	0.51	0.53		
C3-C7	0.05	0.05		
H2O	2.94			

MOLECULAR WEIGHT OF DRY C2- GAS = 5.75
HIGH HEATING VALUE OF DRY C2- GAS = 485.9 BTU/SCF

Feed ~~COAL~~, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	Char ~~COAL~~ (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	77.69	77.88	125.67	78.52	78.73	109.34	78.99	79.16	107.98
H	1.10	1.10	1.78	0.98	0.98	1.36	1.77	1.77	2.42
S	3.50	3.51	5.66	1.99	2.00	2.77	2.64	2.65	3.61
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	0.60	0.60	0.97	0.21	0.21	0.29	0.40	0.40	0.55
ASH	37.93	38.03		27.92	28.00		26.64	26.70	
H2O	0.25			0.27			0.21		

Feed ~~COAL~~ AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	Feed ~~COAL~~	CHAR
- + 40	16.5	28.3
- 40+ 50	15.4	7.8
- 50+ 70	21.0	12.0
- 70+100	15.1	12.9
-100+200	23.7	26.7
-200+325	5.9	9.2
-325	2.3	3.0

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC MF MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	10.94	1.52
C2H4	.00	.00
C2H6	0.01	.00
CO	0.15	.00
CO2	0.01	0.06
H2	87.21	94.89
N2	1.35	3.18
H2S	0.34	0.35
C3-C7	.00	.00

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C6H6	0.05	.00
TOTAL	0.05	.00

OTHER PARAMETERS -

LETDOWN PRESSURE	44.3 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 70. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	90.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0149 CM
MINIMUM FLUIDIZATION VELOCITY	0.0081 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	37.83 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	32.74 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 13.221 , P = 1.290

PARTIAL PRESSURES (PSI) - H2 = 371.8 H2O = 15.1 CO = 0.9

VOLUMES (SCF) - VIN = 535.552 COR = 47.324 VFIN = 4.028 VH2O = 4.951

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 32.3310068 01.05.78 EIGHTEENTH MOVING-BED HYDROGASIFICATION RUN

TIMES –

STARTUP	1257.
BEG. OF STEADY-STATE	2020.
END OF STEADY-STATE	2130.
END OF COAL FEED	2200.
END OF RUN	2430.

TIME INTERVALS (HR.) – STEADY-STATE TIME = 1.167 FEED TIME = 9.050 TOTAL RUN TIME =11.550

CONDITIONS –

PRESSURE	513. PSIA
TEMPERATURE	1771. F AVERAGE , 1855. F MAXIMUM
BED DEPTH	4.00 FT

YIELDS AND MATERIAL BALANCES –

	STEADY-STATE PERIOD – MATERIAL SCFH	LB/HR	LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS –								
COAL		7.765	1.	6.033	0.088	70.277	54.598	0.793
H2 STREAM	97.9	0.523	0.0674	.000	0.519	4.734	.000	4.701
TOTAL						75.011	54.598	5.494
OUTPUTS –								
SS DRY GAS	84.0	1.369	0.1763	0.735	0.066	1.597	0.857	0.660
WATER		0.123	0.0159		0.014	1.116		0.125
LIQ. PROD.		0.001	0.0001	0.001	0.000	0.010	0.009	0.001
CHAR		6.809	0.3768	5.204	0.089	61.629	47.097	0.803
OTHER GAS						10.515	4.384	4.433
TOTAL						74.858	52.347	6.022
MATERIAL BALANCES (PCT.)						99.80	95.88	109.61

CALCULATED PARAMETERS –

WET PRODUCT GAS RATE	91.4 SCFH OR 11.2 ACFH
COAL RESIDENCE TIME	41.61 MIN.
GAS RESIDENCE TIME	53.10 SEC.
SUPER. GAS VELOCITY	0.075 FT/SEC
MAF CONVERSION	1.79 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	~~13.74~~ 19.54	~~9.66~~ 13.65	~~12.18~~ 17.32
CARBON CONV. RATE (LB/HR/FT3)	5.01	3.50	4.44

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	ORY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	26.65	27.43	13.63	99.20
C2H4	.00	.00	.00	.00
C2H6	0.01	0.01	0.01	0.07
CO	0.18	0.19	0.09	0.69
CO2	0.01	0.01	0.00	0.04
H2	69.37	71.40		
N2	0.35	0.36		
H2S	0.53	0.55		
C3-C7	0.05	0.05		
H2O	2.84			

MOLECULAR WEIGHT OF DRY C2- GAS = 6.19
HIGH HEATING VALUE OF DRY C2- GAS = 508.6 BTU/SCF

Feed ~~COAL~~, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	Char ~~COAL~~ (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	77.69	77.88	125.67	78.52	78.73	109.34	78.99	79.16	107.98
H	1.10	1.10	1.78	0.98	0.98	1.36	1.77	1.77	2.42
S	3.50	3.51	5.66	1.99	2.00	2.77	2.64	2.65	3.61
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	0.60	0.60	0.97	0.21	0.21	0.29	0.40	0.40	0.55
ASH	37.93	38.03		27.92	28.00		26.64	26.70	
H2O	0.25			0.27			0.21		

Feed ~~COAL~~ AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	Feed ~~COAL~~	CHAR
- + 40	16.5	28.3
- 40 + 50	15.4	7.8
- 50 + 70	21.0	12.0
- 70 +100	15.1	12.9
-100 +200	23.7	26.7
-200 +325	5.9	9.2
-325	2.3	3.0

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	11.22	1.52
C2H4	.00	.00
C2H6	0.01	.00
CO	0.15	.00
CO2	0.01	0.06
H2	86.95	94.89
N2	1.32	3.18
H2S	0.33	0.35
C3-C7	.00	.00

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C6H6	0.05	.00
TOTAL	0.05	.00

OTHER PARAMETERS -

LETDOWN PRESSURE	44.3 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 70. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	90.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0149 CM
MINIMUM FLUIDIZATION VELOCITY	0.0079 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	37.83 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	32.52 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 13.034 , P = 1.250

PARTIAL PRESSURES (PSI) - H2 = 356.2 H2O = 14.6 CO = 0.9

VOLUMES (SCF) - VIN = 535.552 COR = 47.324 VFIN = 4.028 VH2O = 4.951

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 35.3377015 02.16.78 TWENTY FIRST MOVING-BED HYDROGASIFICATION RUN

TIMES - STARTUP 1518.
BEG. OF STEADY-STATE 1550.
END OF STEADY-STATE 1830.
END OF COAL FEED 2220.
END OF RUN 2300.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.667 FEED TIME = 7.033 TOTAL RUN TIME =12.700

CONDITIONS - PRESSURE 1015. PSIA
TEMPERATURE 1481. F AVERAGE , 1879. F MAXIMUM
BED DEPTH 5.00 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	MATERIAL LB/HR	MATERIAL LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		7.035	1.	5.102	0.068	49.483	35.885	0.479
H2 STREAM	100.4	0.536	0.0762	.000	0.533	~~4.666~~ 4.149 ~~3.773~~	.000	~~3.747~~ ~~4.226~~ 4.640 5.119
TOTAL						~~53.256~~	35.885	
OUTPUTS -								
SS DRY GAS	95.7	1.346	0.1913	0.669	0.622	2.243	1.149	1.037
WATER		0.216	0.0307		0.024	1.517		0.170
LIQ. PROD.		0.002	0.0003	0.002	0.000	0.016	0.015	0.001
CHAR		5.621	0.7990	3.930	0.071	39.537	27.643	0.499
OTHER GAS						10.948	6.130	4.519
TOTAL						54.262	34.937	6.226
MATERIAL BALANCES (PCT.)						100.2/~~101.89~~	97.36	~~147.32~~ 121.62

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE 107.6 SCFH OR 5.8 ACFH
COAL RESIDENCE TIME 55.25 MIN.
GAS RESIDENCE TIME 128.07 SEC.
SUPER. GAS VELOCITY 0.039 FT/SEC
MAF CONVERSION 26.76 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	~~22.97~~ 32.42	~~20.28~~ 29.03	~~13.51~~ 19.07
CARBON CONV. RATE (LB/HR/FT3)	5.66	5.00	3.33

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	21.60	22.55	22.74	98.99
C2H4	.00	.00	.00	.00
C2H6	0.11	0.11	0.22	0.97
CO	.00	.00	.00	.00
CO2	0.01	0.01	0.01	0.04
H2	73.59	76.83		
N2	0.26	0.27		
H2S	0.17	0.18		
C3-C7	0.05	0.05		
H2O	4.23			

MOLECULAR WEIGHT OF DRY C2- GAS = 5.34
HIGH HEATING VALUE OF DRY C2- GAS = 478.2 BTU/SCF

Feed ~~COAL~~, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	Char ~~COAL~~ (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	72.52	73.10	108.11	75.18	75.18	110.28	60.33	60.35	120.89
H	0.88	0.89	1.31	1.10	1.10	1.61	0.94	0.94	1.88
S	3.36	3.39	5.01	2.30	2.30	3.37	4.66	4.66	9.34
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	0.49	0.49	0.73	0.14	0.14	0.21	0.15	0.15	0.30
ASH	32.13	32.39		31.83	31.83		50.05	50.07	
H2O	0.79			.01			0.04		

Feed ~~COAL~~ AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	Feed ~~COAL~~	CHAR
- + 40	14.1	43.7
- 40+ 50	7.9	6.4
- 50+ 70	20.7	8.4
- 70+100	11.4	8.3
-100+200	25.8	18.8
-200+325	11.6	7.9
-325	8.5	6.6

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
H2O	100.00		

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	11.35	2.01
C2H4	.00	.00
C2H6	0.01	.00
CO	.00	.00
CO2	0.01	.00
H2	88.37	97.97
N2	0.24	0.27
H2S	0.01	0.01
C3-C7	.00	.00

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C6H6	0.05	.00
TOTAL	0.05	.00

OTHER PARAMETERS -

LETDOWN PRESSURE	51.8 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 68. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0154 CM
MINIMUM FLUIDIZATION VELOCITY	0.0108 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	34.62 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	31.30 LB/FT3
REDUCED CONDITIONS OF EFFLUENT GAS -	T = 11.426 , P = 2.398

PARTIAL PRESSURES (PSI) - H2 = 747.1 H2O = 42.9 CO = .0

VOLUMES (SCF) - VIN =1084.689 COR = 56.382 VFIN = 4.151 VH2O = 4.781

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 35.3377015 02.16.78 TWENTY FIRST MOVING-BED HYDROGASIFICATION RUN

TIMES -

STARTUP	1518.
BEG. OF STEADY-STATE	2050.
END OF STEADY-STATE	2220.
END OF COAL FEED	2220.
END OF RUN	2800.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 1.500 FEED TIME = 7.033 TOTAL RUN TIME =12.700

CONDITIONS -

PRESSURE	1015. PSIA
TEMPERATURE	1687. F AVERAGE , 1879. F MAXIMUM
BED DEPTH	5.00 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	LB/HR	LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		7.035	1.	5.102	0.068	49.483	35.885	0.479
H2 STREAM	100.4	0.536	0.0762	.000	0.533	~~3.773~~ 4.666	.000	~~3.747~~ 4.640
TOTAL						~~53.256~~ 54.149	35.885	~~4.226~~ 5.119
OUTPUTS -								
CG DRY GAS	84.6	1.651	0.2346	0.998	0.014	2.476	1.497	0.021
WATER		0.216	0.0307		0.024	1.517		0.170
LIQ. PROD.		0.002	0.0003	0.002	0.000	0.013	0.012	0.001
CHAR		5.621	0.7990	3.930	0.071	39.537	27.643	0.499
OTHER GAS						10.455	5.554	4.596
TOTAL						53.999	34.706	6.187
MATERIAL BALANCES (PCT.)						99.72 ~~101.39~~	96.72	~~146.48~~ 120.86

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	96.5 SCFH DR 5.8 ACFH
COAL RESIDENCE TIME	54.95 MIN.
GAS RESIDENCE TIME	129.14 SEC.
SUPER. GAS VELOCITY	0.039 FT/SEC
MAF CONVERSION	26.76 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	~~22.97~~ 33.05	~~19.69~~ 28.27	~~49.56~~ 28.14
CARBON CONV. RATE (LB/HR/FT3)	5.66	4.84	4.82

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	35.37	37.12	22.85	99.46
C2H4	.00	.00	.00	.00
C2H6	0.04	0.04	0.05	0.21
CO	.00	.00	.00	.00
CO2	0.11	0.12	0.07	0.32
H2	59.29	62.22		
N2	0.24	0.25		
H2S	0.19	0.20		
C3-C7	0.05	0.05		
H2O	4.71			

MOLECULAR WEIGHT OF DRY C2- GAS = 7.42
HIGH HEATING VALUE OF DRY C2- GAS = 576.6 BTU/SCF

Feed ~~Coal~~, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	CHAR ~~COAL~~ (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	72.52	73.10	108.11	75.18	75.18	110.26	60.33	60.35	120.88
H	0.68	0.89	1.31	1.10	1.10	1.61	0.94	0.94	1.88
S	3.36	3.39	5.01	2.30	2.30	3.37	4.66	4.66	9.34
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	0.49	0.49	0.73	0.14	0.14	0.21	0.15	0.15	0.30
ASH	32.13	32.39		31.83	31.83		50.05	50.07	
H2O	0.79			.00			0.04		

FEED ~~COAL~~ AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U. S. MESH	FEED ~~COAL~~	CHAR
- + 40	14.1	43.7
- 40+ 50	7.9	6.4
- 50+ 70	20.7	8.4
- 70+100	11.4	8.3
-100+200	25.8	18.8
-200+325	11.6	7.9
-325	8.5	6.6

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

	AS REC	MF	MAF
H2O	100.00		

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	10.06	2.01
C2H4	.00	.00
C2H6	0.02	.00
CO	.00	.00
CO2	0.01	.00
H2	89.66	97.97
N2	0.24	0.27
H2S	0.01	0.01
C3-C7	.00	.00

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C6H6	0.05	.00
TOTAL	0.05	.00

OTHER PARAMETERS -

LETDOWN PRESSURE	51.8 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.4 PSIA AND 68. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0154 CM
MINIMUM FLUIDIZATION VELOCITY	0.0080 FT/SEC
GAS DENSITY AT MIN. FLUID. VEL.	34.62 LB/FT3
GAS DENSITY AT ACTUAL VELOCITY	31.13 LB/FT3
REDUCED CONDITIONS OF EFFLUENT GAS -	T = 10.006 . P = 2.008

PARTIAL PRESSURES (PSI) - H2 = 601.9 H2O = 47.8 CO = .0

VOLUMES (CCF) - VIN =1064.669 COR = 56.382 VFIN = 4.151 VH2O = 4.781

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 45.3419275 8.28.78 HYDROGASIFICATION OF CHAR-COUNTERCURRENT FLOW

TIMES -

STARTUP	1553.
BEG. OF STEADY-STATE	2015.
END OF STEADY-STATE	2100.
END OF COAL FEED	2245.
END OF RUN	2300.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 0.750 FEED TIME = 6.867 TOTAL RUN TIME =13.117

CONDITIONS -

PRESSURE	1015. PSIA
TEMPERATURE	1753. F AVERAGE , 1790. F MAXIMUM
BED DEPTH	4.75 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	LB/HR	LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		5.737	1.	4.347	0.060	39.396	29.846	0.413
H2 STREAM	107.6	0.575	0.1002	.000	0.571	4.799 ~~3.948~~	.000	~~3.921~~ 4.772
TOTAL						44.195 ~~43.344~~	29.846	~~4.333~~ 5.184
OUTPUTS -								
SS DRY GAS	81.2	1.498	0.2612	0.841	0.570	1.124	0.631	0.427
WATER		0.169	0.0295		0.019	1.163		0.130
LIQ. PROD.		0.001	0.0001	0.001	0.000	0.005	0.005	0.000
CHAR		3.845	0.6701	2.740	0.038	26.399	18.812	0.259
OTHER GAS						11.082	5.456	4.962
TOTAL						39.773	24.903	5.780
MATERIAL BALANCES (PCT.)						90.00 ~~91.76~~	83.44	~~133.37~~ 111.50

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	101.5 SCFH OR 6.3 ACFH
COAL RESIDENCE TIME	71.28 MIN.
GAS RESIDENCE TIME	113.85 SEC.
SUPER. GAS VELOCITY	0.042 FT/SEC
MAF CONVERSION	44.56 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	~~36.97~~ 54.05	~~20.39~~ 29.81	~~19.35~~ 28.19
CARBON CONV. RATE (LB/HR/FT3)	8.17	4.51	4.28

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	31.36	32.51	35.69	99.24
C2H4	.00	.00	.00	.00
C2H6	0.03	0.03	0.07	0.18
CO	0.18	0.19	0.21	0.58
CO2	.00	.00	.00	.00
H2	63.71	66.03		
N2	0.15	0.16		
H2S	1.00	1.04		
C3-C7	0.04	0.04		
H2O	3.52			

MOLECULAR WEIGHT OF DRY C2- GAS = 7.01
HIGH HEATING VALUE OF DRY C2- GAS = 542.8 BTU/SCF

FEED ~~COAL~~, CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	CHAR ~~COAL~~ (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	75.76	76.29	106.39	78.22	78.90	113.46	56.89	57.02	152.19
H	0.97	0.98	1.36	0.69	0.70	1.00	0.86	0.86	2.30
S	3.45	3.47	4.84	3.30	3.33	4.79	6.83	6.85	18.27
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	0.22	0.22	0.31	0.13	0.13	0.19	0.14	0.14	0.37
ASH	20.10	20.30		30.20	30.46		62.40	62.54	
H2O	0.69			0.86			0.22		

FEED ~~COAL~~ AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	FEED ~~COAL~~	CHAR
- + 40	48.8	54.6
- 40+ 50	23.3	15.4
- 50+ 70	16.3	12.9
- 70+100	7.2	8.9
-100+200	3.7	6.8
-200+325	0.2	0.4
-325	0.5	0.5

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC MF MAF

HYDROGEN STREAM COMPOSITION -

	ML. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	10.11	0.31
C2H4	.00	.00
C2H6	0.01	.00
CO	0.05	.00
CO2	.00	.00
H2	89.36	99.11
N2	0.23	0.35
H2S	0.23	0.23
C3-C7	.00	.00

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C6H6	0.04	-.00
TOTAL	0.04	.00

OTHER PARAMETERS -

LETDOWN PRESSURE	117.3 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.3 PSIA AND 75. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0277 CM
MINIMUM FLUIDIZATION VELOCITY	0.0250 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	37.32 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	34.66 LB/FT3
REDUCED CONDITIONS OF EFFLUENT GAS -	T = 11.376 , P = 2.214

PARTIAL PRESSURES (PSI) - H2 = 646.7 H2O = 35.7 CO = 1.9

VOLUMES (SCF) - VIN =1038.862 COR = 124.427 VFIN = 8.679 VH2O = 9.421

DATA FROM CONTINUOUS GASIFICATION UNIT — WORKUP DATE 09/07/79

RUN 45.3419275 8.28.78 HYDROGASIFICATION OF CHAR-COUNTERCURRENT FLOW

TIMES -

STARTUP	1553.
BEG. OF STEADY-STATE	2130.
END OF STEADY-STATE	2330.
END OF COAL FEED	2245.
END OF RUN	2300.

TIME INTERVALS (HR.) - STEADY-STATE TIME = 2.000 FEED TIME = 6.867 TOTAL RUN TIME =13.117

CONDITIONS -

PRESSURE	1015. PSIA
TEMPERATURE	1863. F AVERAGE , 1886. F MAXIMUM
BED DEPTH	4.75 FT

YIELDS AND MATERIAL BALANCES -

	STEADY-STATE PERIOD - MATERIAL SCFH	LB/HR	LB/LB CL	C LB/HR	H LB/HR	TOTAL RUN LB	LB C	LB H
INPUTS -								
COAL		5.737	1.	4.347	0.060	39.396	29.846	0.413
H2 STREAM	107.6	0.575	0.1002	.000	0.571	4.799 ~~3.948~~	.000	~~3.921~~ 4.772
TOTAL						44.195 ~~43.344~~	29.846	~~4.333~~ 5.184
OUTPUTS -								
SS DRY GAS	80.4	1.605	0.2797	0.937	0.581	3.210	1.873	1.162
WATER		0.169	0.0295		0.019	1.163		0.130
LIQ. PROD.		0.002	0.0003	0.002	0.000	0.013	0.012	0.001
CHAR		3.845	0.6701	2.740	0.038	26.399	18.812	0.259
OTHER GAS						5.596	1.592	3.380
TOTAL						36.381	22.289	4.932
MATERIAL BALANCES (PCT.)						82.32 ~~83.93~~	74.68	~~113.81~~ 95.14

CALCULATED PARAMETERS -

WET PRODUCT GAS RATE	100.7 SCFH OR 6.5 ACFH
COAL RESIDENCE TIME	70.68 MIN.
GAS RESIDENCE TIME	108.56 SEC.
SUPER. GAS VELOCITY	0.044 FT/SEC
MAF CONVERSION	44.56 PCT.

BASIS	COAL-CHAR	TOTAL GAS	SS GAS
CARBON CONVERSION (PCT.)	~~36.97~~ 55.02	~~11.61~~ 17.28	~~21.55~~ 32.07
CARBON CONV. RATE (LB/HR/FT3)	8.17	2.57	4.76

PRODUCT GAS COMPOSITION -

	- MOLE PERCENT - WET	DRY	PCT. OF CONVERTED CARBON	PCT. OF CARBON IN GAS
CH4	35.20	36.50	35.63	99.08
C2H4	.00	.00	.00	.00
C2H6	0.03	0.03	0.06	0.16
CO	0.27	0.28	0.28	0.76
CO2	.00	.00	.00	.00
H2	59.78	61.98		
N2	0.13	0.14		
H2S	0.99	1.03		
C3-C7	0.04	0.04		
H2O	3.54			

MOLECULAR WEIGHT OF DRY C2- GAS = 7.58
HIGH HEATING VALUE OF DRY C2- GAS = 570.2 BTU/SCF

FEED ~~COAL~~ CHAR, AND DISCHARGED BED COMPOSITIONS (WT. PCT.) -

	CHAR ~~COAL~~ (FEEDSTOCK) AS REC	MF	MAF	CHAR (PRODUCT) AS REC	MF	MAF	DISCHARGED BED AS REC	MF	MAF
C	75.76	76.29	106.39	78.22	78.90	113.46	56.89	57.02	152.19
H	0.97	0.98	1.36	0.69	0.70	1.01	0.86	0.86	2.30
S	3.45	3.47	4.84	3.30	3.33	4.79	6.83	6.85	18.27
O	-.00	.00	.00	-.00	.00	.00	-.00	.00	.00
N	0.22	0.22	0.31	0.13	0.13	0.19	0.14	0.14	0.37
ASH	20.10	20.30		30.20	30.46		62.40	62.54	
H2O	0.69			0.85			0.22		

FEED ~~COAL~~ AND CHAR PARTICLE SIZE DISTRIBUTIONS (WT. PCT.) -

U.S. MESH	FEED ~~COAL~~	CHAR
- + 40	48.8	54.6
- 40+ 50	23.3	15.8
- 50+ 70	16.3	12.9
- 70+100	7.2	8.9
-100+200	3.7	6.8
-200+325	0.2	0.4
-325	0.5	0.5

LIQUID PRODUCTS COMPOSITION (WT. PCT.) -

AS REC	MF	MAF

HYDROGEN STREAM COMPOSITION -

	MOL. PCT.
H2	99.95
N2	0.05

OTHER GAS COMPOSITIONS (MOLE PCT.) -

	OTHER GAS	FINAL GAS
CH4	3.09	0.31
C2H4	.00	.00
C2H6	0.01	.00
CO	0.03	.00
CO2	.00	.00
H2	91.40	99.11
N2	0.24	0.35
H2S	0.23	0.23
C3-C7	.00	.00

CONCENTRATIONS OF C3-C7 SPECIES IN GASES (MOLE PCT.) -

	SS GAS	NON-SS
C6H6	0.04	-.00
TOTAL	0.04	.00

OTHER PARAMETERS -

LETDOWN PRESSURE	117.3 PSIA
DRY GAS MEASUREMENT CONDITIONS	24.3 PSIA AND 75. F

FLUIDIZATION CALCULATIONS -

TRUE DENSITY OF CHAR	82.00 LB/FT3
AVERAGE PARTICLE DIAMETER	0.0277 CM
MINIMUM FLUIDIZATION VELOCITY	0.0232 FT/SEC
BED DENSITY AT MIN. FLUID. VEL.	37.32 LB/FT3
BED DENSITY AT ACTUAL VELOCITY	34.37 LB/FT3

REDUCED CONDITIONS OF EFFLUENT GAS - T = 11.288 , P = 2.123

PARTIAL PRESSURES (PSI) - H2 = 606.5 H2O = 36.0 CO = 2.7

VOLUMES (SCF) - VIN =1036.334 COR = 124.427 VFIN = 8.679 VH2O = 9.421

APPENDIX E

SUMMARY OF STEAM/O_2 GASIFICATION RUNS

TABLE E-1. OPERATING CONDITIONS AND RESULTS FOR GASIFICATION OF ILLINOIS #6 COAL-DERIVED BTC IN THE SYNTHANE PDU AT 40 ATMOSPHERES PRESSURES

Run No.	298A	298B	304	320	321	357A	357B	359
Sample Identification	BTC-11	BTC-11	BTC-11	BTC-12	BTC-12	BTC-24	BTC-24	BTC-24
CaO/NaOH/Water/Coal Ratios for Treatment	0.05/0/1.2/1	0.05/0/1.2/1	0.05/0/1.2/1	0.05/0/1.2/1	0.05/0/1.2/1	0.10/0.003/ 2.0/1	0.10/0.003/ 2.0/1	0.10/0.003/ 2.0/1
Operating Time, hr	2.5	2.5	2.2	5.0	4.1	5.0	5.0	4.5
Steady State Period, hr	1.0	1.0	1.5	4.0	3.5	1.0	2.0	1.5
Coal Feed Rate, lb/hr (as rec'd)	20.0	20.0	21.7	19.3	24.2	2.84	28.4	16.2
Steam/Coal (as rec'd), lb/lb	1.20	1.20	1.04	1.59	1.24	1.40	1.37	2.30
Oxygen/Coal (as rec'd), lb/lb	0.18	0.30	0.20	0.26	0.25	0.23	0.29	0.42
Temperature, C								
Peak	805	995	804	865	965	1028	1028	960
Average maximum	790	940	792	850	886	850	925	891
Bed average	764	885	767	811	824	775	836	839
Superficial Gas Velocity at Average Bed Temp, ft/sec	0.20	0.26	0.20	0.26	0.28	0.32	0.35	0.31
Yields and Conversions								
Carbon conversion to gas and liquids, wt %	54	94.5	52.8	72.0	66.0	61.2	73.1	92.3
Steam decomposition, wt %	18.7	42.1	18.9	20.7	23.1	22.0	29.6	24.3
Gaseous Btu yield, Btu/lb maf coal	6295	10,901	6340	7127	7163	6917	8419	9401
Gaseous Btu yield, Btu/lb oxygen	25,180	29,597	25,361	21,596	23,878	23,057	22,156	17,093
Equivalent Methane[a] Yield, scf/lb maf coal	3.27	4.55	3.30	3.32	3.36	3.42	3.84	3.73
Organic Liquid Yield, wt % of coal fed (as rec'd)	3.7[b]	3.7[b]	2.5	12.1	7.6	5.4[b]	5.4[b]	8.2

(a) Based on CH_4 and C_2H_6.

(b) Estimated.

TABLE E-2. OPERATING CONDITIONS AND RESULTS FOR GASIFICATION OF UNTREATED ILLINOIS #6 COAL IN THE SYNTHANE PDU AT 40 ATMOSPHERES PRESSURE

Run No.	296	299A	299B	300	345	346
Sample Identification	Batch I	Batch I	Batch I	Batch I	Batch I	Batch I
Operating Time, hr	4.2	5.9	5.9	5.0	3.5	6.0
Steady State Period, hr	1.0	1.0	3.5	3.0	2.0	4.0
Coal Feed Rate, lb/hr (as rec'd)	19.3	20.3	20.3	17.7	22.0	17.8
Steam/Coal (as rec'd), lb/lb	1.25	1.21	1.21	1.33	1.34	1.78
Oxygen[(a)]/Coal (as rec'd), lb/lb	0.45	0.32	0.36	0.39	0.33	0.38
Temperature, C						
Peak	960	796	977	1048	900	910
Average maximum	943	789	941	930	882	884
Bed average	902	748	895	887	833	840
Superficial Gas Velocity at Average Bed Temp, ft/sec	0.24	0.17	0.24	0.23	0.23	0.25
Yields and Conversions						
Carbon conversion to gas and liquids, wt %	72.1	32.6	58.4	60.5	48.5	55.8
Steam decomposition, wt %	30.3	10.9	19.3	16.1	24.2	13.4
Gaseous Btu yield, Btu/lb maf coal	7669	2718	6432	6434	4978	5331
Gaseous Btu yield, Btu/lb oxygen	15,037	7347	15,687	14,622	12,446	11,846
Equivalent Methane[(b)] Yield, scf/lb maf coal	3.78	2.41	3.38	3.30	2.93	2.83
Organic Liquid Yield, wt % of coal fed (as rec'd)	1.8	3.0[(c)]	3.0[(c)]	3.2	0.7	2.8

(a) Total oxygen fed to pretreater and gasifier.
(b) Based on CH_4 and C_2H_6.
(c) Estimated.

APPENDIX F

PROCESS ANALYSIS

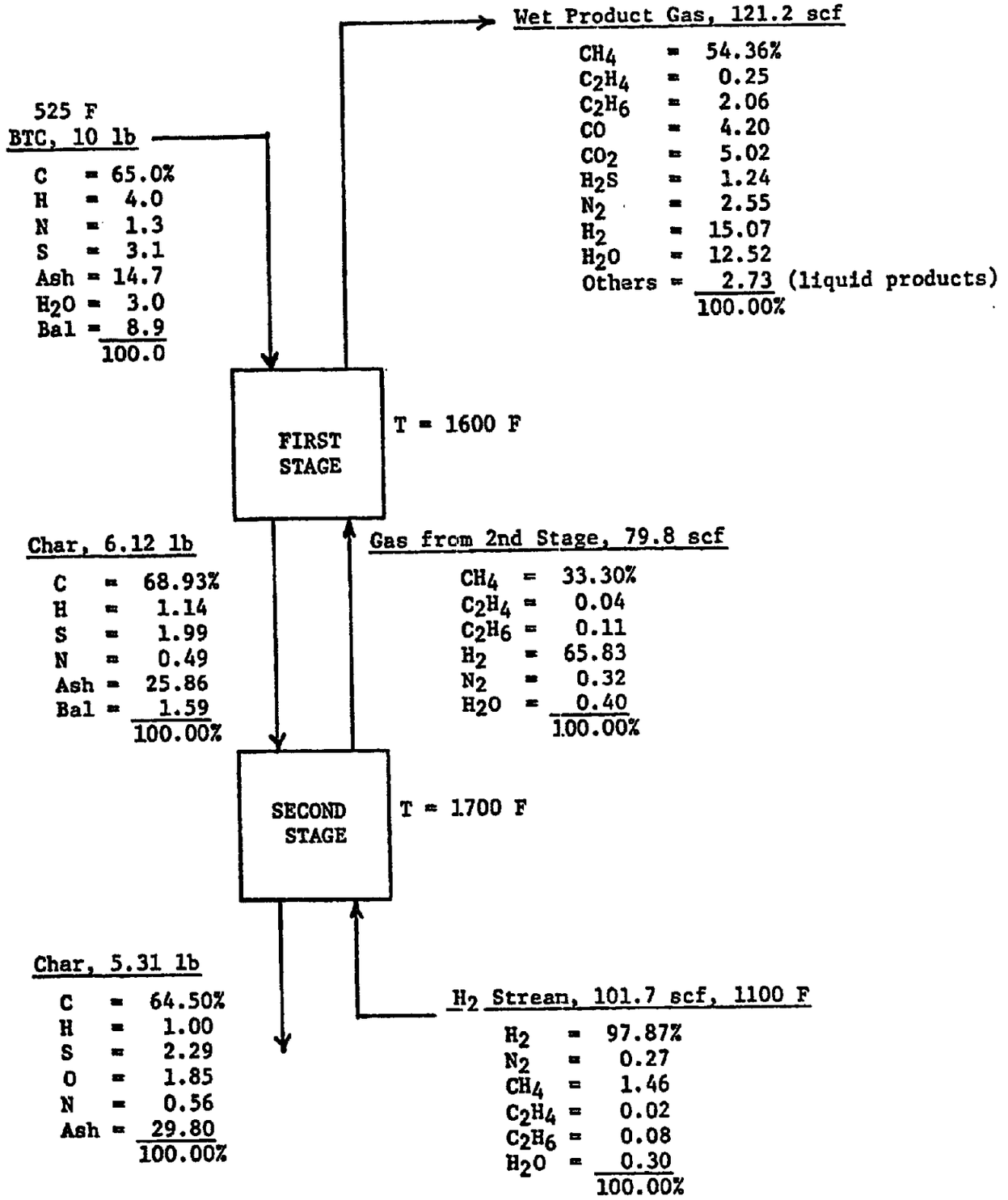


FIGURE F-1. INTEGRATED MATERIAL BALANCE AROUND A TWO-STAGED HYDROGASIFIER FOR CARBON CONVERSION OF 47.3 PERCENT (35.1 percent on 1st Stage and 22.2 percent in 2nd stage)

TABLE F-1. ENERGY BALANCE AROUND TWO-STAGED HYDROGASIFIER
(Low Carbon Conversion Case)

Basis: 10 lb BTC

Stream	Temperature, F	Sensible Heat, Btu	Heating Value, Btu	Total Energy, Btu
First Stage				
Energy In				
Coal	525	1,795	107,820	109,615
Gas from 2nd Stage	1700	3,281	44,040	47,321
Total		5,076	151,860	156,936
Energy Out				
Char	1600	2,790	64,116	66,906
Wet Product Gas	1600	6,814	80,020	86,834
Total		9,604	144,136	153,740
Energy In-Energy Out				3,196 (2.04%)
Second Stage				
Energy In				
Char	1600	2,790	64,116	66,906
Hydrogen Feed	1100	1,951	33,986	35,937
Total		4,741	98,102	102,843
Energy Out				
Char	1700	2,581	51,984	54,565
Gas	1700	3,281	44,040	47,321
Total		5,862	96,024	101,886
Energy In-Energy Out				957 (0.93%)

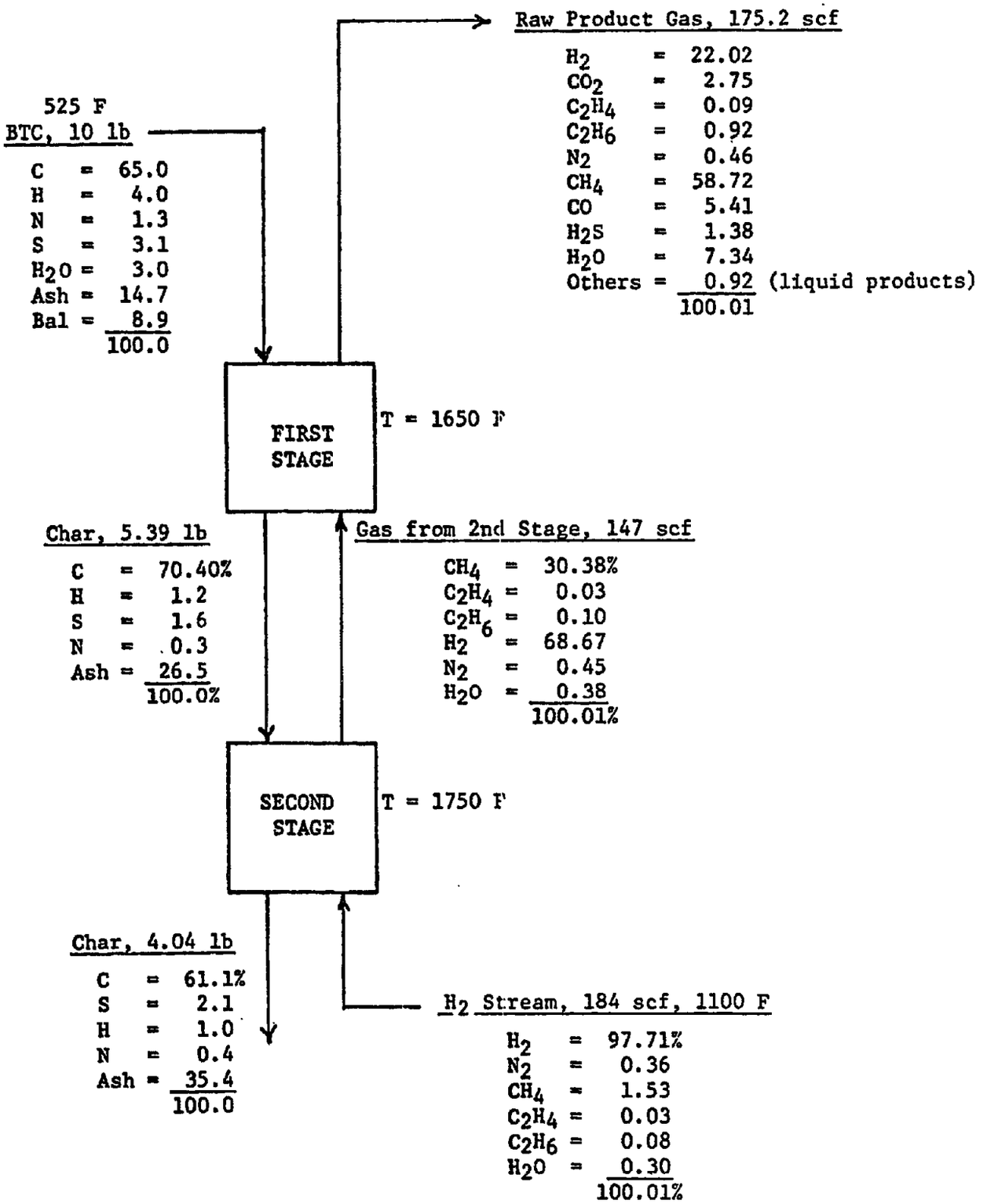
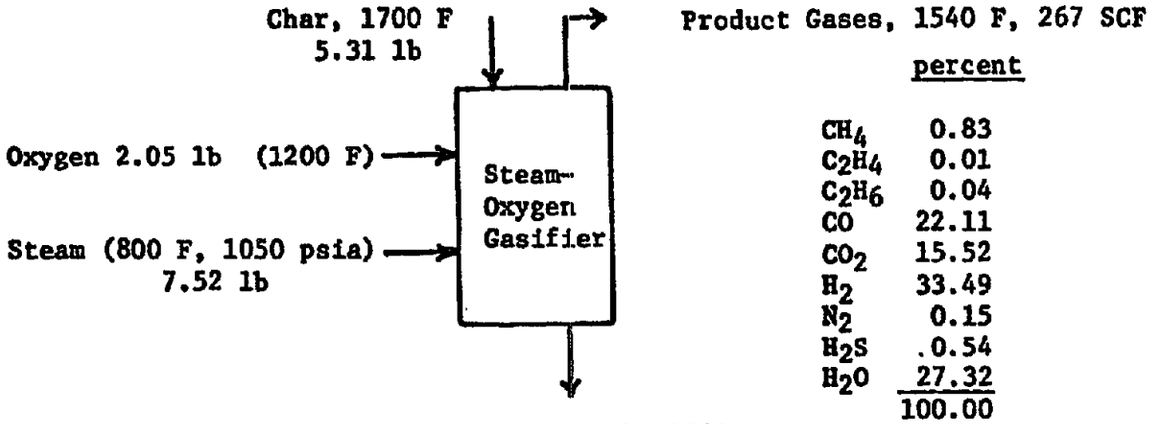


FIGURE F-2. INTEGRATED MATERIAL BALANCE AROUND A TWO-STAGED HYDROGASIFIER FOR CARBON CONVERSION OF 62 PERCENT (41.6 percent in 1st Stage and 20.4 percent in 2nd Stage)

TABLE F-2. ENERGY BALANCE AROUND TWO-STAGED HYDROGASIFIER
(High Carbon Conversion Case)

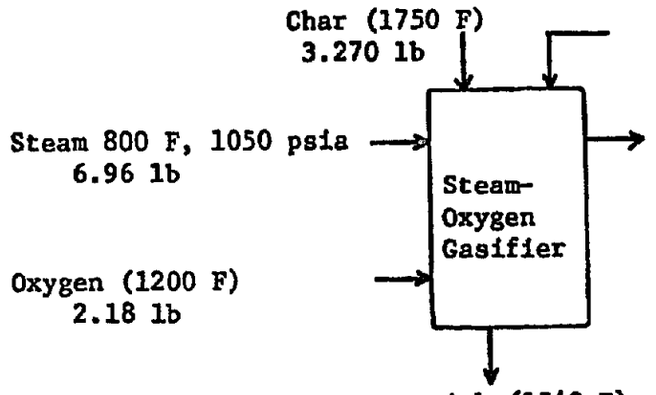
Basis: 10 lb BTC)

Stream	Temperature, F	Sensible Heat, Btu	Heating Value, Btu	Total Energy, Btu
First Stage				
Energy In				
Coal	525	1,795	107,820	109,615
Gas from 2nd Stage	1750	6,097	77,771	83,868
Total		7,892	185,591	193,483
Energy Out				
Char	1650	2,538	57,721	60,259
Wet Product Gas	1650	9,358	123,916	133,274
Total		11,896	181,637	193,533
Energy In-Energy Out				-50 (-0.03%)
Second Stage				
Energy In				
Char	1650	2,538	57,721	60,259
Hydrogen Feed	1100	3,505	61,213	64,718
Total		6,043	118,934	124,977
Energy Out				
Char	1750	2,024	37,621	39,645
Gas	1750	6,097	77,771	83,868
Total		8,121	115,392	123,513
Energy In-Energy Out				1,464 (1.17%)



Stream	Temperature, F	Sensible Heat, Btu	Heating Value, Btu	Total Enthalpy, Btu
Enthalpy, In:				
Char	1700	24,210	519,840	544,050
Oxygen	1200	6,100		6,100
Steam	800	100,640		100,640
Total In		130,950	519,840	650,790
Enthalpy, Out:				
Ash	1540	8,550	28,330	36,880
Gas	1540	122,600	512,520	635,120
Total Out		131,150	540,850	672,000
Enthalpy In-Enthalpy Out				-21,210

FIGURE F-3. MATERIAL AND HEAT BALANCES FOR CHAR GASIFICATION WITH STEAM/OXYGEN (Low Carbon Conversion Case; Basis: 10 lb BTC to 1st Stage Hydrogasifier)



	percent
CH_4	0.88
C_2H_4	0.01
C_2H_6	0.04
CO	21.58
CO_2	14.81
H_2	34.46
N_2	0.21
H_2S	0.55
H_2O	27.46
	100.00

	percent
C	8.27
S	0.28
Ash	91.45
	100.00

Stream	Temperature, F	Sensible Heat, Btu	Heating Value, Btu	Total Enthalpy, Btu
Enthalpy, In:				
BTC	525	3,420	205,720	209,140
Char	1750	16,380	304,470	320,850
Steam	800	93,120	-	93,120
Oxygen	1200	5,830	-	5,830
Total In		118,750	510,190	628,940
Enthalpy Out:				
Ash	1540	6,380	24,420	30,800
Gas	1540	119,350	491,080	610,430
Total Out		125,730	515,500	641,230
Enthalpy In-Enthalpy Out				-12,290

FIGURE F-4. MATERIAL AND HEAT BALANCES FOR CHAR GASIFICATION WITH STEAM/OXYGEN (High Carbon Conversion Case; Basis: 10 lb BTC to 1st Stage Hydrogasifier)

TABLE F-3. BATTELLE TWO-STAGE HYDROGASIFICATION OF CaO CATALYZED COAL FLOW RATES AND COMPOSITIONS OF VARIOUS STREAMS (Low Carbon Conversion Case, Plant Size: 250 x 10^9 Btu/day)

Stream Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Location	Coal to Mixing Tank	Lime to Mixing Tank	Water to Mixing Tank	Slurry to Holding Tank	Slurry from Reactor	Slurry to Coal Dryer	Coal to Primary Hydro-Gasifier	Coal to Steam-O_2 Gasifier	Wet Gas to Dryer	Product Gas to Preheater	Product Gas to Condensor	Product Gas to Scrubber	Product Gas to Acid Gas Removal
Gas Composition (Mole %)													
CH_4									54.36	20.66	20.66	61.57	63.53
C_2H_4									0.25	0.10	0.10	0.30	0.31
C_2H_6									2.06	0.79	0.79	2.34	2.41
CO									4.20	1.60	1.60	4.76	4.91
CO_2									5.02	1.90	1.90	5.68	5.86
H_2									15.07	5.72	5.72	17.05	17.60
N_2									2.55	0.97	0.97	2.88	2.97
H_2S									1.24	0.47	0.47	1.40	1.44
H_2O									12.52	66.77	66.77	0.94	0.97
Others									2.73	1.04	1.04	3.09	
Gas Flow Rate (10^3 lb moles/hr)									43.0	113.2	113.2	37.98	36.81
Liquid Flow Rate (10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)	1302.5	73.9	1231.4	2610.3	2610.3	2610.3	1345.5	0					
Coal (M-F)	1228.8			1228.8	1305.2	1305.2	1305.2						
Char													
Water	73.7		1231.4	1305.1	1305.1	1305.1	40.3						
Sulfur													
Lime		73.9		73.9									
NaOH				2.5									
Temperature (F)	80	80	275	200	475	475	530	530	1600	530	475	275	200
Pressure (PSIA)	14.7	14.7	1011	1011	1011	1011	1015	1015	1015	1013	1008	1006	1004

Table F-3. (Continued)

Stream Number	14	15	16	17	18	19	20	21	22	23	24	25	26
Location	Product Gas from Acid Gas Removal	Gas to Methanator	Gas from Methanator	Gas to WHRA	Gas to Dryer	Product Gas	Char to Second Hydro-Gasifier	Gas to First Stage	Char to Steam-O_2 Gasifier	Char to Disposal	Gas from Steam-O_2 Gasifier	Gas to WHRZ	Gas to Shift Reactor 1
Gas Composition (Mole %)													
CH_4	68.53	68.53	89.30	89.30	89.30	96.14		33.30			0.83	0.83	0.83
C_2H_4	0.33	0.33						0.04			0.01	0.01	0.01
C_2H_6	2.60	2.60						0.11			0.04	0.04	0.04
CO	5.30	5.30									22.11	22.11	22.11
CO_2											15.52	15.52	15.52
H_2	18.98	18.98						65.83			33.49	33.49	33.49
N_2	3.20	3.20	3.59	3.59	3.59	3.86		0.32			0.15	0.15	0.15
H_2S											0.54	0.54	0.54
H_2O	1.05	1.05	7.11	7.11	7.11			0.40			27.32	27.32	27.32
Others													
Gas Flow Rate (10^3 lb moles/hr)	34.12	34.12	30.46	30.46	30.46	28.29		28.30			94.54	94.54	94.54
Liquid Flow Rate (10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)							823.4		714.4	236.8			
Coal (M-F)													
Char							823.4		714.4	236.8			
Water													
Sulfur													
Lime													
NaOH													
Temperature (F)	125	400	850		125	125	1600	1700	1700	1540	1540		550
Pressure (PSIA)	996	994	989	987	985	982	1010	1010	1010	1008	1008	1006	1004

Table F-3. (Continued)

Stream Number	27	28	29	30	31	32	32	33	34	35	36	37	38
Location	Gas from Shift Reactor 1	Gas from Shift Reactor 2	Gas to WHR 3	Gas from Acid Gas Removal	Hydrogen Steam	H_2 Stream to Steam-O_2 Gasifier	Excess H_2	Air to Oxygen Plant	Excess Nitrogen	Oxygen to Steam-O_2 Gasifier	Steam to Steam-O_2 Gasifier	Steam to Shift Reactor 1	Steam to Shift Reactor 2
Gas Composition (Mole %)													
CH_4	0.34		0.33	1.44	1.46	1.46	1.46						
C_2H_4	T		T	0.02	0.02	0.02	0.02						
C_2H_6	0.02		0.02	0.07	0.08	0.08	0.08						
CO	0.45	1.30	0.46	1.99									
CO_2	14.83	26.49	15.03										
H_2	22.13	26.49	22.21	95.92	97.87	97.87	97.87						
N_2	0.06		0.06	0.26	0.27	0.27	0.27	79.01	100.00				
H_2S	0.22		0.22										
H_2O	61.94	45.64	61.67	0.30	0.30	0.30	0.30				100.00	100.00	100.00
Others								20.99		100.00			
Gas Flow Rate (10^3 lb moles/hr)	232.78	3.93	236.71	54.80	53.71	36.08	17.61	45.57	36.01	9.56	56.15	138.23	2.84
Liquid Flow Rate (10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)													
Coal (H-F)													
Char													
Water													
Sulfur													
Lime													
NaOH													
Temperature (F)	750	750	750	125	130	1100	130	80	1200		800	800	800
Pressure (PSIA)	999	999	999	999	1020	1015	999	14.7	1015		1015	1015	1015

Table F-3. (Continued)

Stream Number	39	40	41,42	43	44	45	46	47	48
Location	Water from Condensor	Excess Water	Liquid Products	Gas to Shift Reactor 2	NaOH to Mixer	Acid Gas to Sulfur Removal	Condensate from WHR3	Sulfur By-product	Flue Gas to Stack
Gas Composition (Mole %)									
CH_4									
C_2H_4									
C_2H_6									
CO				100.0					
CO_2						97.31			97.31
H_2									
N_2									
H_2S						2.69			
H_2O							100.0		2.69
Others									
Gas Flow Rate (10^3 lb moles/hr)				1.09		38.77	145.99		38.77
Liquid Flow Rate (10^3 lb/hr)			71.0						
Solid-Liquid Flow Rates (10^3 lb/hr)	1355.4	124.0			2.5			33.35	
Coal (M-F)									
Char									
Water	1355.4	124.0						33.35	
Sulfur									
Lime									
NaOH					2.5				
Temperature (F)	80	80	80	200	80	200	100	80	80
Pressure (PSIA)	14.7	14.7	14.7	14.7	14.7	990	14.7	14.7	14.7

TABLE F-4. BATTELLE TWO-STAGE HYDROGASIFICATION OF CaO CATALYZED COAL FLOW RATES AND COMPOSITIONS OF VARIOUS STREAMS (High Carbon Conversion Case, Plant Size: 250 x 10^9 Btu/day)

Stream Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Location	Coal to Mixing Tank	Lime to Mixing Tank	Water to Mixing Tank	Slurry to Holding Tank	Slurry from Catal. Reactor	Slurry to Coal Dryer	Coal to Primary Hydro-Gasifier	Coal to Steam-Oxygen Gasifier	Product Gas to Dryer	Product Gas to Pre-heater	Product Gas to Con-densor	Product Gas to Scrubber	Product Gas to Regenera-tor
Gas Composition (Mole %)													
CH_4									58.72	24.49	24.49	60.42	60.99
C_2H_4									0.09	0.03	0.03	0.08	0.08
C_2H_6									0.92	0.38	0.38	0.94	0.95
CO									5.41	2.26	2.26	5.57	5.62
CO_2									2.75	1.15	1.15	2.84	2.87
H_2									22.02	9.18	9.18	22.66	22.87
N_2									0.46	0.19	0.19	0.47	0.97
H_2S									1.38	0.58	0.58	1.43	1.45
H_2O									7.34	61.36	61.36	4.66	4.70
Others									.92	0.38	0.38	0.94	
Gas Flow Rate (10^3 lb moles/hr)									40.15	96.28	96.28	39.02	38.66
Liquid Flow Rate (10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)	1045.3	62.6	976.7	2086.6	2086.6	2086.6	870.5	205.3					
Coal (M-F)	978.7			978.7	1043.3	1043.3	844.4	199.1					
Char													
Water	66.6		976.7	1043.3	1043.3	1043.3	26.1	6.2					
Sulfur													
Lime		62.6		62.6									
NaOH				2.0									
Temperature (F)	80	80	275	200	475	475	530	530	1650	530	475	275	200
Pressure (PSIA)	14.7	14.7	1011	1011	1011	1015	1015	1015	1015	1013	1008	1006	1004

TABLE F-4. (Continued)

Stream Number	14	15	16	17	18	19	20	21	22	23	24	25	26
Location	Product Gas from 2nd Bed	Product Gas to Meth.	Product Gas from Meth.	Gas to WHR5	Gas to Dryer	Product Gas	Char to 2nd Stage Hydro-Gasifier	Gas to 1st Stage	Char to Steam-O_2 Gasifier	Ash to Disposal	Gas from Steam-O_2 Gasifier	Gas to WHR2	Gas to Shift Reactor #1
Gas Composition (Mole %)													
CH_4	66.83	66.83	85.90	85.90	85.90	92.75		30.38			0.88	0.88	0.88
C_2H_4	0.09	0.09						0.03			0.01	0.01	0.01
C_2H_6	1.04	1.04						0.10			0.04	0.04	0.04
CO	6.16	6.16									21.58	21.58	21.58
CO_2	25.06	25.06	6.13	6.13	6.13	6.61		68.67			14.81	14.81	14.81
H_2	0.52	0.52	0.59	0.59	0.59	0.64		0.45			34.46	34.46	34.46
N_2											0.21	0.21	0.21
H_2S	0.30	0.30	7.38	7.38	7.38			0.38			0.55	0.55	0.55
H_2O											27.46	27.46	27.46
Others													
Gas Flow Rate (10^3 lb moles/hr)	35.28	35.28	30.90	30.90	30.90	28.62		33.72			73.73	73.73	73.73
Liquid Flow Rate (10^3 lb/hr)							469.0						
Solid-Liquid Flow Rates (10^3 lb/hr)							469.0						
Coal (M-F)							469.0		351.7	167.1			
Char													
Water													
Sulfur													
Lime													
NaOH													
Temperature (F)	125	400	850		125	125	1650	1750	1750	1540	1540		550
Pressure (PSIA)	966	994	989	987	985	982	1010	1010	1010	1008	1008	1006	1004

TABLE F-4.(Continued)

Stream Number	27	28	29	30	31	32	32	33	34	35	36	37	38
Location	Gas from Shift Reactor #1	Gas from Shift Reactor #2	Gas to WHR3	Gas to CO Absorber	Gas to H_2 Pre-heater	Gas to Hydro-gasifier	Not Used	Air to O_2 Plants	Nitrogen to Storage	Oxygen to Steam-O_2 Gasifier	Steam to Steam-O_2 Gasifier	Steam to Shift Reactor 1	Steam to Shift Reactor 2
Gas Composition (Mole %)													
CH_4	0.36		0.35	1.50	1.53	1.53							
C_2H_4	0.01		0.01	0.02	0.03	0.03							
C_2H_6	0.02		0.02	0.07	0.08	0.08							
CO	0.44	1.49	0.46	1.95									
CO_2	14.42	27.65	14.63										
H_2	22.45	27.65	22.53	95.81	97.71	97.71							
N_2	0.08		0.08	0.35	0.36	0.36		79.01	100.00				
H_2S	0.23		0.22										
H_2O	62.00	43.20	61.71	0.30	0.30	0.30					100.00	100.00	100.00
Others								20.99		100.00			
Gas Flow Rate (10^3 lb moles/hr)	180.51	2.88	183.39	43.12	42.28	42.28	0	34.85	27.54	7.31	41.53	106.79	2.03
Liquid Flow Rate (10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)													
Coal (M-F)													
Char													
Water													
Sulfur													
Lime													
NaOH													
Temperature (F)	750	750	750	125	130	1100		80		1200	800	800	800
Pressure (PSIA)	999	999	999	999	102	1015		14.7		1020	1015	1015	1015

TABLE F-4. (Continued)

Stream Number	39	40	41&42	43	44	45	46	47	48
Location	Water from WHR1	Excess Water	Liquid Products	Gas to Shift Reactor 2	NaOH to Mixing Tank	Gas to Stretford	Water from WHR3	Sulfur	Flue Gas to Stack
Gas Composition (Mole %)									
CH_4									
C_2H_4									
C_2H_6									
CO				99.74					
CO_2						96.36			96.36
H_2									
N_2						3.34			
H_2S				0.26		0.30	100.00		.30
H_2O									
Others									3.34
Gas Flow Rate (10^3 lb moles/hr)				0.84		28.98	114.64		28.98
Liquid Flow Rate (10^3 lb/hr)			36.10						
Solid-Liquid Flow Rates (10^3 lb/hr)	1031.5	54.8			2.0			31.0	
Coal (M-F)									
Char									
Water	1031.5	54.8						31.0	
Sulfur									
Lime									
NaOH					2.0				
Temperature (F)	275	275		550	80	200	200		125
Pressure (PSIA)	14.7	14.7		1003	14.7	999	14.7		14.7

TABLE F-5. STEAM BALANCES FOR BATTELLE TWO-STAGE HYDROGASIFICATION PROCESS

(Plant Size: 250 x 10^9 Btu/day)

Process	Low Carbon Conversion			High Carbon Conversion		
	Temperature, F	Steam 10^3 lb/hr	Net Heat, 10^6 Btu/hr	Temperature, F	Steam 10^3 lb/hr	Net Heat, 10^6 Btu/hr
Steam In						
Dryer	1000	1,033	1,433	1000	533	801
Steam/Oxygen Gasifier	800	1,012	1,403	800	748	1,037
Shift Reactor #1	800	2,490	3,453	800	1,924	2,669
Shift Reactor #2	800	51	71	800	37	51
Acid Gas Removal	800	1,605	2,226	800	1,134	1,572
Oxygen Plant	800	958	1,328	800	745	1,033
Total In		7,149	9,914		5,121	7,163
Steam Out						
Methanator	550	27	32	550	37	44
Dryer	550	945	1,124	550	533	634
WHR #1	400	-	919	400	-	711
WHR #2	550	528	628	550	322	383
WHR #3	550	2,037	2,424	550	1,578	1,878
WHR #4	550	152	181	550	171	204
Total Out			5,308			3,854
Additional Heat Required			4,606			3,309
Fuel Needed (Assume 85% Efficiency			5,419			3,893

TABLE F-6. ENERGY DISTRIBUTIONS AND THERMAL EFFICIENCIES FOR BATTELLE TWO-STAGE HYDROGASIFICATION

(Plant Size: 250 x 10^9 Btu/day)

	Low Carbon Conversion Case		High Carbon Conversion Case	
Energy In, 10^6 Btu/hr				
Coal to Hydrogasifiers	14,455	(72.73)[d]	9,386	(60.58)
Coal to Steam/Oxygen Gasifier	0	(0)	2,214	(14.29)
Coal to Boiler	5,419	(27.27)	3,893	(25.13)
Total Energy In	19,874	(100.00)	15,493	(100.00)
Energy Distribution, 10^6 Btu/hr				
Product Gas	10,417	(52.41)	10,417	(67.24)
Liquid By-products[a]	1,278	(6.43)	650	(4.20)
Excess Hydrogen	2,232	(11.23)	0	(0)
Subtotal	13,927	(70.08)	11,067	(71.43)
Consumed and Losses	5,947	(29.92)	4,426	(28.57)
Total Energy Out	19,874	(100.00)	15,493	(100.00)
Cold Gas Efficiency, percent	63.6[b]		67.2	
Planned Thermal Efficiency,[c] percent	70.1		71.4	

(a) Heating value of liquid by-products = 18,000 Btu/lb (assumed)
(b) Excess hydrogen was included.
(c) By-product sulfur was not included.
(d) Values in parentheses represent percentages.

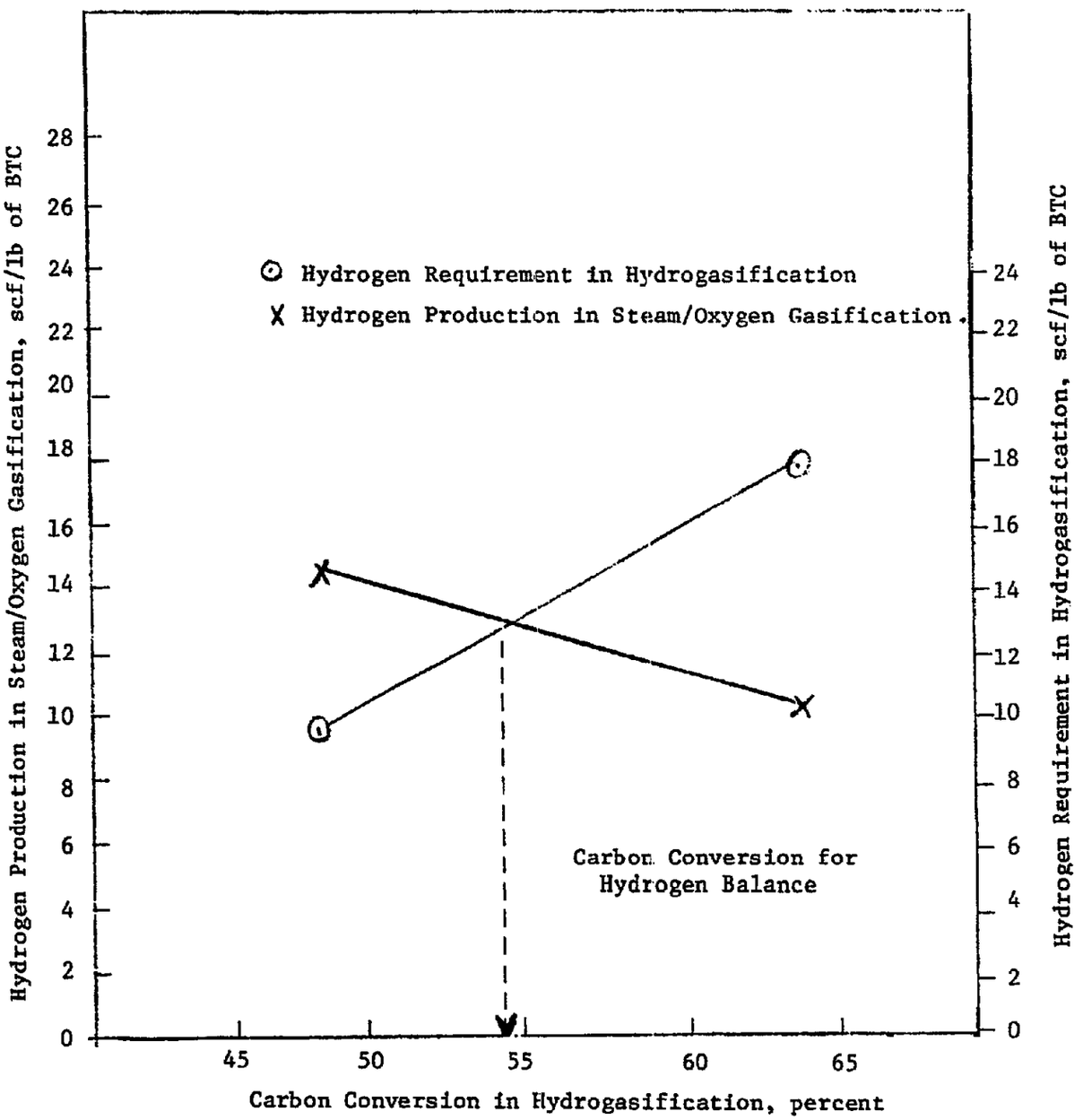


FIGURE F-5. HYDROGEN REQUIREMENT IN HYDROGASIFICATION AND HYDROGEN PRODUCTION FROM STEAM/OXYGEN GASIFICATION AS A FUNCTION OF CARBON CONVERSION IN HYDROGASIFICATION

TABLE F-7. EEA'S ESTIMATE OF INSTALLED COST FOR BATTELLE TWO-STAGE HYDROGASIFICATION[12]

(High Carbon Conversion Case; Plant Size, 250 x 10^9 Btu/day)

Process Section	Installed Cost,[a] 10^6 dollars
Coal & Receiving & Preparation	34.80
Catalyst Receiving and Preparation	2.45
Coal Treatment	8.30
BTC Slurry Drying	12.10
Hydrogasification	35.47
Aromatics Scrubbing	14.32
Acid Gas Removal I	52.37
Methanation & Product Gas Drying	10.95
Aromatics Refining	0.70
Steam-Oxygen Gasification	13.13
Shift Conversion	30.00
Acid Gas Removal II	69.75
CO Removal (Methanation)	8.23
Sour Water System	4.66
Stretford System	2.50
Oxygen Production	48.38
Ash Disposal	9.50
Waste Water Treatment	28.50
Steam & Electricity Production	222.78
Support Facilities	114.00
Total	723.00

(a) 1978 dollars.

TABLE F-8. EEA'S ESTIMATE OF TOTAL CAPITAL REQUIREMENT FOR BATTELLE TWO-STAGE HYDROGASIFICATION(1)

(High Carbon Conversion Case; Plant Size, 250 x 10^9 Btu/day)

Item	Cost,(a) 10^6 dollars
TOTAL PLANT INVESTMENT	
Installed Cost	723.00
Constructor's Home Office Costs and Fee	80.33
SUBTOTAL	
Project Contingency (15% of SUBTOTAL	120.50
	923.83
INITIAL CHARGE OF CATALYSTS AND CHEMICALS	8.00
ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION (Total Plant Investment x Average Spending Period in years x 9%)	99.77
START-UP COSTS (20% of Total Annual Gross Operating Costs)	48.32
WORKING CAPITAL (14 Day Inventory of Raw Materials + Materials and Supplies at 0.9% ot Total Plant Investment + Net Receivables at 1/24 Annual Gas and By-Product Revenue at Calculated Sales Price)	35.69(b)
TOTAL CAPITAL REQUIREMENT	1115.67

(a) 1978 dollars.
(b) Based on private financing method.

TABLE F-9. EEA'S ESTIMATE OF ANNUAL OPERATING COST FOR BATTELLE TWO-STAGE HYDROGASIFICATION (1)

(High Carbon Conversion Case; Plant Size, 250 x 10^9 Btu/day)

Item	Cost, 10^6 dollars(a)	
Raw Materials		
Coal (19,635 tons/day at 25$/ton)		161.25
CATALYSTS AND CHEMICALS		
Lime (667.92 tons/day at 30$/ton)	6.52	
NaOH (26.37 tons/day at 350$/ton, 76% purity)	3.03	
Catalysts and Other Chemicals	3.00	
		12.55
PURCHASED WATER (gpm at $.40/M gal)		4.50
LABOR		
Process Operating Labor (58 men/shift at $6.7/hr)	3.40	
Maintenance Labor (60% of Total Maintenance)	10.89	
Supervision (20% of Direct Labor)	2.86	
		17.15
ADMINISTRATION AND GENERAL OVERHEAD (60% of Labor)		10.25
SUPPLIES		
Operating (30% of Process Operating Labor)	1.02	
Maintenance (40% of Total Maintenance)	7.24	
		8.28
LOCAL TAXES AND INSURANCE (2.7% of Total Plant Investment)		26.95
ASH DISPOSAL		0.65
TOTAL GROSS ANNUAL OPERATING COSTS		241.58
BY-PRODUCT CREDITS		
Sulfur (33.84 Mlb/hr at $11.16/Mlb)	2.97	
BTX (10.83 Mlb/hr at $0.80/gal)	10.15	
Tar and Oils (18.07 Mlb/hr at $0.4/gal)	6.43	
Hydrogen (0.0 MMSCFH at $0.86/MSCF)		
		19.55
TOTAL NET ANNUAL OPERATING COST		222.03

(a) 1978 dollar.

TABLE F-10. EEA'S ESTIMATES OF GAS COST FOR BATTELLE TWO-STAGE HYDROGASIFICATION PROCESS(1)

(High Carbon Conversion Case; Plant Size, 250 x 10^9 Btu/day)

	Utility Financing(a)	Private Financing(b)
Total Capital Requirement, $\$10^6$	1111.17	1115.67
Total Net Operating Cost, $\$10^6$/yr	222.03	222.03
Gas Cost, $\$/10^6$ Btu		
Average	3.89	
Constant		5.10

(a) Project life = 20 years; Depreciation = 20 year straight line on plant investment, allowance for funds used during construction and capitalized portion of start-up costs; Dept/equity ratio = 75/25; Interest on dept = 9%; Return on equity = 15%; Federal Income Tax rate = 48%.

(b) Project life = 20 years; Depreciation = 16 year sum of the years digits on total plant investment; Financing = 100% equity; Rate of return = 12% DCF; Federal Income Tax rate = 48%.

TABLE F-11. STEAM BALANCES FOR STEAM/OXYGEN GASIFICATION OF BTC IN FLUIDIZED-BED REACTOR (PLANT SIZE: 250 x 10^9 BTU/DAY)

	Case 1			Case 2		
Process	Temperature, F	Steam 10^3 lb/hr	Net Heat 10^6 Btu/hr	Temperature, F	Steam 10^3 lb/hr	Net Heat 10^6 Btu/hr
Steam In						
Gasifier	800	2,389	3,314	800	1,988	2,757
Shift Reactor	800	129	179	800	284	394
Acid Gas Removal	800	1,391	1,930	800	1,674	2,322
Oxygen Plant	800	1,314	1,823	800	2,189	3,037
Total In		5,223	7,246		6,135	8,510
Steam Out						
Methanator	550	1,732	2,061	550	1,718	2,044
WHR #1	400	–	2,250	400	–	2,064
WHR #2	550	449	534	550	461	549
WHR #3	550	421	501	550	419	498
Total Out			5,346			5,155
Additional Heat Required			1,900			3,355
Fuel Needed (Assume 85% Efficiency)			2,235			3,947

TABLE F-12. MASS BALANCES FOR THE DIRECT HYDROGASIFICATION OF ILLINOIS NO. 6 BASED BTC FOR THE PRODUCTION OF SNG AND SYNGAS *

Stream Number / Location		1 Coal to Mixing Tank	2 Lime to Mixing Tank	3 Water to Mixing Tank	4 NaOH to Mixing Tank	5 Slurry to Holding Tank	6 Slurry to Catalytic Reactor	7 Slurry from Catalytic Reactor	8 Slurry to Coal Dryer	9 Coal to Hydro-gasifier	10 Product Gas to Dryer	11 Product Gas to Preheater	12 Product Gas to Condensor
Gas Composition (Mole %)	CH_4										58.80	24.1	24.1
	C_2H_4										.59	.04	.04
	C_2H_6										.92	.38	.38
	CO										5.43	2.23	2.23
	CO_2										2.73	1.12	1.12
	H_2										22.07	9.06	9.06
	N_2										.46	.19	.19
	H_2S										1.37	.56	.56
	H_2O			1.00							7.36	61.86	61.86
	Others										.92	.38	.38
Gas Flow Rate(10^3lb moles/hr)				.70							24.88	60.57	60.57
Liquid Flow	Rate (10^3 lb/hr)												
Liquid Comp.(wt %)	H_2O												
	Other												
S/L Flow Rate(10^3 lb/hr)		105.3	62.6	615.0	2.0	1737.5	1737.5	1737.5	1737.5	1035.9			
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal	978.6				978.7	978.7	1063.4	1063.4	1063.4			
	Char												
	Water			615.0		674.1	674.1	674.1	674.1	32.5			
	Sulfur												
	Lime		62.6										
	NaOH				2.0	2.0	2.0						
	$Ca(OH)_2$					32.7	32.7						
Temperature (°F)		80	80	212	80	200	212	275	465	530	1600	530	465
Pressure (PSIA)		14.7	14.7	14.7	14.7	14.7	1011	1011	1015	1015	1015	1013	1008

* See Figure 35 in text flowchart.

TABLE F-12. (CONTINUED)

Stream Number / Location		13 Product Gas to Scrubber	14 Product Gas to Regenera-tor	15 Product Gas From ZnO Bed	16 Product Gas to Methana-tion	17 Product Gas From Methana-tion	18 Product Gas to WHR4	19 Product Gas to Dryer	20 Product Gas	21 Char to Steam-O_2 Gasifier	22 Ash to Disposal	23 Gas from Steam-O_2 Gasifier	8
Gas Composition (Mole %)	CH_4	60.48	63.22	66.86	66.86	83.36	83.36	89.78	89.93			.40	.40
	C_2H_4	.09	.10	.10	0.10	.11	.11	.12	.12				
	C_2H_6	.95	.99	1.05	1.05	1.20	1.20	1.29	1.29				
	CO	5.58	5.83	6.17	6.17							24.11	24.11
	CO_2	2.81	2.94									18.05	18.05
	H_2	22.70	23.73	25.09	25.09	7.46	7.46	8.03	8.05			30.45	30.45
	N_2	.48	.50	.55	.55	.63	.63	.67	.68			.11	.11
	H_2S	1.41	1.47									.37	.37
	H_2O	4.51	1.17	.18	.18	7.30	7.30	.17				26.47	26.47
	Others	.95											
Gas Flow Rate(10^3 lb moles/hr)		24.19	23.14	21.88	21.88	19.17	19.17	17.8	17.77			97.68	97.68
Liquid Flow	Rate (10^3 lb/hr)							24.66	.54				
Liquid Comp.(wt %)	H_2O							100	100				
	Other												
S/L Flow Rate(10^3 lb/hr)										732.1	210.41		
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char									732.1	210.41		
	Water												
	Sulfur												
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		275	200	125	300	800	675	125	125	1600	1550	1550	1425
Pressure (PSIA)		1006	1004	996	994	989	987	985	982	1010	1008	1008	1006

TABLE F-12. (CONTINUED)

Stream Number / Location		25 Gas from WHR2	26 Gas to Shift Reactor 1	27 Gas from Shift Reactor 1	28 Gas from Shift Reactor 1	29 Gas to WHR3	30 Gas to CO Adsorber	31 Gas to H_2 Pre-heater	32 Gas to Shift Reactor 2	33 Gas from Shift Reactor 2	34 Gas to Syn Gas	35 Gas to Hydro-gasifier	36 Steam to Steam O_2 Gasifier
Gas Composition (Mole %)	CH_4	.40	.40	.160	.16	.16	.71	.72			.77	.77	
	C_2H_4												
	C_2H_6												
	CO	24.11	24.11	.49	.49	.51	2.32		100	1.48	.23		
	CO_2	18.05	18.05	16.45	16.45	16.63				27.34			
	H_2	30.45	30.45	21.45	21.45	.15	96.64	98.92		27.34	99.00	98.92	
	N_2	.11	.11	.05	.05	.03	.14	.15				.15	
	H_2S	.37	.37	.15	.15	21.55							
	H_2O	26.47	26.47	61.26	61.26	50.96	.19	.21		43.85		.21	100
	Others												
Gas Flow Rate(10^3lb moles/hr)		97.68	60.29	150.09	93.21	94.9	21.16	19.38	.487	1.69	1.293	19.38	52.73
Liquid Flow Rate (10^3 lb/hr)													
Liquid Comp.(wt %)	H_2O												
	Other												
S/L Flow Rate(10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char												
	Water												
	Sulfur												
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		550	550	750	750	750	125	125	125	750	125	400	600
Pressure (PSIA)		1004	1004	999	999	999	999	1020	1003	999	1020	1015	1015

TABLE F-12. (CONTINUED)

Stream Number / Location		37 Steam to Shift Reactor 1	38 Steam to Shift Reactor 2	39 Gas to WHR5	40 Synthesis Gas Before Cooling	41 Synthesis Gas After Cooling	42 Condensate	43 Air to Oxygen Plant	44 Nitrogen to Storage	45 Oxygen to Steam-O_2 Gasifier	46 Water from WHR3	47 Liquid Product	48 Liquid Product
Gas Composition (Mole %)	CH_4			.40	.25	.48							
	C_2H_4												
	C_2H_6												
	CO			24.10	9.87	18.76							
	CO_2			18.05	17.08	32.47							
	H_2			30.45	25.03	47.60							
	N_2			.11	.07	.13		76.08	100				
	H_2S			.37	.24	.46							
	H_2O	100	100	26.47	47.47	.12							
	Others									100			
								20.99					
Gas Flow Rate(10^3lb moles/hr)		89.90	1.203	37.39	94.27	49.58		76.08	60.11	15.97			
Liquid Flow	Rate (10^3 lb/hr)						804.42				1,041	35.92	0.0
Liquid Comp.(wt %)	H_2O						100				100	41.09	
	Other											58.91	
S/L Flow Rate(10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char												
	Water												
	Sulfur												
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		800	800	550	675	100	100	80	400°F	400	200	200	
Pressure (PSIA)		1015	1015	1004	999	996	14.7	14.7		1020	14.7	14.7	

TABLE F-12. (CONTINUED)

Stream Number / Location		49 Water to	50 Water from	51 Excess Water	52 Gas to Stretford	53 Sulfur	54 Flue Gas to Stack	55 Gas Bypass to WHR5	56 Synthesis Gas				
Gas Composition (Mole %)	CH_4							.16	.49				
	C_2H_4												
	C_2H_6												
	CO							.49	18.29				
	CO_2				95.70		98.45	16.45	31.65				
	H_2							21.45	48.91				
	N_2							.04	.13				
	H_2S				2.79			.15	.44				
	H_2O	100	100		1.51		1.55	61.27	.12				
	Others												
Gas Flow Rate(10^3lb moles/hr)		654.8	563.13		17.21		16.73	56.88	50.885				
Liquid Flow	Rate (10^3 lb/hr)		91.67	27.2									
Liquid Comp.(wt %)	H_2O		100	100									
	Other												
S/L Flow Rate(10^3 lb/hr)						15.36							
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char												
	Water												
	Sulfur					15.36							
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		275	212	212	200	70	125	750	100				
Pressure (PSIA)		14.7	14.7	14.7	999	14.7	14.7	999	996				

TABLE F-13. MASS BALANCES FOR MOFIFICATION AND EXTENSION OF THE DIRECT HYDROGASIFICATION OF ILLINOIS NO. 6 BASED BTC FOR THE PRODUCTION OF SNG/METHANOL AND SNG/GASOLINE*

Stream Number / Location		15 Gas to Methanator Preheater	15' Gas to Methanator Preheater	16' Product Gas to Methanation	17' Product Gas from Methanation	18' Product Gas to WHR4	19' Product Gas to Dryer	20' Product Gas	52 Gas to Stretford	53' Sulfur	54' Flue Gas to Stock	56 Synthesis Gas to Purification	57 Syn Gas to Methanol Synthesis
Gas Composition (Mole %)	CH_4	66.86	52.14	52.14	79.48	94.57						0.49	0.68
	C_2H_4	0.10	0.08	0.08									
	C_2H_6	1.05	0.81	0.81									
	CO	6.17	6.98	6.98								18.29	25.34
	CO_2		3.85	3.85	1.41	1.41	1.68	1.69	95.70		96.92	31.65	5.85
	H_2	25.09	37.93	34.93	2.18	2.59	2.59					48.71	67.79
	N_2	0.55	7.65	0.65	0.81	0.81	0.96	0.96				0.13	0.18
	H_2S								2.79			0.90	
	H_2O	0.18	0.15	0.15	16.12	16.12	0.20		1.51		3.08	0.12	0.16
	Others												
	CH_3OH		0.43	0.43									
Gas Flow Rate(10^3 lb moles/hr)		21.88	28.54	28.54	22.99	22.99	19.32	19.28	17.21		31.39	50.88	36.71
Liquid Flow Rate (10^3 lb/hr)													
Liquid Comp.(wt %)	H_2O												
	Other												
S/L Flow Rate(10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char												
	Water												
	Sulfur									22.59			
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		125	119	300	800	675	135	125	200	80	125	100	80
Pressure (PSIA)		996	996	996	989	987	985	932	999	14.7	14.7	996	996

*Note: Streams Modified from SNG/Syngas case designated by a '. See Figure 36 in text for flowchart

TABLE F-13. (CONTINUED)

Stream Number / Location		58 Methanol to MeOH Conversion	59 HC Products	60 Fractionation Product	61 Gasoline to Blending	62 Alkylates to Blending	63 Butanes to Blending	64 Butane Product LPG	65 Propane Product LPG	66 Gasoline Product	67 Expansion Gas to Methanation	68 Purge Gas to Methanation	69 Methanol Synthesis Product Gas
Gas Composition (Mole %)	CH_4	0.002	3.65								2.98	3.79	3.75
	C_2H_4		0.10										
	C_2H_6		1.06	0.122					0.358				
	CO	0.001	0.07								4.31	9.90	9.62
	CO_2	0.225	1.35								54.77	14.55	16.52
	H_2	0.001	0.15								12.31	70.07	67.25
	N_2		0.0006								0.31	1.03	0.99
	H_2S												
	H_2O	10.187	0.41								0.31	0.02	0.03
	Others C_2^+		93.21	99.878	100	100	100	100	99.642	100			
	CH_3OH	89.579									24.92	0.65	1.83
Gas Flow Rate(10^3 lb moles/hr)		10.68	1.673	0.418	1.128	0.039	0.051	0.164	0.135	1.218	0.325	6.335	6.660
Liquid Flow Rate (10^3 lb/hr)													
Liquid Comp.(wt %)	H_2O												
	Other												
S/L Flow Rate(10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char												
	Water												
	Sulfur												
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		95	155	100	100	100	100	100	100	80	95	95	95
Pressure (PSIA)		15	453	230	145	157	160	160	365	15	20	1110	1040

TABLE F-13. (CONTINUED)

Location \ Stream Number		70 Water From Purification	71 Fuel Gas from Conversion	72 Light Gas	73 Fuel Gas	74 Acid Water (Liquid)	75 Gas to Stretford						
Gas Composition (Mole %)	CH_4		47.14	44.95	45.08								
	C_2H_4		0.44	1.28	1.16								
	C_2H_6		3.57	13.87	12.42								
	CO		2.19	0.85	1.03	0.0006							
	CO_2		9.77	16.96	15.92	0.04	98.41						
	H_2		6.37	1.78	2.39								
	N_2		0.02	0.007	0.01								
	H_2S						1.59						
	H_2O		1.70	4.84	4.39	99.72							
	Others		28.80	15.47	17.60	0.25							
Gas Flow Rate(10^3 lb moles/hr)													
Liquid Flow	Rate (10^3 lb/hr)	Negligible	0.023	0.143	0.166	10.624	14.18						
Liquid Comp.(wt %)	H_2O												
	Other												
S/L Flow Rate(10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char												
	Water												
	Sulfur												
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)			155	93	100	155	80						
Pressure (PSIA)			215	315	300	253	996						

TABLE F-14. MASS AND ENERGY BALANCE FOR BATTELLE DIRECT HYDROPYROLYSIS PROCESS*

Stream Number / Location		1 Feed	2 Feed	3 BIC Feed to Flash Dryer	4 BIC to Hydro-Gasifier	5 Hydro-gasifier Product Gas	6 Product Gas from Flash Dryer	7 Liquid Products	8 Dry and Cooled Product Gas	9 Product Gas	10 Product Gas Recycle	11 Gas to Hydrogen Preheater	12 Hydrogen to Hydro-gasifier
Gas Composition (Mole %)	CH_4					10.22	8.35		11.17	11.17	11.17	9.99	9.99
	C_2H_4					0.26	0.21		0.29	0.29	0.29	0.25	0.25
	C_2H_6					1.81	1.48		1.98	1.98	1.98	1.75	1.75
	CO					1.65	1.35		1.80	1.80	1.80	1.64	1.64
	CO_2					9.63	7.87		10.53	10.53	10.53	9.25	9.25
	H_2					67.07	54.82		73.34	73.34	73.34	76.56	76.56
	N_2					0.53	0.44		0.58	0.58	0.58	0.56	0.56
	H_2S					0.28	0.23		0.31	0.31	0.31		
	H_2O					7.55	24.44	96.74	0.43	0.43	0.43		
	Others					0.99	0.81	3.26					
Gas Flow Rate(10^3 lb moles/hr)						1.264	1.547	0.386	1.156	0.197	0.960	1.082	1.082
Liquid Flow Rate (10^3 lb/hr)								3.52					
Liquid Comp.(wt %)	H_2O							66					
	Other							34					
S/L Flow Rate(10^3 lb/hr)		17.66	17.66	17.66	12.58								
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal	10.00	10.00	10.81	10.81								
	Char												
	Water	7.044	6.85	6.85	1.77								
	Sulfur												
	Lime												
	NaOH	0.023	0.023										
	$Ca(OH)_2$	0.596	0.787										
Temperature (°F)		80	200	530	467	900	467	125	125	125	125	125	
Pressure (PSIA)		14.7	1000	1000	500	500	500	15	500	500	500	500	500

* See Figure 38 in text for flowchart.

TABLE F-14. (CONTINUED)

Stream Number / Location		13 Char to Steam/ Oxygen Gasifier	14 Oxygen to Gasifier	15 Steam to Gasifier	16 Air to Oxygen	17 Ash to Disposal	18 S/O Gasifier Product Gas	19 SYNGAS from H_2 Preheater	20 SYNGAS	21 SYNGAS Recycle	22 Steam to Shift	23 Shifted Gas	24 SYNGAS to Purification
Gas Composition (Mole %)	CH_4						0.39	0.39	0.39	0.39		0.09	0.09
	C_2H_4												
	C_2H_6												
	CO						23.82	23.82	23.82	23.82		0.05	0.05
	CO_2						17.83	17.83	38.52	38.52		9.02	9.02
	H_2						38.52	38.52	38.52	38.52		13.52	13.52
	N_2						0.25	0.24	0.24	0.24		0.05	0.09
	H_2S						0.40	0.40	0.40	0.40		0.09	0.09
	H_2O			100			18.79	18.79	18.79	18.79	100	77.19	77.19
	Others		100		100								
Gas Flow Rate(10^3lb moles/hr)			0.143	0.429	0.681		0.913	0.913	0.712	0.201	0.721	0.922	0.922
Liquid Flow Rate (10^3 lb/hr)													
Liquid Comp.(wt %)	H_2O												
	Other												
S/L Flow Rate(10^3 lb/hr)		8.075				3.03							
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char	8.075				3.03							
	Water												
	Sulfur												
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		900	400	600	75	1550	1550		500	500	750	600	125
Pressure (PSIA)		500	515	515	15	15	500	500	500	500	520	500	500

TABLE F-14. (Continued)

Stream Number / Location		25 Acid Gas	26 Acid Gas	27 Gas to Methanol Synthesis	28 Methanol to Mobil Synthesis	29 Propane Product LPG	30 Butane Product LPG	31 Gasoline Product	32 Purge and Expansion Gas	33 Methanated Gas	34 SNG Product	35 Fuel Gas	
Gas Composition (Mole %)	CH_4			3.86					19.35	59.80	89.08	45.00	
	C_2H_4			0.09					0.45			1.16	
	C_2H_6			0.61		0.36			3.06			12.42	
	CO			27.06					9.36			1.03	
	CO_2	90.20	95.35	2.56	trace				6.66	2.15		15.92	
	H_2			65.37					57.07	4.05	6.03	2.39	
	N_2			0.46					2.34	3.29	4.90	0.01	
	H_2S	9.80	4.65										
	H_2O									30.72		4.39	
	Others					99.64	100	100				17.60	
									1.71				
Gas Flow Rate(10^3 lb moles/hr)		0.092	0.138	0.640	0.1748	0.0024	0.0029	0.0213	0.127	0.09	0.061	0.0029	
Liquid Flow	Rate (10^3 lb/hr)				5.448								
Liquid Comp.(wt %)	H_2O				2.55								
	Other				97.27								
S/L Flow Rate(10^3 lb/hr)													
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal												
	Char												
	Water												
	Sulfur												
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		125	125	125	95	100	100	80	95	800	125	100	
Pressure (PSIA)		15	15	1010	15	365	160	15	1040	1020	1000	300	

TABLE F-15. COAL GASIFICATION-TEXACO PROCESS*

Stream Number / Location		1 Coal	2 Oxygen	3 Gasifier* Product Gas	4 Ash	5 Quenched and Dust Free Gas	6 Shifted Product Gas	7 Cooled Product Gas	8 Product Gas to Methanol Synthesis	9 Gas to Methanator	10 Methanated Gas	11 SNG Product Gas	12 Methanol to Mobil Synthesis
Gas Composition (Mole %)	CH_4			0.09		0.07	0.07	0.09	0.10	0.64	31.06	54.27	0.002
	C_2H_4												
	C_2H_6												
	CO			42.52		30.80	14.07	18.43	25.24	9.51			0.0008
	CO_2			8.71		6.31	23.05	30.19	5.84	16.25	12.52	21.87	0.224
	H_2			28.88		20.92	37.66	49.31	67.54	66.22	5.12	8.95	0.0008
	N_2			0.79		0.57	0.57	0.74	1.01	5.52	0.54	14.92	
	H_2S/COS			1.08		0.78	0.78	1.02					
	H_2O			17.92		40.56	23.81	0.24	0.25	0.06	42.76		10.26
	Others		100										
	CH_3OH									1.80			
Gas Flow Rate(10^3 lb moles/hr)			26.70	110.22		152.13	152.14	116.18	84.82	15.57	10.07	5.77	24.60
Liquid Flow	Rate (10^3 lb/hr)				163.35								
Liquid Comp.(wt %)	H_2O				65.28								
	Other Ash				98.07								
S/L Flow Rate(10^3 lb/hr)		1,471.0											
Solid-Liquid Flow Rates (10^3 lb/hr)	Coal	978.7											
	Char	492.34											
	Water												
	Sulfur												
	Lime												
	NaOH												
	$Ca(OH)_2$												
Temperature (°F)		170	300	2000		550	700	125	125	95	530	125	95
Pressure (PSIA)		827	950	815		812	805	798	783	1043	1020	1000	20

* Does not include dust in stream 37.90 X 10^3 lbs Sulfur recovered 577 Btu/scf product gas. See Figure 40 in text for flowchart.