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FLASH HYDROLYSIS OF COAL

QUARTERLY REPORT NO. 10
JULY 1 - SEPTEMBER 30, 1979

MEYER STEINBERG
PETER FALLON
BHARAT L. BHATT

MASTER

December 1979

DEPARTMENT OF ENERGY AND ENVIRONMENT

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MEYER STEINBERG, HEAD
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Summary

The parametric study of New Mexico sub-bituminous coal is completed except for a few experiments that may be found necessary when the data is correlated. This coal has been found to be considerably more reactive than the lignite previously studied, particularly at 500 psi where the gaseous yields were approximately twice that of the lignite (35% vs 17%) and liquids two to four times greater (10% vs 2.6-4.6%).

The relationship between the yield of gaseous hydrocarbons from sub-bituminous coal at 900°C and the hydrogen partial pressure is not as linear as originally thought. At pressures below 1000 psi, there is an absolute increase of 3.75% per 100 psi increase in hydrogen partial pressure while above 1000 psi, the value is reduced to 2.2% per 100 psi. Neither the reduction in particle size to less than 50 microns nor the addition of Na_2CO_3 showed any significant change in yield obtained with the sub-bituminous coal at 900°C and 1000 psi.

A sample of high mineral matter ($\approx 46\%$) Brazilian coal yielded more liquid than gaseous hydrocarbons (16.8% vs 12.1%) at 750°C and 2500 psi and less gaseous yield than the sub-bituminous coal (38% vs 50%) at 900°C and 1500 psi.

Material balances, particularly carbon, continue to be well within the expected experimental error. Determination of the sulfur distribution in the lignite, sub-bituminous and bituminous coal used experimentally shows most of the sulfur to be in the organic form (57-73%).

The experimental equipment has been modified and tested to allow steam to be injected into the feed gas.

All the data from experiments using North Dakota lignite in which the H_2 /coal ratio was approximately 1 has been correlated to produce one

set of pre-exponential factors and activation energies for the reaction rate equations for all the hydrocarbon products. The activation energy for the initial products formation was calculated at 42,700 cal/mole with an estimated error of 80 cal/mole and the overall correlation coefficient was 0.83. A draft copy of the final report on this work is included in the appendix of this report.

I. OBJECTIVE AND SCOPE OF WORK

The program objective is to obtain process chemistry and design information on the Flash Hydropyrolysis of Coal (FHP), a rapid gas-phase non-catalytic coal hydrogenation technique.^(1,2) The work includes the design, construction, and operation of a 1 lb/hr down-flow entrained tubular reactor system capable of operating at up to 900°C and 4000 psi and incorporating on-line product analysis. The experimental unit is used to study the effect of such process variables as temperature, pressure, feed rates, residence time, coal type and feed gas composition on the yields of liquid and/or gaseous hydrocarbon products. Complete mass balances of feed to product are made, the data are correlated and modelled for determination of rate equations.

II. TUBULAR REACTOR EXPERIMENTAL RESULTS

Work Accomplished

a) Parametric Study of New Mexico Sub-bituminous Coal

Except for a few experiments that may be deemed necessary when all the data on New Mexico sub-bituminous coal is correlated, the parametric study of this coal is complete.

b) Low Pressure Reactivity of New Mexico Sub-bituminous Coal

An interesting observation regarding the New Mexico sub-bituminous coal is the much greater reactivity as compared to North Dakota lignite even at pressures as low as 500 psi. For example, the yields from both these coals at 900°C and 500 psi are shown in Table 1. The hydrocarbon gases produced are approximately twice as great for the sub-bituminous coal as for the lignite (32.1 and 37.5% vs 17%) and the liquids almost a factor of four greater (9.4 and 10% vs 2.6%). In no experiment conducted

at 500 psi using lignite did the BTX yield ever exceed 4.6% even at lower temperatures ($\sim 750^{\circ}\text{C}$) which tend to improve liquid yields. The sub-bituminous coal has produced BTX yields as high as 9% under the same conditions.

c) Effect of Hydrogen Partial Pressure on Gaseous Yields from New Mexico Sub-bituminous Coal.

When the hydrogen and the H/coal feed rates are reduced, the concentration of products is increased causing a subsequent decrease in hydrogen partial pressure. This in turn results in lower conversions of the feed coal to product.

In Figure 1, the yield of gaseous hydrocarbon products at pressures below 1000 psi are shown to increase linearly at a rate of approximately 3.75% for each 100 psi increase in hydrogen partial pressure at 900°C . The absolute increase in yield is greater than the 2.2% per 100 psi previously reported (3) at pressures above 1000 psi as shown in Figure 2, indicating the relationship is not entirely linear but only appears to be over certain regions of hydrogen partial pressures.

Figure 3 shows the relationship of the gaseous hydrocarbon concentration in the product stream and the yield of gaseous products. In performing the experiments, it was noted that the maximum concentration attainable was between approximately 42 and 47% representing conversions as high as 29% to as low as 19%. Because of the low H/coal feed ratio (0.04) at the low conversion (19%), almost all the hydrogen being fed was consumed in the formation of hydrocarbons and water leaving only a 20 psi hydrogen partial pressure in a total system pressure of 1000 psi.

d) Effect of Particle Size on Product Yields from New Mexico Sub-bituminous Coal

One experiment, number 296, was conducted using sub-bituminous coal particles less than 53 microns (< 53) rather than the normal size of < 150 , because particle size could effect several parameters of the system including residence time and heat-up-rate. It appears from Table 2 that if there is any difference in results from these two sizes, it may be a slight increase in CO, (2.3% vs 1.4%) with the gaseous and liquid hydrocarbons remaining approximately the same (47-51% gas and 5-8% liquid).

e) The Effect of Na_2CO_3 addition on New Mexico Sub-bituminous Coal

A sample of sub-bituminous coal was treated with 10% by weight Na_2CO_3 as a possible method of improving its gasification reactivity. The results of two experiments conducted at 900°C and 1000 psi are shown in Table 3. When these results are compared to those from a similar experiment using the same coal untreated, no improvement is seen in the gaseous hydrocarbon yield. A slight improvement in BTX yield and a large increase in CO, are noted. The CO effect may be due to the decomposition of the Na_2CO_3 to CO_2 with subsequent shifts and reduction to CO. A series of runs will be made at lower temperatures to determine whether there is a catalytic effect at lower temperatures.

f) Flash Hydropyrolysis of High Mineral Matter Brazilian Coal.

A sample of Brazilian coal, a sub-bituminous coal containing 46.3% mineral matter, was run in the experimental equipment. The purpose was to study the effect of high mineral content (high ash content) on hydrogenation yields. This particular coal, called Candiota, was chosen because petrographic examination has shown the mineral matter to be very

uniformly dispersed through-out the coal. The results of these experiments shown in Table 4 were unusual in two respects. The first effect noted is that the liquid yield at 750°C and 2500 psi greatly exceeded the gaseous yield (16.8% vs 12.1%) and the second is the very low gaseous yields ($\approx$ 38%) even at 900°C and 1500 psi. In none of the experiments to date, using either lignite or sub-bituminous coal has the liquid yields ever exceed the gaseous yields and at 900°C and 1500 psi, the gaseous products usually exceed 50%. However the BTX yields for this high ash content coal are rather high, much like those experienced when using New Mexico sub-bituminous coal.

Work Forecast

The major effort will be toward the use of two caking bituminous coals, Illinois No. 6 and Pittsburg No. 8 (Ireland Mine). First experiments will be performed using diluents such as spent char, limestone and organic matter after which treatment to reduce the caking qualities will be attempted. Other exploratory work will be performed as interest dictates and further experiments will be conducted in an attempt to increase both product yields and concentrations simultaneously.

III. PRODUCT ANALYSES AND MATERIAL BALANCES

Work Accomplished

a) General Analytic Procedure

Routine analyses of liquid products plus periodic char analyses and sulfur determinations continue. Most recent experiments have been conducted at high temperatures ($\approx$ 900°C) where little liquid product aside from BTX is produced. The small quantity of heavier liquids ($\geq$ C₉) continue to be of the same distribution of polynuclear aromatics as previously report.⁽⁴⁾

A complete carbon balance on run 286 selected at random (Table 1) continues to indicate excellent carbon closure with 98.5% of the carbon accounted for.

b) Sulfur Distribution in Coals Used Experimentally

Table 5 shows the results of analyses for the various forms of sulfur (sulfate, pyritic and organic) in the coals primarily used experimentally. The predominant form is the organic, representing 64% for the lignite, 73% for the sub-bituminous and 57% for the bituminous. Although the organic sulfur is determined by the difference between the total and the other forms, the results obtained for the Illinois #6 bituminous coal agreed very well with that reported by others (2.45% vs 2.78%).⁽⁵⁾ This information will be used in future studies of the disposition of the various forms in the products, particularly the char, as was done with the lignite.⁽⁶⁾ This information should provide some insight into the chemistry of the hydrogenation reaction, particularly with regard to the sulfur.

Work Forecast

Aside from the study of the sulfur distribution outlined above and a continuation of the general analytic work and material balances, no new areas of investigation are anticipated.

IV. REACTION MODELLING AND DATA CORRELATION

Work Accomplished

The data from 83 experimental runs using North Dakota lignite in which the hydrogen to coal weight ratio was approximately 1, has been correlated to produce one set of pre-exponential factors and activation energies for the reaction rate equations for all the hydrocarbon products.

A draft copy of the report being written concerning this correlation is included in the appendix. Due to the complexity of the kinetic expressions developed, the final version of this report will contain families of curves produced from these expressions for use in reactor engineering and design.

A total of 228 data points, corresponding to different gas and coal particle residence times in the reactor were available for the CH_4 , C_2H_6 and BTX yields as determined by the on-line gas chromatograph and 13 data points were available for the light oils ($\geq \text{C}_9$) as determined after the experiment. The three-step reaction model developed previously was modified to include an additional step for the production and decomposition of these oils. The weighted error of a single object function formulated for the four dependent process variables yields of methane, ethane, BTX and light oils, was minimized using a library program "MINUIT" containing three independent iteration techniques. The results were a set of kinetic expressions relating all the process variables, temperature, pressure, particle residence time and gas residence time to both the formation and subsequent decomposition of all the previously mentioned products. The activation energy for the initial products formation was calculated to be 42,700 cal/mole with an estimated error of 80 cal/mole, and the correlation coefficients varied from 0.85 to 0.72 with an overall coefficient of 0.83. Further details can be obtained by referring to the correlation given in the appendix.

Work Forecast

The correlation of the lignite data will be published and a similar correlation will be accomplished for the sub-bituminous data.

V. EXPERIMENTAL EQUIPMENT AND MODIFICATION

Work Accomplished

The system designed to permit water to be injected into the fed gas has been completed and tested. Two successful trial runs were conducted using an inert gas but the amount of water in the gas stream could not be accurately measured by the on-line gas chromatograph. The water gas injected could be determined by measurements of both gas and water flow rates. Use of the system is anticipated in the next report period.

Work Forecast

No further modifications to the system are planned.

VI. CONCLUSIONS

The following conclusions can be drawn from this work:

1. The low pressure (< 500 psi) reactivity of New Mexico sub-bituminous coal is approximately twice as great as that of the North Dakota lignite (43-50% yield vs 25%).
2. The low pressure yield of BTX from the sub-bituminous coal is greater than 3 times that from lignite (9.4-10% vs 2.6%).
3. The rate of increase in yield of gaseous hydrocarbons from the sub-bituminous coal is not as linear with hydrogen partial pressure as originally thought. The rate of increase in reactivity at system pressures lower than 1000 psi (3.75% yield/100 psi H₂) is higher than at pressures greater than 1000 psi (2.2% yield/100 psi H₂).
4. The yields at 900°C and 1000 psi from sub-bituminous coal using particle sizes in the range of < 150 or < 53 does not appear to be significantly different.

5. Treatment of the sub-bituminous coal with Na_2CO_3 does not appreciably change the product yield at 900°C and 1000 psi, except for CO which is probably a result of the decomposition of the carbonate and reduction of CO_2 .

6. The high mineral content (high ash) Brazilian coal produces the same quantity of BTX ($\approx 15\%$) as the sub-bituminous coal but significantly less gases (12% vs 27%).

7. Carbon balances continue to be better than the $\pm 5\%$ expected.

8. Measurement of the forms of sulfur in the coals used are in agreement with others using the same ASTM methods.

9. A regression analysis of all the data obtained for lignite shows a very good fit with the first order, chemical reaction rate controlling expression. An overall correlation coefficient of 0.83 was obtained.

10. In the kinetic model for correlating the lignite data the assumption that the activation energy is the same for the initial formation of all products from coal is justified by the small estimated error actually obtained (80 cal/gmole out of 42,700 cal/gmole).

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TABLE 1
FLASH HYDROLYSIS OF LIGNITE AND SUB-BITUMINOUS COAL
AT 900°C AND 500 PSI

	North Dakota Lignite	New Mexico Sub-Bituminous	
Run No	106	286	289
Date	2/1/78	8/8/79	8/28/79
Reactor Temperature (°C)	900	900	900
Reactor Pressure (psi)	500	500	500
H ₂ Feed Rate (lb/hr)	0.62	1.04	1.02
Coal Feed Rate (lb/hr)	1.40	1.05	0.93
H ₂ /Coal Weight Ratio	0.44	0.99	1.10
Residence Time (sec)	1.3	3.1	3.1
<u>Product Yield (% Carbon Converted)</u>			
CH ₄	16.2	32.1	37.5
C ₂ H ₆	<u>0.8</u>	<u>0</u>	<u>0</u>
Total Gaseous HC	17.0	32.1	37.5
BTX	<u>2.6</u>	<u>9.4</u>	<u>10.0</u>
Total HC	19.6	41.5	46.5
CO	5.4	1.4	2.1
CO ₂	0.2	0	0
Char	—	<u>55.6</u>	—
Total	25.2	98.5	49.6

TABLE 2

FLASH HYDROLYSIS OF NEW MEXICO SUB-BITUMINOUS COAL
EFFECT OF PARTICLE SIZE ON PRODUCT YIELD

	<u><150</u>	<u><53</u>
Particle Size,		
Run No	243b	243d
Date	3/29/79	3/29/79
Reactor Temperature (°C)	900	900
Reactor Pressure (psi)	1000	1000
H ₂ Feed Rate (lb/hr)	0.98	0.98
Coal Feed Rate (lb/hr)	1.02	1.02
H ₂ /Coal Weight Ratio	0.96	0.96
Residence Time (sec)	3.2	6.4
		5.0
<u>Product Yield (% Carbon Converted)</u>		
CH ₄	46.5	50.6
C ₂ H ₆	<u>0</u>	<u>0</u>
Total Gaseous HC	46.5	50.6
BTX	<u>7.0</u>	<u>4.6</u>
Total HC	53.5	55.2
CO	<u>0</u>	<u>1.4</u>
Total	53.5	56.6
		57.0

TABLE 3

FLASH HYDROLYSIS OF NEW MEXICO SUB-BITUMINOUS COAL
EFFECT OF Na_2CO_3 ON PRODUCT YIELD

	Untreated		Na_2CO_3 Treated	
Run No	243b	243d	297	298
Date	3/29/79	3/29/79	9/26/79	9/27/79
Reactor Temperature ($^{\circ}\text{C}$)	900	900	900	900
Reactor Pressure (psi)	1000	1000	1000	1000
H_2 Feed Rate (lb/hr)	0.98	0.98	0.82	1.02
Coal Feed Rate (lb/hr)	1.02	1.02	3.34	0.99
H_2 /Coal Weight Ratio	0.96	0.96	0.25	1.03
Residence Time (sec)	3.2	6.4	5.1	4.7
<u>Product Yield (% Carbon Converted)</u>				
CH_4	46.5	50.6	47.5	40.1
C_2H_6	<u>0</u>	<u>0</u>	<u>0.3</u>	<u>0.5</u>
Total Gaseous HC	46.5	50.6	47.8	40.6
BTX	<u>7.0</u>	<u>4.6</u>	<u>6.6</u>	<u>7.2</u>
Total HC	53.5	55.2	54.4	47.8
CO	0	1.4	8.4	5.0
CO_2	<u>0</u>	<u>0</u>	<u>1.0</u>	<u>0.1</u>
Total	53.5	56.6	63.8	52.9

TABLE 4

FLASH HYDROLYSIS OF BRAZILIAN CANDIOTA COAL

Run No	279b	279c	288
Date	7/20/79	7/20/79	8/23/79
Reactor Temperature (°C)	825	900	750
Reactor Pressure (psi)	1500	1500	2500
H ₂ Feed Rate (lb/hr)	1.08	1.08	0.95
Coal Feed Rate (lb/hr)	0.81	0.81	0.91
H ₂ /Coal Weight Ratio			
Residence Time (sec)	3.8	5.6	7.2
<u>Product Yield (% Carbon Converted)</u>			
CH ₄	23.3	37.7	12.1
BTX	12.1	9.3	14.8
≥ C ₉	<u>(1)</u>	<u>(1)</u>	<u>2.0</u>
Total Liquids	12.1	9.3	16.8
Total HC	35.4	47.0	28.9

(1) Insufficient sample

TABLE 5

SULFUR DISTRIBUTION IN COALS USED IN
FLASH HYDROLYSIS EXPERIMENTS

	North Dakota		New Mexico		Illinois # 6	
	Lignite		Sub-Bituminous		Bituminous	
	wt %	Fraction %	wt %	Fraction %	wt %	Fraction %
Sulfate	0.085	15	0.076	9	0.52	12
Pyritic	0.124	21	0.155	18	1.34	21
Organic*	<u>0.366</u>	<u>64</u>	<u>0.629</u>	<u>73</u>	<u>2.45</u>	<u>57</u>
Total	0.575	100	0.860	100	4.31	100

*By difference

Figure 1. Flash Hydropyrolysis of New Mexico Sub-Bituminous Coal
 Fraction Carbon Converted to Gaseous HC ($\text{CH}_4 + \text{C}_2\text{H}_6$) vs. Hydrogen
 Partial Pressure, System Pressure 1000 psi Temperature 900°C

Figure 2. Flash Hydropyrolysis of New Mexico Sub-Bituminous Coal
 Fraction Carbon Converted to Gaseous HC vs. Hydrogen Partial Pressure,
 Temperature 900°C

Figure 3. Flash Hydrolysis of New Mexico Sub-Bituminous Coal
Fraction Carbon Converted to Gaseous HC vs. Gaseous HC Concentration,
System Pressure - 1000 psi, Temperature - 900°C

APPENDIX

RUN NO. 279

SAMPLE NO. 1

DATE 7 -20 - 1979

COAL TYPE- BRAZILIAN CANDIOTA

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 1.899 SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.		
COAL FEED RATE	.8080	LB/HR	COAL FED	427.9	GRAMS
HYDROGEN FLOW RATE	1.077	LB/HR	CHAR	306.5	GRAMS
HYDROGEN VELOCITY	.3610	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	750.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	750.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1500.	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	88.77	0.
HYDROGEN	2.650	0.
OXYGEN	11.07	0.
NITROGEN	.4500	0.
SULFUR	.7600	0.
ASH	46.30	64.63

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	.2390	4.921	4.745
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.3300E-01	4.082	3.194
TOLUENE	.6000E-02	.8657	.6850
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		9.868	8.624

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	4.95	6.22	0.	0.	0.	3.88
HYDROCARBON GASES	4.92	24.2	0.	0.	0.	4.75
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	3.64	0.	100.	0.	1.02
HYDROGEN SULFIDE	0.	1.79	0.	0.	100.	1.50
CHAR	0.	0.	0.	0.	0.	47.2
TOTAL	9.87	35.8	0.	100.	100.	58.3

HYDROGEN CONSUMPTION- -.1701E-01 LB HYDROGEN/LB COAL
-.5264 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.2504 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 9.868 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 7.733 PERCENT

RUN NO. 279

SAMPLE NO. 2

DATE 7 -20 - 1979

COAL TYPE- BRAZILIAN CANDIOTA

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	3.766	SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.	
COAL FEED RATE	.8080	LB/HR	COAL FED	427.9 GRAMS
HYDROGEN FLOW RATE	1.077	LB/HR	CHAR	306.5 GRAMS
HYDROGEN VELOCITY	.3875	FT/SEC	LIGHT OILS	0. GRAMS
REACTOR TEMP.	825.0	DEG C	BTX	0. GRAMS
PREHEAT TEMP.	750.0	DEG C	WATER	0. GRAMS
HYDROGEN PRESSURE	1500.	PSI		

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	38.77	0.
HYDROGEN	2.650	0.
OXYGEN	11.07	0.
NITROGEN	.4500	0.
SULFUR	.7600	0.
ASH	46.30	64.63

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	1.130	23.27	22.43
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.9800E-01	12.12	9.485
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		35.39	31.92

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	12.1	14.9	0.	0.	0.	9.49
HYDROCARBON GASES	23.3	114.	0.	0.	0.	22.4
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	3.64	0.	100.	0.	1.02
HYDROGEN SULFIDE	0.	1.79	0.	0.	100.	1.50
CHAR	0.	0.	0.	0.	0.	47.2

TOTAL	35.4	135.	0.	100.	100.	81.6
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HYDROGEN CONSUMPTION-	.9157E-02	LB HYDROGEN/LB COAL
	.2834	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.3019	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	35.39	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	31.78	PERCENT

RUN NO. 279

SAMPLE NO. 3

DATE 7 -20 - 1979

COAL TYPE- BRAZILIAN CANDIOTA

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	5.597	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.8080	LB/HR	COAL FED	427.9	GRAMS
HYDROGEN FLOW RATE	1.077	LB/HR	CHAR	306.5	GRAMS
HYDROGEN VELOCITY	.4139	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	750.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1500.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	38.77	0.
HYDROGEN	2.650	0.
OXYGEN	11.07	0.
NITROGEN	.4500	0.
SULFUR	.7600	0.
ASH	46.30	64.63

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	1.830	37.68	36.33
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.7500E-01	9.276	7.259
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL	46.95	43.59
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TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	9.28	11.4	0.	0.	0.	7.26
HYDROCARBON GASES	37.7	185.	0.	0.	0.	36.3
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	3.64	0.	100.	0.	1.02
HYDROGEN SULFIDE	0.	1.79	0.	0.	100.	1.50
CHAR	0.	0.	0.	0.	0.	47.2

TOTAL	47.0	202.	0.	100.	100.	93.3
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HYDROGEN CONSUMPTION-	.2699E-01	LB HYDROGEN/LB COAL
	.8353	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.3691	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	46.95	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	44.58	PERCENT

RUN NO. 279

SAMPLE NO. 4

DATE 7 -20 - 1979

COAL TYPE- BRAZILIAN CANDIOTA

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	7.462	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.8080	LB/HR	TOTAL ACCUMULATED WTS.		
HYDROGEN FLOW RATE	1.077	LB/HR	COAL FED	427.9	GRAMS
HYDROGEN VELOCITY	.4139	FT/SEC	CHAR	306.5	GRAMS
REACTOR TEMP.	900.0	DEG C	LIGHT OILS	0.	GRAMS
PREHEAT TEMP.	750.0	DEG C	BTX	0.	GRAMS
HYDROGEN PRESSURE	1500.	PSI	WATER	0.	GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	38.77	0.
HYDROGEN	2.650	0.
OXYGEN	11.07	0.
NITROGEN	.4500	0.
SULFUR	.7600	0.
ASH	46.30	64.63

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	1.650	33.97	32.76
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.6000E-01	7.421	5.807
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		41.39	38.57

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	7.42	9.11	0.	0.	0.	5.81
HYDROCARBON GASES	34.0	167.	0.	0.	0.	32.8
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	3.64	0.	100.	0.	1.02
HYDROGEN SULFIDE	0.	1.79	0.	0.	100.	1.50
CHAR	0.	0.	0.	0.	0.	47.2
TOTAL	41.4	181.	0.	100.	100.	88.3

HYDROGEN CONSUMPTION-	.2156E-01	LB HYDROGEN/LB COAL
	.6673	FROM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.3576	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	41.39	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	39.57	PERCENT

RUN NO. 280

SAMPLE NO. 1

DATE 7 -24 - 1979

COAL TYPE- NEW MEXICO SUB BITUMINOUS

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 2.114 SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.028	LB/HR	COAL FED	644.8	GRAMS
HYDROGEN FLOW RATE	1.102	LB/HR	CHAR	286.4	GRAMS
HYDROGEN VELOCITY	.2974	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	825.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	825.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	2000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS,%	CHAR ANALYSIS,%
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	39.80

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	1.328	14.39	13.84
ETHYLENE	0.	0.	0.
ETHANE	.1710	3.706	3.342
BENZENE	.1070	6.963	5.437
TOLUENE	.6000E-02	.4555	.3596
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	22.96
TOTAL		25.51	45.94

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	7.42	8.91	0.	0.	0.	5.80
HYDROCARBON GASES	18.1	81.7	0.	0.	0.	17.2
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	50.2	100.	0.	0.	23.0
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	32.5
TOTAL	25.5	148.	100.	100.	100.	81.3

HYDROGEN CONSUMPTION- .2023E-01 LB HYDROGEN/LB COAL
.4094 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.4279 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 25.51 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 34.48 PERCENT

RUN NO. 280

SAMPLE NO. 2

DATE 7 -24 - 1979

COAL TYPE- NEW MEXICO SUB BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	4.228	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.028	LB/HR	TOTAL ACCUMULATED WTS.		
HYDROGEN FLOW RATE	1.102	LB/HR	COAL FED	644.8	GRAMS
HYDROGEN VELOCITY	.2974	FT/SEC	CHAR	286.4	GRAMS
REACTOR TEMP.	825.0	DEG C	LIGHT OILS	0.	GRAMS
PREHEAT TEMP.	825.0	DEG C	BTX	0.	GRAMS
HYDROGEN PRESSURE	2000.	PSI	WATER	0.	GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	39.80

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	3.665	39.70	38.20
ETHYLENE	0.	0.	0.
ETHANE	.4000E-01	.8670	.7817
BENZENE	.1610	10.48	8.181
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	22.96
TOTAL		51.05	70.12

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	10.5	12.5	0.	0.	0.	8.18
HYDROCARBON GASES	40.6	192.	0.	0.	0.	39.0
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	50.2	100.	0.	0.	23.0
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	32.5
TOTAL	51.0	262.	100.	100.	100.	105.

HYDROGEN CONSUMPTION-	.6787E-01	LB HYDROGEN/LB COAL
	1.373	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.5844	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	51.05	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	73.73	PERCENT

RUN NO. 280

SAMPLE NO. 3

DATE 7 -24 - 1979

COAL TYPE- NEW MEXICO SUB BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	6.341	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.028	LB/HR	COAL FED	644.8	GRAMS
HYDROGEN FLOW RATE	1.102	LB/HR	CHAR	286.4	GRAMS
HYDROGEN VELOCITY	.2974	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	825.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	825.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	2000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	39.80

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	4.746	51.42	49.47
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.9300E-01	6.052	4.726
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	22.96
TOTAL		57.47	77.15

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	6.05	7.20	0.	0.	0.	4.73
HYDROCARBON GASES	51.4	245.	0.	0.	0.	49.5
CARBON OXIDES	0.	0	0.	0.	0.	0.
WATER	0.	50.2	100.	0.	0.	23.0
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	32.5
TOTAL	57.5	310.	100.	100.	100.	112.

HYDROGEN CONSUMPTION-	.8769E-01	LB HYDROGEN/LB COAL
	1.774	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.6871 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION-	57.47	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	86.32	PERCENT

RUN NO. 280

SAMPLE NO. 4

DATE 7 -24 - 1979

COAL TYPE- NEW MEXICO SUB BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	8.455	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.028	LB/HR	TOTAL ACCUMULATED WTS.		
HYDROGEN FLOW RATE	1.102	LB/HR	COAL FED	644.8	GRAMS
HYDROGEN VELOCITY	.2974	FT/SEC	CHAR	286.4	GRAMS
REACTOR TEMP.	825.0	DEG C	LIGHT OILS	0.	GRAMS
PREHEAT TEMP.	825.0	DEG C	BTX	0.	GRAMS
HYDROGEN PRESSURE	2000.	PSI	WATER	0.	GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	39.80

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	4.434	48.04	46.22
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.6900E-01	4.490	3.506
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	22.96
TOTAL		52.53	72.68

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	4.49	5.34	0.	0.	0.	3.51
HYDROCARBON GASES	48.0	229.	0.	0.	0.	46.2
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	50.2	100.	0.	0.	23.0
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	32.5
TOTAL	52.5	292.	100.	100.	100.	108.

HYDROGEN CONSUMPTION-	.8018E-01	LB HYDROGEN/LB COAL
	1.623	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	- .6704	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	52.53	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	79.46	PERCENT

RUN NO. 285

SAMPLE NO. 1

DATE 8 -7 - 1979

COAL TYPE- BATTELLE ILLINOIS #6

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 5.377 SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	2.060	LB/HR	COAL FED	1285.	GRAMS
HYDROGEN FLOW RATE	.7295	LB/HR	CHAR	660.0	GRAMS
HYDROGEN VELOCITY	.4206	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	30.00	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	68.80	0.
HYDROGEN	5.000	0.
OXYGEN	10.00	0.
NITROGEN	1.200	0.
SULFUR	4.200	0.
ASH	10.80	21.03

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	4.920	15.20	27.34
CARBON DIOXIDE	.6030	1.863	5.265
METHANE	11.68	36.00	37.09
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.4300	7.962	6.656
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL 61.02 76.33

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	7.96	9.19	0.	0.	0.	6.66
HYDROCARBON GASES	36.0	166.	0.	0.	0.	37.1
CARBON OXIDES	17.1	0.	173.	0.	0.	32.6
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	5.14	0.	100.	0.	1.63
HYDROGEN SULFIDE	0.	5.25	0.	0.	100.	5.00
CHAR	0.	0.	0.	0.	0.	45.5

TOTAL 61.0 186. 173. 100. 100. 128.

HYDROGEN CONSUMPTION- .4293E-01 LB HYDROGEN/LB COAL
.7487 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.6402E-01 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 58.18 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 71.05 PERCENT

RUN NO. 286

SAMPLE NO. 1

DATE 8 -8 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	1.032	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.051	LB/HR	COAL FED	508.6	GRAMS
HYDROGEN FLOW RATE	1.042	LB/HR	CHAR	345.3	GRAMS
HYDROGEN VELOCITY	1.202	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	500.0	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	26.04

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	1.260	12.61	12.14
ETHYLENE	0.	0.	0.
ETHANE	.4400E-01	.8813	.7947
BENZENE	.8500E-01	5.112	3.992
TOLUENE	.4000E-02	.2806	.2216
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		18.89	17.14

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	5.39	6.47	0.	0.	0.	4.21
HYDROCARBON GASES	13.5	63.2	0.	0.	0.	12.9
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	61.0
TOTAL	18.9	77.2	0.	100.	100.	81.0

HYDROGEN CONSUMPTION-	-.9531E-02	LB HYDROGEN/LB COAL
	-.1929	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.4021	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	18.89	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	26.05	PERCENT

RUN NO. 286

SAMPLE NO. 2

DATE 8 -8 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	2.065	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.051	LB/HR	COAL FED	508.6	GRAMS
HYDROGEN FLOW RATE	1.042	LB/HR	CHAR	345.3	GRAMS
HYDROGEN VELOCITY	1.202	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	500.0	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	26.04

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	3.240	32.44	31.21
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1410	8.480	6.621
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		40.92	37.83

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	8.48	10.1	0.	0.	0.	6.62
HYDROCARBON GASES	32.4	154.	0.	0.	0.	31.2
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	61.0
TOTAL	40.9	172.	0.	100.	100.	102.

HYDROGEN CONSUMPTION-	.3012E-01	LB HYDROGEN/LB COAL
	.6096	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.5256	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	40.92	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	59.21	PERCENT

RUN NO. 286

SAMPLE NO. 3

DATE 8 -8 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	3.097	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.051	LB/HR	TOTAL ACCUMULATED WTS.		
HYDROGEN FLOW RATE	1.042	LB/HR	COAL FED	508.6	GRAMS
HYDROGEN VELOCITY	1.202	FT/SEC	CHAR	345.3	GRAMS
REACTOR TEMP.	900.0	DEG C	LIGHT OILS	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	BTX	0.	GRAMS
HYDROGEN PRESSURE	500.0	PSI	WATER	0.	GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	26.04

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.1390	1.395	2.343
CARBON DIOXIDE	0.	0.	0.
METHANE	3.202	32.06	30.84
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1560	9.382	7.326
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		42.83	40.51

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	9.38	11.2	0.	0.	0.	7.33
HYDROCARBON GASES	32.1	153.	0.	0.	0.	30.8
CARBON OXIDES	1.39	0.	6.56	0.	0.	2.34
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	61.0
TOTAL	42.8	171.	6.56	100.	100.	104.

HYDROGEN CONSUMPTION-	.2982E-01	LB HYDROGEN/LB COAL
	.6034	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.4955	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	42.83	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	59.53	PERCENT

RUN NO. 286

SAMPLE NO. 4

DATE 8 -8 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 4.129 SECONDS

NOMINAL CONDITIONS				TOTAL ACCUMULATED WTS.	
COAL FEED RATE	1.051	LB/HR	COAL FED	508.6	GRAMS
HYDROGEN FLOW RATE	1.042	LB/HR	CHAR	345.3	GRAMS
HYDROGEN VELOCITY	1.202	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	500.0	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.100	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	26.04

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.1400	1.405	2.360
CARBON DIOXIDE	0.	0.	0.
METHANE	2.800	28.03	26.97
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1390	8.360	6.527
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		37.80	35.86

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	8.36	9.95	0.	0.	0.	6.53
HYDROCARBON GASES	28.0	133.	0.	0.	0.	27.0
CARBON OXIDES	1.40	0.	6.61	0.	0.	2.36
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	61.0
TOTAL	37.8	151.	6.61	100.	100.	99.7

HYDROGEN CONSUMPTION- .2130E-01 LB HYDROGEN/LB COAL
.4310 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.4714 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 37.80 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 52.22 PERCENT

RUN NO. 287

SAMPLE NO. 1

DATE 8 -9 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	2.889	SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.	
COAL FEED RATE	1.580	LB/HR	COAL FED	884.2 GRAMS
HYDROGEN FLOW RATE	.4863	LB/HR	CHAR	381.1 GRAMS
HYDROGEN VELOCITY	.9347E-01	FT/SEC	LIGHT OILS	0. GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0. GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0. GRAMS
HYDROGEN PRESSURE	3000.	PSI		

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	41.02

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	17.08	53.09	51.08
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.4600E-01	.8589	.6706
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		53.95	51.75

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	.859	1.02	0.	0.	0.	.671
HYDROCARBON GASES	53.1	253.	0.	0.	0.	51.1
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	30.9
TOTAL	53.9	261.	0.	100.	100.	85.5

HYDROGEN CONSUMPTION-	.6744E-01	LB HYDROGEN/LB COAL
	1.365	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.7108	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	53.95	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	83.64	PERCENT

RUN NO. 287

SAMPLE NO. 2

DATE 8 -9 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	5.778	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.580	LB/HR	COAL FED	884.2	GRAMS
HYDROGEN FLOW RATE	.4863	LB/HR	CHAR	381.1	GRAMS
HYDROGEN VELOCITY	.9347E-01	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	3000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	41.02

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	18.08	56.20	54.07
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.5000E-02	.9336E-01	.7289E-01
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		56.29	54.14

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	.934E-01	.111	0.	0.	0.	.729E-01
HYDROCARBON GASES	56.2	268.	0.	0.	0.	54.1
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	30.9
TOTAL	56.2	275.	0.	100.	100.	87.9

HYDROGEN CONSUMPTION-	.7324E-01	LB HYDROGEN/LB COAL
	1.482	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.7368	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	56.29	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	87.71	PERCENT

RUN NO. 287

SAMPLE NO. 3

DATE 8 -9 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	8.667	SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.	
COAL FEED RATE	1.580	LB/HR	COAL FED	884.2 GRAMS
HYDROGEN FLOW RATE	.4863	LB/HR	CHAR	381.1 GRAMS
HYDROGEN VELOCITY	.9347E-01	FT/SEC	LIGHT OILS	0. GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0. GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0. GRAMS
HYDROGEN PRESSURE	3000.	PSI		

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	41.02

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.3640	1.134	1.905
CARBON DIOXIDE	0.	0.	0.
METHANE	15.37	47.77	45.96
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	0.	0.	0.
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		48.91	47.87

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	0.	0.	0.	0.	0.	0.
HYDROCARBON GASES	47.8	227.	0.	0.	0.	46.0
CARBON OXIDES	1.13	0.	5.33	0.	0.	1.90
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	30.9

TOTAL	48.9	235.	5.33	100.	100.	81.6
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HYDROGEN CONSUMPTION-	.5643E-01	LB HYDROGEN/LB COAL
	1.142	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.6582	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	48.91	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	74.48	PERCENT

RUN NO. 287

SAMPLE NO. 4

DATE 8 -9 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	11.56	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.580	LB/HR	COAL FED	884.2	GRAMS
HYDROGEN FLOW RATE	.4863	LB/HR	CHAR	381.1	GRAMS
HYDROGEN VELOCITY	.9347E-01	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	3000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.220	0.
SULFUR	.8100	0.
ASH	17.68	41.02

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.2900	.9034	1.518
CARBON DIOXIDE	0.	0.	0.
METHANE	15.90	49.42	47.55
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	0.	0.	0.
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL	50.32	49.07
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TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	0.	0.	0.	0.	0.	0.
HYDROCARBON GASES	49.4	235.	0.	0.	0.	47.5
CARBON OXIDES	.903	0.	4.25	0.	0.	1.52
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	30.9

TOTAL	50.3	243.	4.25	100.	100.	82.8
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HYDROGEN CONSUMPTION-	.5971E-01	LB HYDROGEN/LB COAL
	1.208	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.6738	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	50.32	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	77.05	PERCENT

RUN NO. 288

SAMPLE NO. 1

DATE 8 -23 - 1979

COAL TYPE- BRAZILIAN CONDIOTA

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 2.392 SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.		
COAL FEED RATE	.9085	LB/HR	COAL FED	521.9	GRAMS
HYDROGEN FLOW RATE	.9474	LB/HR	CHAR	351.2	GRAMS
HYDROGEN VELOCITY	.1906	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	750.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	750.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	2500.	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	88.77	0.
HYDROGEN	2.650	0.
OXYGEN	11.07	0.
NITROGEN	.4500	0.
SULFUR	.7600	0.
ASH	46.30	68.80

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	.4930	7.942	7.658
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.8300E-01	8.032	6.286
TOLUENE	.4000E-02	.4516	.3573
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		16.43	14.30

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	8.48	10.5	0.	0.	0.	6.64
HYDROCARBON GASES	7.94	39.0	0.	0.	0.	7.66
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	3.64	0.	100.	0.	1.02
HYDROGEN SULFIDE	0.	1.79	0.	0.	100.	1.50
CHAR	0.	0.	0.	0.	0.	39.1
TOTAL	16.4	54.9	0.	100.	100.	55.9

HYDROGEN CONSUMPTION- -.1195E-01 LB HYDROGEN/LB COAL
-.3697 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.2523 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 16.43 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 13.44 PERCENT

RUN NO. 288

SAMPLE NO. 2

DATE 8 -23 - 1979

COAL TYPE- BRAZILIAN CONDIOTA

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 4.784 SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9085	LB/HR	TOTAL ACCUMULATED WTS.		
HYDROGEN FLOW RATE	.9474	LB/HR	COAL FED	521.9	GRAMS
HYDROGEN VELOCITY	.1906	FT/SEC	CHAR	351.2	GRAMS
REACTOR TEMP.	750.0	DEG C	LIGHT OILS	0.	GRAMS
PREHEAT TEMP.	750.0	DEG C	BTX	0.	GRAMS
HYDROGEN PRESSURE	2500.	PSI	WATER	0.	GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	88.77	0.
HYDROGEN	2.650	0.
OXYGEN	11.07	0.
NITROGEN	.4500	0.
SULFUR	.7600	0.
ASH	46.30	68.80

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	.7080	11.41	11.00
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1250	12.10	9.466
TOLUENE	.1000E-02	.1129	.8932E-01
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL 23.02 20.55

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	12.2	15.0	0.	0.	0.	9.56
HYDROCARBON GASES	11.4	56.0	0.	0.	0.	11.0
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	3.64	0.	100.	0.	1.02
HYDROGEN SULFIDE	0.	1.79	0.	0.	100.	1.50
CHAR	0.	0.	0.	0.	0.	39.1
TOTAL	23.6	76.4	0.	100.	100.	62.2

HYDROGEN CONSUMPTION- -.6242E-02 LB HYDROGEN/LB COAL
-.1932 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.2559 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 23.62 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 19.68 PERCENT

RUN NO. 288

SAMPLE NO. 3

DATE 8 -23 - 1979

COAL TYPE- BRAZILIAN CONDORA

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	7.175	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9085	LB/HR	TOTAL ACCUMULATED WTS.	
HYDROGEN FLOW RATE	.9474	LB/HR	COAL FED	521.9 GRAMS
HYDROGEN VELOCITY	.1906	FT/SEC	CHAR	351.2 GRAMS
REACTOR TEMP.	750.0	DEG C	LIGHT OILS	0. GRAMS
PREHEAT TEMP.	750.0	DEG C	BTX	0. GRAMS
HYDROGEN PRESSURE	2500.	PSI	WATER	0. GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	88.77	0.
HYDROGEN	2.650	0.
OXYGEN	11.07	0.
NITROGEN	.4500	0.
SULFUR	.7600	0.
ASH	46.30	68.80

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	.7510	12.10	11.67
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1530	14.81	11.59
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL	26.90	23.25
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TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	14.8	18.2	0.	0.	0.	11.6
HYDROCARBON GASES	12.1	59.4	0.	0.	0.	11.7
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	3.64	0.	100.	0.	1.02
HYDROGEN SULFIDE	0.	1.79	0.	0.	100.	1.50
CHAR	0.	0.	0.	0.	0.	39.1

TOTAL	26.9	83.0	0.	100.	100.	64.9
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HYDROGEN CONSUMPTION-	-.4501E-02	LB HYDROGEN/LB COAL
	-.1393	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.2507	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	26.90	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	22.19	PERCENT

RUN NO. 288

SAMPLE NO. 4

DATE 8 -23 - 1979

COAL TYPE- BRAZILIAN CONDIOTA

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 9.567 SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9085	LB/HR	COAL FED	521.9	GRAMS
HYDROGEN FLOW RATE	.9474	LB/HR	CHAR	351.2	GRAMS
HYDROGEN VELOCITY	.1906	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	750.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	750.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	2500.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	38.77	0.
HYDROGEN	2.650	0.
OXYGEN	11.07	0.
NITROGEN	.4500	0.
SULFUR	.7600	0.
ASH	46.30	68.80

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	.7510	12.10	11.67
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1450	14.03	10.98
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		26.13	22.65

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	14.0	17.2	0.	0.	0.	11.0
HYDROCARBON GASES	12.1	39.4	0.	0.	0.	11.7
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	3.64	0.	100.	0.	1.02
HYDROGEN SULFIDE	0.	1.79	0.	0.	100.	1.50
CHAR	0.	0.	0.	0.	0.	39.1
TOTAL	26.1	82.1	0.	100.	100.	64.3

HYDROGEN CONSUMPTION- -.4753E-02 LB HYDROGEN/LB COAL
-.1471 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.2531 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 26.13 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 21.67 PERCENT

RUN NO. 289

SAMPLE NO. 1

DATE 8 -28 - 1979.

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 1.044 SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.		
COAL FEED RATE	.9328	LB/HR	COAL FED	543.1	GRAMS
HYDROGEN FLOW RATE	1.023	LB/HR	CHAR	287.3	GRAMS
HYDROGEN VELOCITY	1.180	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	500.0	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	33.42

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	1.151	12.75	12.27
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.7400E-01	4.925	3.845
TOLUENE	.2000E-02	.1553	.1226
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		17.83	16.24

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	5.08	6.07	0.	0.	0.	3.97
HYDROCARBON GASES	12.8	60.7	0.	0.	0.	12.3
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	42.8

TOTAL	17.8	74.3	0.	100.	100.	61.9
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HYDROGEN CONSUMPTION- -.1074E-01 LB HYDROGEN/LB COAL
-.2173 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.4016 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 17.83 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 24.89 PERCENT

RUN NO. 289

SAMPLE NO. 2

DATE 8 -28 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 2.088 SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.		
COAL FEED RATE	.9328	LB/HR	COAL FED	543.1	GRAMS
HYDROGEN FLOW RATE	1.023	LB/HR	CHAR	287.3	GRAMS
HYDROGEN VELOCITY	1.180	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	500.0	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.000	0.
SULFUR	.8100	0.
ASH	17.68	33.42

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	2.420	26.81	25.79
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1000	6.655	5.196
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		33.46	30.99

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	6.66	7.92	0.	0.	0.	5.20
HYDROCARBON GASES	26.8	128.	0.	0.	0.	25.8
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	42.8

TOTAL	33.5	143.	0.	100.	100.	76.6
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HYDROGEN CONSUMPTION- .1801E-01 LB HYDROGEN/LB COAL
.3645 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.4941 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 33.46 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 48.57 PERCENT

RUN NO. 289

SAMPLE NO. 3

DATE 8 -28 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	3.132	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9328	LB/HR	TOTAL ACCUMULATED WTS.		
HYDROGEN FLOW RATE	1.023	LB/HR	COAL FED	543.1	GRAMS
HYDROGEN VELOCITY	1.180	FT/SEC	CHAR	287.3	GRAMS
REACTOR TEMP.	900.0	DEG C	LIGHT OILS	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	BTX	0.	GRAMS
HYDROGEN PRESSURE	500.0	PSI	WATER	0.	GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	33.42

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.1880	2.087	3.507
CARBON DIOXIDE	0.	0.	0.
METHANE	3.383	37.48	36.06
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1500	9.983	7.794
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		49.55	47.36

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	9.98	11.9	0.	0.	0.	7.79
HYDROCARBON GASES	37.5	178.	0.	0.	0.	36.1
CARBON OXIDES	2.09	0.	9.81	0.	0.	3.51
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	42.8
TOTAL	49.5	198.	9.81	100.	100.	93.0

HYDROGEN CONSUMPTION-	.4090F-01	1.8 HYDROGEN/LB COAL
	.8277	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.5201 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION-	49.55	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	68.59	PERCENT

RUN NO. 289

SAMPLE NO. 4

DATE 8 -28 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	4.176	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9328	LB/HR	TOTAL ACCUMULATED WTS.		
HYDROGEN FLOW RATE	1.023	LB/HR	COAL FED	543.1	GRAMS
HYDROGEN VELOCITY	1.180	FT/SEC	CHAR	287.3	GRAMS
REACTOR TEMP.	900.0	DEG C	LIGHT OILS	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	BTX	0.	GRAMS
HYDROGEN PRESSURE	500.0	PSI	WATER	0.	GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	33.42

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.1000	1.110	1.865
CARBON DIOXIDE	0.	0.	0.
METHANE	2.330	25.81	24.84
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1150	7.653	5.976
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		34.58	32.68

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	7.65	9.11	0.	0.	0.	5.98
HYDROCARBON GASES	25.8	123.	0.	0.	0.	24.8
CARBON OXIDES	1.11	0.	5.22	0.	0.	1.87
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	42.8
TOTAL	34.6	140.	5.22	100.	100.	78.3

HYDROGEN CONSUMPTION-	.1653E-01	LB HYDROGEN/LB COAL
	.3344	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.4638	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	34.58	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	48.04	PERCENT

RUN NO. 290

SAMPLE NO. 1

DATE 8 -30 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	2.548	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9918	LB/HR	COAL FED	539.7	GRAMS
HYDROGEN FLOW RATE	.5274	LB/HR	CHAR	240.6	GRAMS
HYDROGEN VELOCITY	.1520	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	2000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	39.66

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	10.73	57.63	55.44
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.4900E-01	1.581	1.234
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		59.21	56.68

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	1.58	1.88	0.	0.	0.	1.23
HYDROCARBON GASES	57.6	274.	0.	0.	0.	55.4
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	32.7
TOTAL	59.2	284.	0.	100.	100.	92.2

HYDROGEN CONSUMPTION-	.7683E-01	LB HYDROGEN/LB COAL
	1.555	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	- .7398	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	57.81	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	89.29	PERCENT

RUN NO. 290

SAMPLE NO. 2

DATE 8 -30 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	5.096	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9918	LB/HR	COAL FED	539.7	GRAMS
HYDROGEN FLOW RATE	.5274	LB/HR	CHAR	240.6	GRAMS
HYDROGEN VELOCITY	.1520	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	2000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	39.66

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	14.85	79.75	76.73
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1600E-01	.5162	.4030
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		80.27	77.14

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	.516	.614	0.	0.	0.	.403
HYDROCARBON GASES	79.8	380.	0.	0.	0.	76.7
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	32.7
TOTAL	80.3	388.	0.	100.	100.	113.

HYDROGEN CONSUMPTION-	.1203	LB HYDROGEN/LB COAL
	2.435	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.9038	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	61.24	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	95.27	PERCENT

RUN NO. 290

SAMPLE NO. 3

DATE 8 -30 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	7.643	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9918	LB/HR	COAL FED	539.7	GRAMS
HYDROGEN FLOW RATE	.5274	LB/HR	CHAR	240.6	GRAMS
HYDROGEN VELOCITY	.1520	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	2000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	39.66

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.3060	1.647	2.767
CARBON DIOXIDE	0.	0.	0.
METHANE	12.47	66.97	64.43
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.6000E-02	.1936	.1511
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		68.81	67.35

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	.194	.230	0.	0.	0.	.151
HYDROCARBON GASES	67.0	319.	0.	0.	0.	64.4
CARBON OXIDES	1.65	0.	7.74	0.	0.	2.77
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	32.7
TOTAL	68.8	327.	7.74	100.	100.	103.

HYDROGEN CONSUMPTION-	.9473E-01	LB HYDROGEN/LB COAL
	1.917	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	- .7865	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	59.59	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	90.58	PERCENT

RUN NO. 290

SAMPLE NO. 4

DATE 8 -30 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	10.19	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9918	LB/HR	COAL FED	539.7	GRAMS
HYDROGEN FLOW RATE	.5274	LB/HR	CHAR	240.6	GRAMS
HYDROGEN VELOCITY	.1520	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	2000.	PSI			

TOTAL ACCUMULATED WTS.

COAL ANALYSIS, %

CARBON	59.30
HYDROGEN	4.180
OXYGEN	16.80
NITROGEN	1.230
SULFUR	.8100
ASH	17.68

CHAR ANALYSIS, %

0.
0.
0.
0.
0.
39.66

PRODUCT CONC. IN
GAS, MOLE %% CARBON CONV.
TO PRODUCT% HAF COAL CONV.
TO PRODUCT

CARBON MONOXIDE	.2880	1.550	2.604
CARBON DIOXIDE	0.	0.	0.
METHANE	10.41	55.91	53.79
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	0.	0.	0.
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL

57.46

56.39

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	0.	0.	0.	0.	0.	0.
HYDROCARBON GASES	55.9	266.	0.	0.	0.	50.0
CARBON OXIDES	1.55	0.	7.29	0.	0.	2.60
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	32.7
TOTAL	57.5	274.	7.29	100.	100.	91.9

HYDROGEN CONSUMPTION-	.7262E-01	LB HYDROGEN/LB COAL
	1.470	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-1.7097	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	57.46	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	87.16	PERCENT

RUN NO. 291

SAMPLE NO. 1

DATE 9 -12 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	1.504	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.123	LB/HR	COAL FED	602.9	GRAMS
HYDROGEN FLOW RATE	1.115	LB/HR	CHAR	298.3	GRAMS
HYDROGEN VELOCITY	.6290	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	875.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	875.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	35.73

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	1.550	15.54	14.96
ETHYLENE	0.	0.	0.
ETHANE	.1180	2.368	2.135
BENZENE	.1020	6.145	4.798
TOLUENE	.3000E-02	.2108	.1664
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		24.27	22.05

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	6.36	7.60	0.	0.	0.	4.96
HYDROCARBON GASES	17.9	82.5	0.	0.	0.	17.1
CARBON OXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	38.6
TOTAL	24.3	97.6	0.	100.	100.	63.5

HYDROGEN CONSUMPTION-	-.1009E-02	LB HYDROGEN/LB COAL
	-.2042E-01	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.4270	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	24.27	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	33.66	PERCENT

RUN NO. 291

SAMPLE NO. 2

DATE 9 -12 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	3.008	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.123	LB/HR	TOTAL ACCUMULATED WTS.	
HYDROGEN FLOW RATE	1.115	LB/HR	COAL FED	602.9 GRAMS
HYDROGEN VELOCITY	.6290	FT/SEC	CHAR	298.3 GRAMS
REACTOR TEMP.	875.0	DEG C	LIGHT OILS	0. GRAMS
PREHEAT TEMP.	875.0	DEG C	BTX	0. GRAMS
HYDROGEN PRESSURE	1000.	PSI	WATER	0. GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	35.73

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	0.	0.	0.
CARBON DIOXIDE	0.	0.	0.
METHANE	3.610	36.20	34.83
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1480	8.916	6.962
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		45.12	41.79

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	8.92	10.6	0.	0.	0.	6.96
HYDROCARBON GASES	36.2	172.	0.	0.	0.	34.8
CARBON DIOXIDES	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	38.6
TOTAL	45.1	191.	0.	100.	100.	83.3

HYDROGEN CONSUMPTION-	.3783E-01	LB HYDROGEN/LB COAL
	.7656	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.5552 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION-	45.12	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	65.52	PERCENT

DATE 9 -12 - 1979

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	4.511	SECONDS

COAL FEED RATE	1.123	LB/HR	COAL FED	602.9	GRAMS
HYDROGEN FLOW RATE	1.115	LB/HR	CHAR	298.3	GRAMS
HYDROGEN VELOCITY	.6290	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	875.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	875.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	35.73

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.1020	1.025	1.722
CARBON DIOXIDE	0.	0.	0.
METHANE	3.579	35.89	34.53
ETHYLENE	0.	0.	0.
ETHANE	.1220	2.448	2.207
BENZENE	0.	0.	0.
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		39.36	38.46

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	0.	0.	0.	0.	0.	0.
HYDROCARBON GASES	38.3	180.	0.	0.	0.	36.7
CARBON OXIDES	1.03	0.	4.82	0.	0.	1.72
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	38.6
TOTAL	39.4	187.	4.82	100.	100.	79.9

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HEAT OF REACTION- -.5859 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION-	39.36	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	59.23	PERCENT

RUN NO. 291

SAMPLE NO. 4

DATE 9 -12 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	6.015	SECONDS

NOMINAL CONDITIONS:

COAL FEED RATE	1.123	LB/HR	COAL FED	602.9	GRAMS
HYDROGEN FLOW RATE	1.115	LB/HR	CHAR	298.3	GRAMS
HYDROGEN VELOCITY	.6290	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	875.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	875.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.0100	0.
ASH	17.68	35.73

	PRODUCT CONCN. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% HAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.1700	1.709	2.870
CARBON DIOXIDE	0.	0.	0.
METHANE	3.410	34.20	32.90
ETHYLENE	0.	0.	0.
ETHANE	.9800E-01	1.966	1.773
BENZENE	0.	0.	0.
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL	37.87	37.55
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TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	HAF COAL
LIQUIDS	0.	0.	0.	0.	0.	0.
HYDROCARBON GASES	36.2	170.	0.	0.	0.	34.7
CARBON OXIDES	1.71	0.	8.03	0.	0.	2.87
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	38.6
TOTAL	37.9	177.	8.03	100.	100.	79.0

HYDROGEN CONSUMPTION-	.3234E-01	LB HYDROGEN/LB COAL
	.6545	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-1.5612	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	37.87	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	55.94	PERCENT

RUN NO. 292

SAMPLE NO. 1

DATE 9 -13 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	11.924	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.805	LB/HR	TOTAL ACCUMULATED WTS.	
HYDROGEN FLOW RATE	.6000	LB/HR	COAL FED	900.7 GRAMS
HYDROGEN VELOCITY	.3386	FT/SEC	CHAR	463.1 GRAMS
REACTOR TEMP.	875.0	DEG C	LIGHT OILS	0. GRAMS
PREHEAT TEMP.	875.0	DEG C	BTX	0. GRAMS
HYDROGEN PRESSURE	1000.	PSI	WATER	0. GRAMS

COAL ANALYSIS, %

CHAR ANALYSIS, %

CARBON	59.30		0.
HYDROGEN	4.180		0.
OXYGEN	16.80		0.
NITROGEN	1.230		0.
SULFUR	.8100		0.
ASH	17.68		34.39

PRODUCT CONC. IN
GAS, MOLE %% CARBON CONV.
TO PRODUCT% MAF COAL CONV.
TO PRODUCT

CARBON MONOXIDE	.9170	3.086	5.184
CARBON DIOXIDE	0.	0.	0.
METHANE	9.267	31.11	29.93
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.3390	6.837	5.338
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL

41.03

40.46

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
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LIQUIDS	6.84	8.14	0.	0.	0.	5.34
HYDROCARBON GASES	31.1	148.	0.	0.	0.	29.9
CARBON OXIDES	3.09	0.	14.5	0.	0.	5.18
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	41.0

TOTAL	41.0	164.	14.5	100.	100.	84.3
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HYDROGEN CONSUMPTION-	.2667E-01	LB HYDROGEN/LB COAL
	.5396	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.4778	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	41.03	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	55.47	PERCENT

RUN NO. 292

SAMPLE NO. 2

DATE 9 -13 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	3.848	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.805	LB/HR	TOTAL ACCUMULATED WTS.	
HYDROGEN FLOW RATE	.6000	LB/HR	COAL FED	900.7 GRAMS
HYDROGEN VELOCITY	.3386	FT/SEC	CHAR	463.1 GRAMS
REACTOR TEMP.	875.0	DEG C	LIGHT OILS	0. GRAMS
PREHEAT TEMP.	875.0	DEG C	BTX	0. GRAMS
HYDROGEN PRESSURE	1000.	PSI	WATER	0. GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	34.39

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.8930	3.005	5.048
CARBON DIOXIDE	0.	0.	0.
METHANE	11.71	39.31	37.82
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.3000	6.050	4.724
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		48.37	47.60

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	6.05	7.20	0.	0.	0.	4.72
HYDROCARBON GASES	39.3	187.	0.	0.	0.	37.8
CARBON OXIDES	3.00	0.	14.1	0.	0.	5.05
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	41.0
TOTAL	48.4	202.	14.1	100.	100.	91.4

HYDROGEN CONSUMPTION-	.4260E-01	LB HYDROGEN/LB COAL
	.8621	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.5417	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	48.37	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	67.45	PERCENT

RUN NO. 292

SAMPLE NO. 3

DATE 9 -13 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	5.772	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.805	LB/HR	COAL FED	900.7	GRAMS
HYDROGEN FLOW RATE	.6000	LB/HR	CHAR	463.1	GRAMS
HYDROGEN VELOCITY	.3386	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	875.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	875.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	34.39

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	1.219	4.102	6.891
CARBON DIOXIDE	0.	0.	0.
METHANE	12.80	42.97	41.35
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.2240	4.518	3.527
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL	51.59	51.76
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TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	4.52	5.38	0.	0.	0.	3.53
HYDROCARBON GASES	43.0	205.	0.	0.	0.	41.3
CARBON OXIDES	4.10	0.	19.3	0.	0.	6.89
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	41.0
TOTAL	51.6	218.	19.3	100.	100.	95.6

HYDROGEN CONSUMPTION-	.4912E-01	LB HYDROGEN/LB COAL
	.9940	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.5572	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	51.59	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	71.59	PERCENT

RUN NO. 292

SAMPLE NO. 4

DATE 9 -13 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 7.696 SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.		
COAL FEED RATE	1.805	LB/HR	COAL FED	900.7	GRAMS
HYDROGEN FLOW RATE	.6000	LB/HR	CHAR	463.1	GRAMS
HYDROGEN VELOCITY	.3386	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	875.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	875.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	34.39

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	1.283	4.317	7.252
CARBON DIOXIDE	0.	0.	0.
METHANE	12.85	43.14	41.51
ETHYLENE	0.	0.	0.
ETHANE	0.	0.	0.
BENZENE	.1380	2.783	2.173
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		50.24	50.93

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	2.78	3.31	0.	0.	0.	2.17
HYDROCARBON GASES	43.1	205.	0.	0.	0.	41.5
CARBON OXIDES	4.32	0.	20.3	0.	0.	7.25
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	41.0
TOTAL	50.2	216.	20.3	100.	100.	94.8

HYDROGEN CONSUMPTION- .4859E-01 LB HYDROGEN/LB COAL
.9833 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.5633 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 50.24 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 70.09 PERCENT

RUN NO. 296

SAMPLE NO. 1

DATE 9 -20 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	2.414	SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.	
COAL FEED RATE	1.546	LB/HR	COAL FED	830.3 GRAMS
HYDROGEN FLOW RATE	1.071	LB/HR	CHAR	387.0 GRAMS
HYDROGEN VELOCITY	.6172	FT/SEC	LIGHT OILS	0. GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0. GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0. GRAMS
HYDROGEN PRESSURE	1000.	PSI		

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	37.93

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.2590	1.816	3.050
CARBON DIOXIDE	0.	0.	0.
METHANE	4.393	30.73	29.56
ETHYLENE	0.	0.	0.
ETHANE	.3600	5.038	4.542
BENZENE	.1550	6.513	5.085
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		44.09	42.24

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	6.51	7.75	0.	0.	0.	5.09
HYDROCARBON GASES	35.8	164.	0.	0.	0.	34.1
CARBON OXIDES	1.82	0.	8.54	0.	0.	3.05
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	35.1
TOTAL	44.1	180.	8.54	100.	100.	80.2

HYDROGEN CONSUMPTION-	.3326E-01	LB HYDROGEN/LB COAL
	.6730	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	- .5067	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	44.09	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	61.28	PERCENT

RUN NO. 296

SAMPLE NO. 2

DATE 9 -20 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	5.015	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.546	LB/HR	COAL FED	830.3	GRAMS
HYDROGEN FLOW RATE	1.017	LB/HR	CHAR	387.0	GRAMS
HYDROGEN VELOCITY	.5863	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.270	0.
SULFUR	.8100	0.
ASH	17.68	37.93

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.3490	2.324	3.904
CARBON DIOXIDE	0.	0.	0.
METHANE	6.984	46.40	44.64
ETHYLENE	0.	0.	0.
ETHANE	.1220	1.622	1.462
BENZENE	.1870	7.463	5.827
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		57.81	55.84

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	7.46	8.88	0.	0.	0.	5.83
HYDROCARBON GASES	48.0	227.	0.	0.	0.	46.1
CARBON OXIDES	2.32	0.	10.9	0.	0.	3.90
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	35.1
TOTAL	57.8	243.	10.9	100.	100.	93.8

HYDROGEN CONSUMPTION-	.5983E-01	LB HYDROGEN/LB COAL
	1.211	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.5968	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	57.51	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	81.68	PERCENT

RUN NO. 296 SAMPLE NO. 3 DATE 9 -20 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 7.242 SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.		
COAL FEED RATE	1.546	LB/HR	COAL FED	830.3	GRAMS
HYDROGEN FLOW RATE	1.071	LB/HR	CHAR	387.0	GRAMS
HYDROGEN VELOCITY	.6172	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	37.93

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.3900	2.734	4.593
CARBON DIOXIDE	.7000E-02	.4908E-01	.1295
METHANE	6.275	43.89	42.23
ETHYLENE	0.	0.	0.
ETHANE	.7570E-01	1.059	.9552
BENZENE	.1250	5.252	4.101
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		52.98	52.01

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	5.25	6.25	0.	0.	0.	4.10
HYDROCARBON GASES	44.9	213.	0.	0.	0.	43.2
CARBON OXIDES	2.78	0.	13.3	0.	0.	4.72
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	35.1
TOTAL	53.0	227.	13.3	100.	100.	90.0

HYDROGEN CONSUMPTION- .5289E-01 LB HYDROGEN/LB COAL
 1.070 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.5808 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 52.98 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 75.19 PERCENT

RUN NO. 296

SAMPLE NO. 4

DATE 9 -20 - 1979

COAL TYPE- NEW MEXICO SUB-BITUMINOUS

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	9.656	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	1.546	LB/HR	TOTAL ACCUMULATED WTS.		
HYDROGEN FLOW RATE	1.071	LB/HR	COAL FED	830.3	GRAMS
HYDROGEN VELOCITY	.6172	FT/SEC	CHAR	387.0	GRAMS
REACTOR TEMP.	900.0	DEG C	LIGHT OILS	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	BTX	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI	WATER	0.	GRAMS

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	59.30	0.
HYDROGEN	4.180	0.
OXYGEN	16.80	0.
NITROGEN	1.230	0.
SULFUR	.8100	0.
ASH	17.68	37.93

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.5130	3.596	6.041
CARBON DIOXIDE	0.	0.	0.
METHANE	6.300	44.06	42.40
ETHYLENE	0.	0.	0.
ETHANE	.4940E-01	.6913	.6233
BENZENE	.9500E-01	3.992	3.117
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		52.34	52.18

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	3.99	4.75	0.	0.	0.	3.12
HYDROCARBON GASES	44.8	212.	0.	0.	0.	43.0
CARBON OXIDES	0.60	0.	16.9	0.	0.	6.04
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.31	0.	100.	0.	1.81
HYDROGEN SULFIDE	0.	1.21	0.	0.	100.	1.05
CHAR	0.	0.	0.	0.	0.	35.1
TOTAL	52.3	225.	16.9	100.	100.	90.2

HYDROGEN CONSUMPTION-	.5206E-01	LB HYDROGEN/LB COAL
	1.054	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.5735	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	52.34	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	73.69	PERCENT

RUN NO. 297

SAMPLE NO. 1

DATE 9 -26 - 1979

COAL TYPE- NA2 CO3 TREATED NEW MEXICO SUB-BITUM.

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 5.126 SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.		
COAL FEED RATE	3.338	LB/HR	COAL FED	630.9	GRAMS
HYDROGEN FLOW RATE	.8242	LB/HR	CHAR	359.2	GRAMS
HYDROGEN VELOCITY	.4752	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	53.90	0.
HYDROGEN	4.020	0.
OXYGEN	13.89	0.
NITROGEN	1.230	0.
SULFUR	.8800	0.
ASH	26.05	45.75

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	3.059	8.413	14.30
CARBON DIOXIDE	.3750	1.031	2.755
METHANE	17.30	47.46	46.20
ETHYLENE	0.	0.	0.
ETHANE	.5840E-01	.3206	.2925
BENZENE	.3990	6.577	5.196
TOLUENE	.1400E-02	.2692E-01	.2150E-01
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		63.83	68.77

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	6.60	7.43	0.	0.	0.	5.22
HYDROCARBON GASES	47.8	215.	0.	0.	0.	46.5
CARBON OXIDES	9.44	0.	54.2	0.	0.	17.1
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.56	0.	100.	0.	2.02
HYDROGEN SULFIDE	0.	1.37	0.	0.	100.	1.26
CHAR	0.	0.	0.	0.	0.	41.8

TOTAL	63.8	230.	54.2	100.	100.	114.
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HYDROGEN CONSUMPTION-	.5227E-01	LB HYDROGEN/LB COAL
	1.164	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -4.053 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION-	58.72	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	67.83	PERCENT

RUN NO. 297

SAMPLE NO. 2

DATE 9 -26 - 1979

COAL TYPE- NA2 CO3 TREATED NEW MEXICO SUB-BITUM.

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	4.559	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	3.338	LB/HR	COAL FED	630.9	GRAMS
HYDROGEN FLOW RATE	1.077	LB/HR	CHAR	359.2	GRAMS
HYDROGEN VELOCITY	.6209	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	53.90	0.
HYDROGEN	4.020	0.
OXYGEN	13.89	0.
NITROGEN	1.260	0.
SULFUR	.8800	0.
ASH	26.05	45.75

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	1.610	5.785	9.833
CARBON DIOXIDE	.1440	.5175	1.382
METHANE	9.718	34.84	33.92
ETHYLENE	0.	0.	0.
ETHANE	.3800E-01	.2726	.2487
BENZENE	.2370	5.104	4.032
TOLUENE	.8000E-03	.2010E-01	.1605E-01
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		40.54	49.43

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	5.12	5.77	0.	0.	0.	4.05
HYDROCARBON GASES	35.1	158.	0.	0.	0.	34.2
CARBON OXIDES	6.30	0.	35.3	0.	0.	11.2
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.72	0.	100.	0.	2.07
HYDROGEN SULFIDE	0.	1.37	0.	0.	100.	1.26
CHAR	0.	0.	0.	0.	0.	41.8
TOTAL	46.5	172.	35.3	100.	100.	94.5

HYDROGEN CONSUMPTION-	.2877E-01	LB HYDROGEN/LB COAL
	.6405	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION= -.3733 KJAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION-	46.54	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	54.42	PERCENT

RUN NO. 298

SAMPLE NO. 1

DATE 9 -27 - 1979

COAL TYPE- NA2 CO3 TREATED NEW MEXICO SUB-BITUM.

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	1.556	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9931	LB/HR	COAL FED	616.2	GRAMS
HYDROGEN FLOW RATE	1.023	LB/HR	CHAR	333.8	GRAMS
HYDROGEN VELOCITY	.5899	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS,%	CHAR ANALYSIS,%
CARBON	53.90	0.
HYDROGEN	4.020	0.
OXYGEN	13.89	0.
NITROGEN	1.260	0.
SULFUR	.8800	0.
ASH	26.05	48.09

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.1380	1.583	2.691
CARBON DIOXIDE	0.	0.	0.
METHANE	2.438	27.91	27.17
ETHYLENE	0.	0.	0.
ETHANE	.2630	6.024	5.496
BENZENE	.9700E-01	6.671	5.270
TOLUENE	.4000E-03	.3209E-01	.2563E-01
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		42.22	40.65

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	6.70	7.54	0.	0.	0.	5.30
HYDROCARBON GASES	33.9	146.	0.	0.	0.	32.7
CARBON OXIDES	1.58	0.	8.18	0.	0.	2.69
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.72	0.	100.	0.	2.07
HYDROGEN SULFIDE	0.	1.37	0.	0.	100.	1.26
CHAR	0.	0.	0.	0.	0.	38.0
TOTAL	42.2	162.	8.18	100.	100.	82.0

HYDROGEN CONSUMPTION-	.2475E-01	LB HYDROGEN/LB COAL
	.5510	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.4026	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	42.22	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	53.05	PERCENT

RUN NO. 298

SAMPLE NO. 2

DATE 9 -27 - 1979

COAL TYPE- NA2 CO3 TREATED NEW MEXICO SUB-BITUM.

COAL RESIDENCE TIME-MEASURED 0. SECONDS
CALCULATED 3.112 SECONDS

NOMINAL CONDITIONS			TOTAL ACCUMULATED WTS.		
COAL FEED RATE	.9931	LB/HR	COAL FED	616.2	GRAMS
HYDROGEN FLOW RATE	1.023	LB/HR	CHAR	333.8	GRAMS
HYDROGEN VELOCITY	.5899	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	53.90	0.
HYDROGEN	4.020	0.
OXYGEN	12.89	0.
NITROGEN	1.260	0.
SULFUR	.8800	0.
ASH	26.05	48.09

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.1890	2.169	3.686
CARBON DIOXIDE	0.	0.	0.
METHANE	3.316	37.96	36.96
ETHYLENE	0.	0.	0.
ETHANE	.4800E-01	1.099	1.003
BENZENE	.1150	7.909	6.248
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		49.14	47.89

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	7.91	8.90	0.	0.	0.	6.25
HYDROCARBON GASES	39.1	175.	0.	0.	0.	38.0
CARBON OXIDES	2.17	0.	11.2	0.	0.	3.69
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.72	0.	100.	0.	2.07
HYDROGEN SULFIDE	0.	1.37	0.	0.	100.	1.26
CHAR	0.	0.	0.	0.	0.	30.0
TOTAL	49.1	192.	11.2	100.	100.	89.3

HYDROGEN CONSUMPTION- .3680E-01 LB HYDROGEN/LB COAL
.8192 ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION- -.4418 KCAL/GRAM OF COAL FED

EFFECTIVE CARBON CONVERSION- 49.14 PERCENT
EFFECTIVE ENERGY EFFICIENCY- 62.45 PERCENT

RUN NO. 298

SAMPLE NO. 3

DATE 9 -27 - 1979

COAL TYPE- NA2 CO3 TREATED NEW MEXICO SUB-BITUM.

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	4.669	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9931	LB/HR	COAL FED	616.2	GRAMS
HYDROGEN FLOW RATE	1.023	LB/HR	CHAR	333.8	GRAMS
HYDROGEN VELOCITY	.5899	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	53.90	0.
HYDROGEN	4.020	0.
OXYGEN	13.89	0.
NITROGEN	1.260	0.
SULFUR	.8800	0.
ASH	26.05	48.09

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.4350	4.991	8.484
CARBON DIOXIDE	.9000E-02	.1033	.2758
METHANE	3.500	40.07	39.01
ETHYLENE	0.	0.	0.
ETHANE	.2100E-01	.4810	.4388
BENZENE	.1050	7.221	5.705
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.

TOTAL	52.86	53.91
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TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	7.22	0.12	0.	0.	0.	5.70
HYDROCARBON GASES	40.5	182.	0.	0.	0.	39.4
CARBON OXIDES	5.09	0.	26.9	0.	0.	8.76
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.72	0.	100.	0.	2.07
HYDROGEN SULFIDE	0.	1.37	0.	0.	100.	1.26
CHAR	0.	0.	0.	0.	0.	38.0
TOTAL	52.9	198.	26.9	100.	100.	95.3

HYDROGEN CONSUMPTION-	.3946E-01	LB HYDROGEN/LB COAL
	.8784	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.4139	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	52.86	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	64.05	PERCENT

RUN NO. 298

SAMPLE NO. 4

DATE 9 -27 - 1979

COAL TYPE- NA2 CO3 TREATED NEW MEXICO SUB-BITUM.

COAL RESIDENCE TIME-MEASURED	0.	SECONDS
CALCULATED	6.225	SECONDS

NOMINAL CONDITIONS

COAL FEED RATE	.9931	LB/HR	COAL FED	616.2	GRAMS
HYDROGEN FLOW RATE	1.023	LB/HR	CHAR	333.8	GRAMS
HYDROGEN VELOCITY	.5899	FT/SEC	LIGHT OILS	0.	GRAMS
REACTOR TEMP.	900.0	DEG C	BTX	0.	GRAMS
PREHEAT TEMP.	900.0	DEG C	WATER	0.	GRAMS
HYDROGEN PRESSURE	1000.	PSI			

TOTAL ACCUMULATED WTS.

	COAL ANALYSIS, %	CHAR ANALYSIS, %
CARBON	53.90	0.
HYDROGEN	4.020	0.
OXYGEN	10.89	0.
NITROGEN	1.260	0.
SULFUR	.8800	0.
ASH	26.05	48.09

	PRODUCT CONC. IN GAS, MOLE %	% CARBON CONV. TO PRODUCT	% MAF COAL CONV. TO PRODUCT
CARBON MONOXIDE	.4830	5.542	9.420
CARBON DIOXIDE	0.	0.	0.
METHANE	3.390	38.81	37.78
ETHYLENE	0.	0.	0.
ETHANE	.1250E-01	.2863	.2612
BENZENE	.8340E-01	5.736	4.531
TOLUENE	0.	0.	0.
XYLENE	0.	0.	0.
LIGHT OIL	0.	0.	0.
WATER	0.	0.	0.
TOTAL		50.37	51.99

TOTAL MATERIAL BALANCE, %

	CARBON	HYDROGEN	OXYGEN	NITROGEN	SULFUR	MAF COAL
LIQUIDS	5.74	6.45	0.	0.	0.	4.53
HYDROCARBON GASES	39.1	176.	0.	0.	0.	38.0
CARBON OXIDES	5.54	0.	28.6	0.	0.	9.42
WATER	0.	0.	0.	0.	0.	0.
AMMONIA	0.	6.72	0.	100.	0.	2.07
HYDROGEN SULFIDE	0.	1.37	0.	0.	100.	1.26
CHAR	0.	0.	0.	0.	0.	38.0

TOTAL	50.4	190.	28.6	100.	100.	93.4
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HYDROGEN CONSUMPTION-	.3624E-01	LB HYDROGEN/LB COAL
	.8069	ATOM HYDROGEN/ATOM CARBON

HEAT OF REACTION-	-.4044	KCAL/GRAM OF COAL FED
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EFFECTIVE CARBON CONVERSION-	50.37	PERCENT
EFFECTIVE ENERGY EFFICIENCY-	60.65	PERCENT

REACTION MODELLING AND CORRELATION
FOR FLASH HYDROLYSIS OF LIGNITE

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Abstract

A reaction model, based on a single coal particle surrounded by H_2 gas, is developed for flash hydrolysis of lignite. Conversion data from flash hydrolysis experiments at various pressures, temperatures, particle residence times and gas residence times are correlated to obtain one set of kinetic parameters. The results of the non-linear regression analysis show that a first order chemical reaction model with respect to C conversion, with a production and a decomposition step for each of CH_4 , C_2H_6 , BTX and Oils, satisfactorily describes the dilute phase flash hydrolysis of lignite.

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REACTION MODELLING AND CORRELATION
FOR FLASH HYDROLYSIS OF LIGNITE

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Introduction

Flash hydrolysis is a short residence time gas phase non-catalytic coal hydrogenation process in which pulverized coal is contacted with hydrogen at elevated pressure and rapidly heated obtaining directly liquid and gaseous hydrocarbons. The data used (1) is from experiments conducted in a 2 lb/hr, 1" I.D. x 8 ft long entrained tubular reactor in the range of 500° to 900°C temperature, 500 to 4000 psi pressure and 1 to 10 seconds coal particle residence time for a lignite coal. An on-line process gas chromatograph analyzed for 10 chemical components every eight minutes with sample taps every two feet along the length of the reactor and down stream of the liquid product traps.(2)

Development of Model

The chemical reaction between solid carbon atoms within the coal particle and H_2 is assumed to be the rate controlling step. The three-step reaction model previously reported (2,3) is modified to include an additional step for production and decomposition of the oils. The flash hydrolysis is assumed to take place via the following reaction steps:

Carbon oxides are not considered in the model because of their relatively small yields. The amount of methane produced from Oils and BTX is assumed to be small compared to that produced directly from coal and it is neglected in the $[\text{CH}_4]$ balance, equation (2), for simplification. The reactions are considered to be first order with respect to fraction of C remaining in coal as well as converted to hydrocarbons and mth order with respect to H_2 partial pressure. The rate equations can be written as follows:

$$-u_s \frac{d[\text{C}]}{dx} = (k_1 + k_2 + k_3 + k_4) P_{\text{H}_2}^m[\text{C}] \quad (1)$$

$$u_g \frac{d[\text{CH}_4]}{dx} = k_1 P_{\text{H}_2}^m[\text{C}] - k_5 P_{\text{H}_2}^m[\text{CH}_4] \quad (2)$$

$$u_g \frac{d[\text{C}_2\text{H}_6]}{dx} = k_2 P_{\text{H}_2}^m[\text{C}] - k_6 P_{\text{H}_2}^m[\text{C}_2\text{H}_6] \quad (3)$$

$$u_g \frac{d[\text{BTX}]}{dx} = k_3 P_{\text{H}_2}^m[\text{C}] - k_7 P_{\text{H}_2}^m[\text{BTX}] \quad (4)$$

$$u_g \frac{d[\text{Oils}]}{dx} = k_4 P_{\text{H}_2}^m[\text{C}] - k_8 P_{\text{H}_2}^m[\text{Oils}] \quad (5)$$

*non-reactive elemental carbon contained in the char product

where [C] = fraction of C remaining in coal
 [CH₄] = fraction of C converted to CH₄
 [C₂H₆] = fraction of C converted to C₂H₆
 [BTX] = fraction of C converted to benzene, toluene and xylene
 [Oils] = fraction of C converted to Oils
 P_{H₂} = partial pressure of H₂ in atms.
 u_g = gas velocity
 u_s = particle velocity
 x = distance along the length of the reactor

The standard pressure was considered to be one atmosphere. The experimental data correlated was obtained from dilute phase operation in an excess of hydrogen atmosphere, so the partial pressure of hydrogen was considered to be approximately equal to the total pressure and was assumed to be constant along the length of the reactor.

Assuming Arrhenius behavior of the rate constant with temperature,

$$k_i = k_{i0} e^{-E_i/RT} \quad \text{for all } i$$

For isothermal conditions, the differential equations can be solved analytically to obtain the following relationships:

$$[CH_4] = \frac{k_1}{u_{gs} k_{1234} - k_5} \left[e^{-k_5 P_{H_2}^m \frac{t_s}{u_{gs}}} - e^{-k_{1234} P_{H_2}^m t_s} \right]$$

$$[C_2H_6] = \frac{k_2}{u_{gs} k_{1234} - k_6} \left[e^{-k_6 P_{H_2}^m \frac{t_s}{u_{gs}}} - e^{-k_{1234} P_{H_2}^m t_s} \right]$$

$$[BTX] = \frac{k_3}{u_{gs} k_{1234} - k_7} \left[e^{-k_7 P_{H_2}^m \frac{t_s}{u_{gs}}} - e^{-k_{1234} P_{H_2}^m t_s} \right]$$

$$[Oils] = \frac{k_4}{u_{gs} k_{1234} - k_8} \left[e^{-k_8 P_{H_2}^m \frac{t_s}{u_{gs}}} - e^{-k_{1234} P_{H_2}^m t_s} \right]$$

Here, $k_{1234} = k_1 + k_2 + k_3 + k_4$, $u_{gs} = u_g/u_s$ and t_s is the solids residence time

Regression Technique

A minimization program 'MINUIT', developed by James and Roos (4) was used on CDC 7600 to best fit the equations to the data and find the unknown parameters. The function minimized was the weighted sum of squares of deviations of experimental values from calculated values, i.e., $\sum_i W_i \sum_j (Y_{ijexp} - Y_{ijcal})^2$. Three different minimization algorithms are available in MINUIT, which can be used separately or together by using different commands. All the techniques have been used for the correlation.

In the Monte Carlo technique, the function is evaluated a given number of times with all of the variable parameter values chosen randomly according to uniform distribution at the best previous values with widths equal to the starting parameter errors.

In the Simplex method of Nelder and Mead (5), the information about a function of n variables consists of $n+1$ points, forming a simplex, in n -dimensional space. A Simplex is the smallest n -dimensional geometrical figure with $n+1$ corners: a triangle for $n=2$, a tetrahedron for $n=3$, etc. The initial simplex is formed by the starting point and the calculated n local minima along each co-ordinate axis. The point at

which the function is maximum is replaced by a new point by using any of the three operations - reflection, contraction and expansion. This process is continued until a minimum is reached such that the standard error of the function is less than a preset value.

In the Variable Metric method of Fletcher (6), a local function minimization is performed using a gradient supplied by the user or calculated by a subroutine in the program. A 'Newton's step' is taken using the starting values of the parameters, the first derivatives and the covariance matrix. A linear search is performed along this direction. The gradient is calculated and the covariance matrix is "corrected" for the new point. These steps are repeated until some convergence criteria are satisfied.

A single object function was formulated for the four dependent variables - conversion to CH_4 , conversion to C_2H_6 , conversion to BTX and conversion to Oils.

$$F = W_1 \sum ([\text{CH}_4]_{\text{exp}} - [\text{CH}_4]_{\text{cal}})^2 + \\ W_2 \sum ([\text{C}_2\text{H}_6]_{\text{exp}} - [\text{C}_2\text{H}_6]_{\text{cal}})^2 + \\ W_3 \sum ([\text{BTX}]_{\text{exp}} - [\text{BTX}]_{\text{cal}})^2 + \\ W_4 \sum ([\text{Oils}]_{\text{exp}} - [\text{Oils}]_{\text{cal}})^2$$

Bhatt (7) used a weighting factor inversely proportional to the variance of each dependent variable for correlation of his hydropyrolysis data. This is supported by first considering the definition of the correlation coefficient

$$r = \sqrt{1 - \frac{\sum (Y - Y_{\text{cal}})^2}{\sum (Y - \bar{Y})^2}}. \text{ Then, to maximize } r, \text{ the fraction } \frac{\sum (Y - Y_{\text{cal}})^2}{\sum (Y - \bar{Y})^2} \text{ should}$$

be minimized. To take into account the variable number of data points available for the dependent variables, the above fraction was multiplied by N_i , the number of data points for i^{th} component. The weighting factors can then be represented as follows:

$$W_1 = \frac{N_1}{\sum ([CH_4]_{\text{exp}} - [\overline{CH_4}]_{\text{exp}})^2},$$

$$W_2 = \frac{N_2}{\sum ([C_2H_6]_{\text{exp}} - [\overline{C_2H_6}]_{\text{exp}})^2},$$

$$W_3 = \frac{N_3}{\sum ([BTX]_{\text{exp}} - [\overline{BTX}]_{\text{exp}})^2},$$

$$W_4 = \frac{N_4}{\sum ([Oils]_{\text{exp}} - [\overline{Oils}]_{\text{exp}})^2}.$$

Results of Regression Analysis

The three methods of 'MINUIT' were used simultaneously to minimize the object function F . For simplification, it was assumed that $E_1=E_2=E_3=E_4=E$. A rationale for this is that during decomposition, coal is in equilibrium with the same transition complex regardless of the final products. Data from 83 experimental runs, with H_2 /coal ratio of about 1:1 by weight, using North Dakota Lignite, were correlated. For these runs, 228 data points corresponding to different locations in the reactor were available for CH_4 , C_2H_6 and BTX concentrations measured by an on-line gas chromatograph. Oil concentrations were obtained from the total amount of oils collected in the condensers located downstream of the reactor. Oil data was available for 13 runs. The data correlated is tabulated in Table 1.

Different starting points were used to obtain the minimum. Large enough initial step sizes were used to avoid convergence at local minimums. A typical computer program and its output are given in the Appendix.

The results obtained for $N_1=N_2=N_3=N=228$ and $N_4=13$ are tabulated in Tables 2 and 3. The standard error of 10.9% C conversion for CH_4 seems to be high but because of higher amounts and variation in the CH_4 data, a correlation coefficient of 0.85 is obtained which indicates good correlation.

Figures 1 to 4 are plots of the calculated conversions vs. experimental conversions. The calculated values are in good agreement with the experimental values for CH_4 , C_2H_6 , and BTX conversions. More data points are desirable for oil conversion correlation.

Using student's t statistic, hypothesis: $\rho=0$ was tested. It was found that the hypothesis: $\rho=0$ can be rejected at 0.005 significance level. It therefore appears almost certain that the % C conversions to CH_4 , C_2H_6 , BTX and Oils can be related to reaction temperature, H_2 partial pressure, particle residence time and gas residence time by the correlations.

Using Fisher's Z transformation, the 95% confidence limits for the overall correlation coefficient were obtained.

$$0.78 < r < 0.87 \text{ at } 95\% \text{ confidence level}$$

A sensitivity analysis was performed on the correlation. The kinetic parameters and correlation coefficients were estimated for $N=228$, 218, 208 and 198 with $N_4=13, 12, 11$ and 10 respectively. The correlation coefficients obtained are tabulated in Table 4. The correlation

coefficients do not show any significant change for CH_4 , C_2H_6 and BTX conversions ($< 3\%$ variation). The correlation for Oils is found to become slightly weaker ($< 10\%$ variation in correlation coefficient) as number of data points are reduced. The smaller number of data points available for oil conversion seems to be the reason for this.

Discussion of Results and Conclusions

The results of regression analysis show that a first order chemical reaction model with respect to fractional C conversion, with a production and a decomposition step for each of CH_4 , C_2H_6 , BTX and Oils, satisfactorily describes the dilute phase flash hydropyrolysis of lignite.

The activation energies estimated were found to be $> 20,000$ cal/gmole. This justifies the assumption that chemical reaction is the rate controlling step. The activation energy for the initial formation of hydrocarbons was found to be $42,700$ cal/gmole with an estimated error of about 80 cal/gmole, which is very small. This indicates that the error involved in the assumption, that all the activation energies for the initial formation of hydrocarbons from coal are the same ($E_1=E_2=E_3=E_4=E$) is probably small. Also, the value of this activation energy is comparable to the mean activation energy of $48,700$ cal/gmole found by Anthony (8) for devolatilization of Montana Lignite and the activation energy of $48,900$ cal/gmole found by Bhatt (7) for hydropyrolysis of North Dakota Lignite. Both Anthony and Bhatt used a few mg of coal contained in an electrically heated metal screen envelope and the gas residence time (time at reaction temperature) was negligible. Their experimental set ups were very different from the flash hydropyrolysis 2 lb/hr downflow unit which has

gas residence times higher than coal residence time. The power of the hydrogen partial pressure, m was found to be about +0.14. This indicates, in general, increase in % C conversion to hydrocarbons with increase in hydrogen partial pressure.

The correlation, with overall correlation coefficient 0.83, having 95% confidence limits of 0.78 and 0.87, is considered good. This is particularly true for CH_4 , C_2H_6 and BTX conversions, for which large number of data points ($N=228$) are available. More experimental data for oil conversion is desirable to get a better correlation for oils.

The mechanism and rate expressions developed satisfactorily represent the experimental data and hence can be used for scale-up and reactor design.

The model developed might be applicable to other types of coal while the regression technique used is applicable to any experimental data for correlation.

Nomenclature

[BTX]	fraction of carbon converted to benzene, toluene and xylene
$\overline{[BTX]}_{\text{exp}}$	mean of $[BTX]_{\text{exp}}$
[C]	fraction of carbon remaining in coal
[CH ₄]	fraction of carbon converted to methane
$[CH_4]_{\text{exp}}$	mean of $[CH_4]_{\text{exp}}$
[C ₂ H ₆]	fraction of carbon converted to ethane
$\overline{[C_2H_6]}_{\text{exp}}$	mean of $[C_2H_6]_{\text{exp}}$
E, E _i	activation energy, cal/gmole
F	object function
k _i	rate constant, /sec
k _{io}	pre-exponential factor, /sec
k ₁₂₃₄	sum k ₁ +k ₂ +k ₃ +k ₄ , /sec
m	order of reaction with respect to H ₂ gas
N, N _i	number of data points
[Oils]	fraction of carbon converted to oils
$\overline{[Oils]}_{\text{exp}}$	mean of $[Oils]_{\text{exp}}$
P _{H2}	partial pressure of hydrogen, psi
r	sample correlation coefficient
R	gas constant, cal/gmole ^o K
t _s	solid residence time, sec
T	temperature (absolute), ^o K
u _g	gas velocity, ft/sec

u_s	solid velocity, ft/sec
u_{gs}	ratio u_g/u_s
W_i	weighting factors
X	distance along the length of the reaction, ft
Y, Y_{ij}	dependent variable
$\bar{Y}$	mean of Y

Greek letter

ρ	theoretical population coefficient of correlation
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Subscripts

cal	calculated value
exp	experimental value
g	gas
i	ith component
s	solid

units: L - length, M - mass, t - time, T - temperature; if no units, quantity is dimensionless.

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TABLE 1

CARBON CONVERSION DATA AT VARIOUS OPERATING CONDITIONS

RUN NO.	H ₂ VEL., FT/SEC	TEMP., DEG C	PRESSURE PSI	REACTOR LENGTH, FT.	% C CONV. TO CH ₄	% C CONV. TO C ₂ H ₆	% C CONV. TO C ₆ H ₆	% C CONV. TO C ₇ H ₈	% C CONV. TO C ₈ H ₁₀	% C CONV. TO OILS	COAL RES. TIME, SEC
50A	.3800	300.0	1500.	8.000	19.27	5.510	7.430	0.	0.	-0.	6.800
50B	.2200	300.0	2500.	8.000	45.29	4.480	3.530	0.	0.	-0.	8.800
51A	.2600	300.0	2000.	8.000	31.73	4.730	7.520	0.	0.	-0.	8.100
51B	.1700	300.0	3000.	8.000	50.62	5.760	2.030	0.	0.	-0.	9.500
52	.1810	750.0	3000.	8.000	32.64	9.550	9.580	0.	0.	-0.	9.500
53	.1750	775.0	3000.	8.000	31.04	8.720	6.180	0.	0.	-0.	9.500
55	.1600	800.0	3000.	8.000	53.78	4.500	7.500	0.	0.	-0.	9.500
56	.1430	750.0	3000.	8.000	18.28	7.270	7.410	0.	0.	-0.	10.00
57	.1470	740.0	3000.	8.000	21.07	10.23	10.02	0.	0.	-0.	9.900
58	.2010	750.0	2000.	8.000	27.45	5.470	7.580	0.	0.	-0.	8.700
59	.2950	750.0	1500.	8.000	24.02	6.770	7.290	0.	0.	-0.	7.400
60A	.1800	900.0	2500.	8.000	54.56	1.900	7.100	0.	0.	-0.	9.200
60B	.1800	800.0	2500.	2.000	50.26	2.080	3.710	0.	0.	-0.	2.300
61A	.1650	750.0	2500.	8.000	26.86	8.260	8.930	0.	0.	-0.	9.600
61B	.1650	750.0	2500.	2.000	20.25	7.080	7.700	0.	0.	-0.	2.400
62	.1340	750.0	3000.	2.000	37.92	9.160	8.070	0.	0.	-0.	2.500
63	.4400	750.0	1000.	8.000	14.29	5.930	6.180	0.	0.	-0.	6.400
64	1.358	750.0	500.0	8.000	10.00	4.470	3.880	0.	0.	-0.	3.600
65	.4020	700.0	1000.	8.000	10.40	5.400	3.740	.6010	0.	-0.	6.400
66	.4400	800.0	1000.	8.000	22.92	2.460	6.130	0.	0.	-0.	6.400
067A	.8650	800.0	500.0	3.000	12.43	3.225	4.367	0.	0.	-0.	4.600
067B	.8650	800.0	500.0	2.000	19.60	3.970	3.705	.5610E-01	0.	-0.	1.150
068A	.8226	700.0	500.0	8.000	7.112	3.977	1.496	.6251	0.	-0.	4.700
068B	.8226	700.0	500.0	2.000	12.50	4.925	2.022	.7084	.1447	-0.	1.180
72	.1650	750.0	2500.	8.000	22.08	10.16	9.380	.9900E-01	0.	-0.	9.500
074A	.4219	800.0	1000.	2.000	25.85	4.666	8.908	.1256	0.	-0.	1.650
074B	.4219	800.0	1000.	8.000	22.45	2.671	6.531	0.	0.	-0.	6.600
075A	.4325	800.0	1000.	2.000	23.59	5.459	6.523	0.	0.	-0.	1.630
075B	.4325	800.0	1000.	8.000	24.05	3.760	7.197	0.	0.	-0.	6.500
76	.4150	750.0	1000.	8.000	14.34	5.340	5.700	.9300E-01	0.	-0.	6.600
77	.4070	725.0	1000.	8.000	15.22	6.760	6.000	.1590	0.	-0.	6.500
78	.8030	725.0	500.0	8.000	9.980	5.440	3.060	.6400	0.	-0.	4.700
79	.4690	725.0	1000.	8.000	13.36	6.640	5.290	.2260	0.	-0.	6.200
80	.2940	725.0	1500.	8.000	17.95	8.160	7.670	.1830	0.	-0.	7.500
81	.1740	725.0	2000.	2.000	17.00	6.710	7.060	.1130	0.	-0.	2.300
082A	.3107	725.0	1500.	2.000	17.97	7.778	5.536	.1808	0.	-0.	1.890
082B	.3107	725.0	1500.	8.000	15.66	7.869	6.006	.1808	0.	9.300	7.500
083A	.1786	725.0	2500.	2.000	16.73	8.742	6.645	.9453	0.	-0.	2.330
083B	.1786	725.0	2500.	8.000	18.01	9.368	8.814	.1614	0.	-0.	9.300
85	.4250	775.0	1000.	8.000	10.48	3.900	5.480	.7100E-01	0.	-0.	6.300
086A	.3232	750.0	1500.	2.000	18.69	7.626	4.354	1.444	0.	-0.	1.750
086B	.3252	750.0	1500.	4.000	10.76	5.123	4.422	.2343	0.	-0.	3.500
086C	.3252	750.0	1500.	8.000	13.14	6.075	6.319	.1020	0.	-0.	7.000
087A	.9001	750.0	500.0	2.000	14.12	4.707	2.700	.6424	0.	-0.	1.150
087B	.9001	750.0	500.0	4.000	12.40	5.348	3.578	.6927	0.	-0.	2.300
087C	.9001	750.0	500.0	8.000	9.714	4.852	4.245	.3254	0.	-0.	4.600

TABLE 1 (Cont'd)

RUN NO.	H2 VEL., FT/SEC	TEMP., DEG C	PRESSURE PSI	REACTOR LENGTH, FT	% C CONV. TO CH4	% C CONV. TO C2H6	% C CONV. TO C2H6	% C CONV. TO C2H4	% C CONV. TO C2H2	% C CONV. TO OILS	COAL RES. TIME, SEC
098A	.2425	800.0	2000.	2.000	24.27	7.005	11.02	0.	0.	-0.	2.110
098B	.2425	800.0	2000.	4.000	33.56	6.963	9.374	0.	0.	-0.	4.220
098C	.2425	800.0	2000.	6.000	36.26	5.274	6.732	0.	0.	-0.	6.330
098D	.2425	800.0	2000.	8.000	31.91	5.830	6.781	0.	0.	-1.700	8.440
100A	.2815	850.0	1500.	2.000	39.03	3.671	5.882	.4730E-01	0.	-0.	1.920
100B	.2944	850.0	1500.	4.000	35.03	2.160	5.292	.1670E-01	0.	-0.	3.790
100C	.2815	850.0	1500.	6.000	38.05	2.135	3.627	0.	0.	-0.	7.670
101S	.2429	850.0	2000.	2.000	37.24	3.448	5.497	.2770E-01	0.	-0.	2.050
102A	.4085	850.0	1000.	2.000	23.43	3.304	4.71E	.4940E-01	0.	-0.	1.680
102B	.4085	850.0	1000.	4.000	26.64	1.529	4.715	0.	0.	-0.	6.720
103A	.3312	850.0	2000.	2.000	37.54	5.607	7.298	.5420E-01	0.	-0.	1.880
103B	.3312	850.0	2000.	4.000	53.35	2.827	2.771	0.	0.	-0.	5.640
103C	.3312	850.0	2000.	6.000	48.76	1.164	1.262	0.	0.	-7.000	7.520
104A	.9605	850.0	500.0	2.000	16.09	2.995	3.517	.7570E-01	0.	-0.	1.150
104B	.9605	850.0	500.0	4.000	16.16	1.851	4.625	.1920E-01	0.	-0.	2.300
105A	.9219	850.0	500.0	2.000	16.32	3.441	3.920	.7210E-01	0.	-0.	1.170
105B	.8832	850.0	500.0	2.000	12.82	3.384	3.030	.8510E-01	0.	-0.	1.200
105C	.9053	850.0	500.0	4.000	19.21	1.032	4.509	0.	0.	-0.	4.730
106A	.9302	900.0	500.0	4.000	14.94	0.	3.224	0.	0.	-0.	4.540
106B	.7150	900.0	500.0	2.000	16.18	.7579	2.639	.1270E-01	0.	-0.	1.340
107A	.6227	900.0	1000.	4.000	31.35	0.	2.689	0.	0.	-0.	5.720
107B	.6227	900.0	1000.	2.000	25.05	2.352	5.037	.2430E-01	0.	-0.	1.430
119A	.2387	850.0	2000.	2.000	34.83	5.145	6.281	.2570E-01	0.	-0.	2.060
119B	.2387	850.0	2000.	4.000	51.23	2.221	2.120	0.	0.	-0.	4.120
119C	.2387	850.0	2000.	6.000	51.23	1.120	1.138	0.	0.	-0.	6.180
119D	.2387	850.0	2000.	8.000	48.50	.6049	.6209	0.	0.	-0.	8.230
120A	.2267	775.0	2000.	2.000	16.22	7.203	4.562	.6535	0.	-0.	2.130
120B	.2267	775.0	2000.	4.000	21.31	7.190	7.655	.7559	0.	-0.	4.260
120C	.2267	775.0	2000.	6.000	20.82	6.820	7.491	.5070E-01	0.	-0.	6.390
120D	.2267	775.0	2000.	8.000	20.48	6.886	7.311	0.	0.	-4.000	8.520
130A	.1845	900.0	2500.	2.000	71.22	.6390	1.085	0.	0.	-0.	2.360
130B	.1845	900.0	2500.	4.000	67.63	.6766	.2170	0.	0.	-0.	4.710
130C	.1845	900.0	2500.	6.000	63.11	.2067	.8680E-01	0.	0.	-0.	7.070
130D	.1845	900.0	2500.	8.000	59.83	0.	.4340E-01	0.	0.	-0.	9.420
132A	.2235	875.0	2500.	2.000	89.35	3.814	4.733	0.	0.	-0.	2.240
132B	.2235	875.0	2500.	4.000	79.54	1.423	.8217	0.	0.	-0.	4.480
132C	.2235	875.0	2500.	6.000	75.75	.6831	.3287	0.	0.	-0.	6.720
132D	.2235	875.0	2500.	8.000	72.66	0.	.2301	0.	0.	-0.	8.960
133A	.2008	825.0	2500.	2.000	36.11	9.086	8.351	0.	0.	-0.	2.320
133C	.2008	825.0	2500.	6.000	75.32	5.506	3.333	0.	0.	-0.	6.960
133D	.2008	825.0	2500.	8.000	68.99	3.628	1.736	0.	0.	-0.	9.280
134A	.1690	775.0	2500.	2.000	23.87	10.43	7.442	0.	0.	-0.	2.380
134B	.1690	775.0	2500.	4.000	26.44	10.08	9.109	0.	0.	-0.	4.770
134C	.1690	775.0	2500.	6.000	29.49	9.799	9.766	0.	0.	-0.	7.150
134D	.1690	775.0	2500.	8.000	29.72	9.392	9.039	0.	0.	-4.100	9.530

TABLE 1 (Cont'd)

RUN NO.	H2 VEL., FT/SEC	TEMP., DEG C	PRESSURE PSI	REACTOR LENGTH, FT	% C CONV. TO CH4	% C CONV. TO C2H6	% C CONV. TO C6H6	% C CONV. TO C7H8	% C CONV. TO C8H10	% C CONV. TO OILS	COAL RES. TIME, SEC
135A	.1286	875.0	2500.	4.000	88.02	.4967	.6519	0.	0.	-0.	4.690
135B	.1286	875.0	2500.	6.000	84.07	.2709	.2868	0.	0.	-0.	7.030
135C	.1286	875.0	2500.	8.000	82.25	0.	.2347	0.	0.	-0.	9.370
136A	.2080	725.0	2500.	2.000	16.75	9.821	4.274	.8289	0.	-0.	2.220
136B	.2080	725.0	2500.	4.000	25.50	12.48	7.040	.2763	0.	-0.	4.440
136C	.2080	725.0	2500.	6.000	19.36	11.22	8.381	.2763	0.	-0.	6.660
136D	.2080	725.0	2500.	8.000	19.79	11.66	8.520	.1934	0.	-0.	8.870
137A	.2252	850.0	2500.	2.000	40.34	8.658	7.336	.6720E-01	0.	-0.	2.260
137B	.1837	850.0	2500.	4.000	60.74	3.041	1.502	0.	0.	-0.	4.750
137C	.1837	850.0	2500.	6.000	57.31	1.220	.6238	0.	0.	-0.	7.130
137D	.1837	850.0	2500.	8.000	57.15	.5201	.3003	0.	0.	-0.	9.500
138A	.3671	900.0	1500.	2.000	45.61	1.323	2.514	0.	0.	-0.	1.900
138B	.3671	900.0	1500.	4.000	52.41	.7257	.9367	0.	0.	-0.	3.800
138C	.3671	900.0	1500.	6.000	49.17	.6421	.7415	0.	0.	-0.	5.710
138D	.3671	900.0	1500.	8.000	41.33	0.	.6903	0.	0.	-0.	7.610
139A	.2897	900.0	2000.	2.000	65.35	1.337	3.029	0.	0.	-0.	2.000
139B	.2897	900.0	2000.	4.000	71.40	.6428	.4157	0.	0.	-0.	4.010
139C	.2897	900.0	2000.	6.000	65.09	.6171	.2376	0.	0.	-0.	6.020
139D	.2897	900.0	2000.	8.000	59.45	0.	0.	0.	0.	-0.	8.030
140A	.2248	875.0	2000.	2.000	50.99	3.446	3.740	0.	0.	-0.	1.980
140B	.2248	875.0	2000.	4.000	64.46	1.891	1.346	0.	0.	-0.	3.870
140C	.2248	875.0	2000.	6.000	63.49	.7772	.7480	0.	0.	-0.	5.950
140D	.2248	875.0	2000.	8.000	61.91	0.	.3590	0.	0.	-0.	7.940
141A	.4238	900.0	1000.	2.000	37.25	1.016	3.249	0.	0.	-0.	1.740
141B	.4238	900.0	1000.	4.000	46.60	1.034	1.719	0.	0.	-0.	3.490
141C	.4238	900.0	1000.	6.000	44.39	.6715	1.677	0.	0.	-0.	5.230
141D	.4238	900.0	1000.	8.000	38.61	.2359	1.320	0.	0.	-0.	6.970
141E	.7150	900.0	1000.	2.000	28.61	2.939	4.773	0.	0.	-0.	1.390
141F	.7150	900.0	1000.	4.000	41.18	1.072	2.510	0.	0.	-0.	2.780
142A	.2960	900.0	1500.	2.000	36.48	.8503	1.946	0.	0.	-0.	2.040
142B	.2960	900.0	1500.	4.000	47.55	.6957	.8034	0.	0.	-0.	4.080
142C	.2960	900.0	1500.	6.000	47.95	.3865	.4999	0.	0.	-0.	6.120
142D	.2960	900.0	1500.	8.000	44.19	0.	.2499	0.	0.	-0.	8.160
145A	.2724	900.0	2000.	2.000	48.96	1.189	2.203	0.	0.	-0.	2.040
145B	.2724	900.0	2000.	4.000	55.70	.6634	.4789	0.	0.	-0.	4.090
145C	.2724	900.0	2000.	6.000	50.52	.5529	.3512	0.	0.	-0.	6.130
145D	.2724	900.0	2000.	8.000	44.04	0.	.2235	0.	0.	-0.	8.170
147A	.3287	900.0	1000.	2.000	27.78	.6408	4.160	0.	0.	-0.	3.620
147B	.3287	900.0	1000.	4.000	28.18	.5668	3.134	0.	0.	-0.	7.240
148A	.2558	875.0	1500.	2.000	34.30	3.167	0.	0.	0.	-0.	2.000
148B	.2558	875.0	1500.	4.000	36.93	1.759	0.	0.	0.	-0.	3.990
148C	.2558	875.0	1500.	6.000	31.66	1.883	0.	0.	0.	-0.	5.990
148D	.2558	875.0	1500.	8.000	35.22	1.918	0.	0.	0.	-0.	7.980

TABLE 1 (Cont'd)

RUN NO.	M2 VEL., FT/SEC	TEMP., DEG C	PRESSURE PSI	REACTOR LENGTH, FT	% C CONV. TO CH4	% C CONV. TO C2H6	% C CONV. TO C6H6	% C CONV. TO C7H8	% C CONV. TO C8H10	% C CONV. TO OILS	COAL RES. TIME, SEC
149A	.5029	400.0	1000.	2.000	1.681	1.148	.7310E-01	0.	0.	-0.	1.640
149B	.5029	700.0	1000.	2.000	3.201	2.123	.3097	.2659	0.	-0.	1.640
149C	.5029	725.0	1000.	2.000	5.170	3.467	.7364	.5751	0.	-0.	1.640
149D	.5029	750.0	1000.	2.000	9.841	5.213	2.922	.7601	0.	-0.	1.640
149E	.5029	775.0	1000.	2.000	11.50	5.946	3.886	.2740	0.	-0.	1.640
149F	.5029	810.0	1000.	2.000	13.18	5.440	4.822	.1445	0.	-0.	1.640
149G	.5029	825.0	1000.	2.000	12.64	5.288	3.828	.3437	0.	-0.	1.640
150A	.1901	750.0	2500.	2.000	11.21	6.850	3.116	.8735	0.	-0.	2.300
150B	.1901	750.0	2500.	8.000	13.89	8.633	5.879	.2180	0.	3.700	9.180
152A	.5930	875.0	1000.	2.000	22.34	4.060	5.000	0.	0.	-0.	1.460
152B	.5930	875.0	1000.	4.000	22.34	2.850	5.630	0.	0.	-0.	2.910
152C	.5930	875.0	1000.	8.000	19.04	2.280	5.000	0.	0.	-0.	5.820
153A	.5630	850.0	1000.	2.000	18.65	5.430	4.840	0.	0.	-0.	1.500
153B	.5630	850.0	1000.	4.000	16.71	4.910	5.670	0.	0.	-0.	3.000
153C	.5630	850.0	1000.	8.000	14.53	4.390	4.840	0.	0.	-0.	6.010
154A	.3680	850.0	1500.	4.000	27.25	4.760	7.240	0.	0.	-0.	3.640
154B	.3680	850.0	1500.	8.000	25.84	4.510	6.510	0.	0.	-0.	7.280
157A	.1530	825.0	3000.	2.000	26.57	8.590	8.430	0.	0.	-0.	2.460
157B	.1530	825.0	3000.	4.000	44.69	7.390	3.770	0.	0.	-0.	4.910
157C	.1530	825.0	3000.	6.000	56.36	3.870	.6400	0.	0.	-0.	7.370
157D	.1530	825.0	3000.	8.000	52.34	2.470	.2900	0.	0.	-0.	9.820
158A	.1670	850.0	3000.	2.000	31.91	0.	0.	0.	0.	-0.	2.420
158B	.1670	850.0	3000.	4.000	57.61	3.320	.8900	0.	0.	-0.	4.850
158C	.1670	850.0	3000.	6.000	60.10	1.440	.4300	0.	0.	-0.	7.270
158D	.1670	850.0	3000.	8.000	60.10	.6400	.1800	0.	0.	-0.	9.690
159A	.6150	875.0	1000.	2.000	17.25	4.400	5.170	0.	0.	-0.	1.440
159B	.6150	875.0	1000.	4.000	33.46	2.200	4.760	0.	0.	-0.	2.880
159C	.6150	875.0	1000.	6.000	30.89	.9600	3.810	0.	0.	-0.	4.320
159D	.6150	875.0	1000.	8.000	26.26	.6900	3.200	0.	0.	-0.	5.750
160A	.5300	850.0	1000.	2.000	20.17	5.690	4.970	.3000E-01	0.	-0.	1.540
160B	.5300	850.0	1000.	4.000	23.18	3.140	5.430	0.	0.	-0.	3.090
160C	.5300	850.0	1000.	6.000	27.82	2.450	5.630	0.	0.	-0.	4.630
160D	.5300	850.0	1000.	8.000	22.48	1.630	4.430	0.	0.	-0.	6.170
161A	.2540	750.0	2000.	2.000	11.59	5.670	2.390	.8500	0.	-0.	2.070
161B	.2540	750.0	2000.	4.000	13.82	7.090	5.380	.4100	0.	-0.	4.130
161C	.2540	750.0	2000.	6.000	14.62	7.760	6.720	.2300	0.	-0.	6.200
161D	.2540	750.0	2000.	8.000	14.26	7.890	7.110	.3000E-01	0.	4.700	8.260
162A	.3460	850.0	1500.	2.000	25.08	7.280	5.950	0.	0.	-0.	1.880
162B	.3460	850.0	1500.	4.000	37.15	3.720	6.920	0.	0.	-0.	3.760
162C	.3460	850.0	1500.	6.000	43.42	3.990	4.090	0.	0.	-0.	5.640
162D	.3460	850.0	1500.	8.000	37.15	1.930	3.380	0.	0.	-0.	7.520
166A	.2470	750.0	2000.	2.000	11.16	6.770	2.500	1.020	0.	-0.	2.180
166B	.2470	750.0	2000.	4.000	15.47	7.600	5.630	.4080	0.	-0.	4.350
166C	.2470	750.0	2000.	6.000	18.01	8.610	8.590	.2160	0.	-0.	6.530
166D	.2470	750.0	2000.	8.000	15.85	8.310	7.590	.1050	0.	2.900	8.700
168A	.2670	900.0	2000.	2.000	71.53	2.650	3.850	0.	0.	-0.	2.150
168B	.2670	900.0	2000.	4.000	76.70	1.870	.8400	0.	0.	-0.	4.300
168C	.2670	900.0	2000.	6.000	64.56	.7200	.5100	0.	0.	-0.	6.450

TABLE 1 (Cont'd)

RUN NO.	H2 VEL., FT/SEC	TEMP., DEG C	PRESSURE PSI	FEACTOR LENGTH, FT	% C CONV. TO CH4	% C CONV. TO C2H6	% C CONV. TO C6H6	% C CONV. TO C7H8	% C CONV. TO C8H10	% C CONV. TO OILS	COAL RES. TIME, SEC
169A	.1440	750.0	3000.	2.000	19.05	11.48	6.270	1.174	0.	-0.	2.490
169B	.1440	750.0	3000.	4.000	23.80	12.81	10.04	.2350	0.	-0.	4.980
170A	.1730	750.0	3000.	2.000	33.24	20.70	10.33	1.709	0.	-0.	2.400
170B	.1730	750.0	3000.	4.000	29.62	15.27	10.44	.2710	0.	-0.	4.810
170C	.1730	750.0	3000.	6.000	32.43	11.69	7.810	0.	0.	-0.	7.210
170D	.1730	750.0	3000.	8.000	36.52	17.08	7.740	0.	0.	5.500	9.610
175A	.5130	750.0	1000.	2.000	13.65	6.170	2.200	1.240	0.	-0.	1.530
175B	.5130	750.0	1000.	4.000	15.46	7.100	4.340	.7560	0.	-0.	3.060
175C	.5130	750.0	1000.	6.000	15.56	7.470	4.370	.4690	0.	-0.	4.590
175D	.5130	750.0	1000.	8.000	12.90	6.800	4.520	.2120	0.	3.500	6.120
177A	.2030	875.0	2500.	2.000	87.71	1.580	1.990	0.	0.	-0.	2.320
177B	.2030	875.0	2500.	4.000	75.74	1.430	1.220	0.	0.	-0.	4.640
177C	.2030	875.0	2500.	6.000	82.56	.7200	.4100	0.	0.	-0.	6.960
177D	.2030	875.0	2500.	8.000	80.97	.1700	.2900	0.	0.	-0.	9.270
180A	1.129	875.0	500.0	2.000	21.63	4.410	3.440	0.	0.	-0.	1.040
180B	1.129	875.0	500.0	4.000	26.62	2.380	3.750	0.	0.	-0.	2.070
180C	1.129	875.0	500.0	6.000	25.36	1.700	4.060	0.	0.	-0.	3.110
180D	1.129	875.0	500.0	8.000	19.61	1.070	4.030	0.	0.	-0.	4.140
181A	1.079	825.0	500.0	2.000	19.33	5.850	3.390	.3730	0.	-0.	1.040
181B	1.079	825.0	500.0	4.000	19.77	5.390	4.680	.6200E-01	0.	-0.	2.080
181C	1.079	825.0	500.0	6.000	17.47	4.350	4.150	0.	0.	-0.	3.120
181D	1.079	825.0	500.0	8.000	14.03	3.810	3.770	0.	0.	-0.	4.150
182A	.2400	825.0	2000.	2.000	29.06	9.430	6.530	0.	0.	-0.	2.140
182B	.2400	825.0	2000.	4.000	36.35	6.620	0.	0.	0.	-0.	4.290
182C	.2400	825.0	2000.	6.000	38.16	7.000	7.760	0.	0.	-0.	6.420
182D	.2400	825.0	2000.	8.000	39.58	4.200	4.370	0.	0.	3.300	8.560
183A	.3710	825.0	1500.	2.000	23.90	8.120	4.960	.3520	0.	-0.	1.800
183B	.3710	825.0	1500.	4.000	26.67	5.800	6.630	.4100E-01	0.	-0.	3.600
183C	.3710	825.0	1500.	6.000	27.52	4.400	6.610	0.	0.	-0.	5.400
183D	.3710	825.0	1500.	8.000	28.37	3.810	6.110	0.	0.	1.000	7.190
184A	.5150	825.0	1000.	2.000	17.67	6.490	4.200	.2800	0.	-0.	1.510
184B	.5150	825.0	1000.	4.000	22.27	5.100	5.200	.5100E-01	0.	-0.	3.020
184C	.5150	825.0	1000.	6.000	22.63	4.240	5.870	0.	0.	-0.	4.530
184D	.5150	825.0	1000.	8.000	19.64	3.340	5.410	0.	0.	1.200	6.030
185A	.1430	825.0	3000.	2.000	41.17	11.50	8.740	.4300E-01	0.	-0.	2.560
185B	.1430	825.0	3000.	4.000	69.49	7.060	3.590	0.	0.	-0.	5.120
185C	.1430	825.0	3000.	6.000	77.43	3.200	1.300	0.	0.	-0.	7.680
185D	.1430	825.0	3000.	8.000	64.55	2.070	.4300	0.	0.	-0.	10.24
187A	.2050	825.0	2500.	2.000	29.60	9.640	8.280	.1160	0.	-0.	2.310
187B	.2050	825.0	2500.	4.000	48.63	7.290	6.310	0.	0.	-0.	4.630
187C	.2050	825.0	2500.	6.000	50.47	5.140	3.740	0.	0.	-0.	6.940
187D	.2050	825.0	2500.	8.000	50.47	3.850	2.220	0.	0.	-0.	9.250
195A	.3580	900.0	1500.	2.000	55.32	0.	9.420	0.	0.	-0.	1.970
195B	.3580	900.0	1500.	4.000	68.57	0.	3.590	0.	0.	-0.	3.940
195C	.3580	900.0	1500.	6.000	66.93	0.	3.170	0.	0.	-0.	5.910
195D	.3580	900.0	1500.	8.000	59.06	0.	2.110	0.	0.	-0.	7.880

Table 2

	Estimated Value	Estimated Error
k_{10}, sec^{-1}	5.0×10^6	6.4×10^5
k_{20}, sec^{-1}	7.5×10^6	1.5×10^6
k_{30}, sec^{-1}	4.4×10^6	6.8×10^5
k_{40}, sec^{-1}	4.6×10^6	1.6×10^6
k_{50}, sec^{-1}	5.2×10^1	2.9×10^1
k_{60}, sec^{-1}	1.7×10^{10}	1.5×10^9
k_{70}, sec^{-1}	1.6×10^9	3.2×10^8
k_{80}, sec^{-1}	4.6×10^{16}	8.2×10^{15}
$E (E_1 - E_4), \text{cal/g mole}$	42,700	80
$E_5, \text{cal/g mole}$	20,100	830
$E_6, \text{cal/g mole}$	54,200	340
$E_7, \text{cal/g mole}$	50,300	110
$E_8, \text{cal/g mole}$	84,200	790
$m (\text{power of } P_{H_2})$	0.137	0.029

Table 3

	Correlation Coefficient	Standard Error, % C Conversion
CH_4	0.85	10.9
C_2H_6	0.82	2.0
BTX	0.82	1.7
Oils	0.72	1.5
Overall	0.83	1.5

Table 4

N	Correlation Coefficient					
	N_4	CH_4	C_2H_6	BTX	Oils	Overall
228	13	0.85	0.82	0.82	0.72	0.83
218	12	0.84	0.82	0.80	0.69	0.82
208	11	0.84	0.83	0.81	0.66	0.83
198	10	0.84	0.82	0.82	0.69	0.83

Figure 1. Calculated % C Converted to CH_4 vs. Experimental % C Converted to CH_4

Figure 2. Calculated % C Converted to C_2H_6 vs. Experimental % C Converted to C_2H_6

Figure 3. Calculated % C Converted to BTX vs. Experimental % C Converted to BTX

Figure 4. Calculated % C Converted to Oils vs. Experimental % C Converted to Oils

APPENDIX

FUNCTION SUBROUTINE IN MINUIT

```

1      SUBROUTINE FEN(HPAR,6,F,X,IFLAG)                                000100
C      OBJECTIVE-TO BEST FIT THE DATA TO THE EQUATIONS OBTAINED FROM THE 000110
C      PROPOSED MODEL AND ESTIMATE THE KINETIC PARAMETERS,              000120
C      USING MINUIT.                                                    000130
5      C      INPUT VARIABLES                                           000140
C      Y1(1) RUN NO.                                                    000150
C      Y2(1) HYDROGEN VELOCITY, FT/SEC                                  000160
C      Y3(1) REACTOR TEMP., DEG C                                       000170
C      Y4(1) HYDROGEN PRESSURE, PSI                                      000180
10     C      Y5(1) REACTOR LENGTH UP TO SAMPLE TAP, FT.                000190
C      Y6(1) % C CONV. TO METHANE                                       000200
C      Y7(1) % C CONV. TO ETHANE                                        000210
C      Y8(1) % C CONV. TO BENZENE                                       000220
C      Y9(1) % C CONV. TO TOLUENE                                       000230
15     C      Y10(1) % C CONV. TO XYLENE                                000240
C      Y11(1) % C CONV. TO LIGHT OIL                                    000250
C      Y12(1) COAL RESIDENCE TIME, SEC                                  000260
C      OTHER VARIABLES                                                  000270
C      X(1) K10,/SEC                                                     000280
20     C      X(2) K20,/SEC                                               000290
C      X(3) K30,/SEC                                                     000300
C      X(4) K40,/SEC                                                     000310
C      X(5) K50,/SEC                                                     000320
C      X(6) K60,/SEC                                                     000330
25     C      X(7) K70,/SEC                                               000340
C      X(8) K80,/SEC                                                     000350
C      X(9) E,CAL/GMOLE                                                  000360
C      X(10) E5,CAL/GMOLE                                                000370
C      X(11) E6,CAL/GMOLE                                                000380
30     C      X(12) E7,CAL/GMOLE                                         000390
C      X(13) E8,CAL/GMOLE                                                000400
C      X(14) N,POWER TO HYDROGEN PRESSURE                              000410
C      F      FUNCTION TO BE MINIMIZED IN MINUIT                        000420
C      CONSTANTS                                                        000430
35     C      H      NUMBER OF TOTAL DATA POINTS                      000440
C      H4      NUMBER OF DATA POINTS WITH OIL CONV.                  000445
C      DIMENSION G(15),X(15),Y1(350),Y2(350),Y3(350),Y4(350),Y5(350), 000450
1*Y6(350),Y7(350),Y8(350),Y9(350),Y10(350),Y11(350),Y12(350),      000460
121(350)                                                                000470
40     C      DIMENSION IRAY(6)                                          000480
C      G=10,(10,20,30,40)IFLAG                                         000490
10 CONTINUE                                                            000500
C      NUMBER OF TOTAL DATA POINTS, N AND DATA POINTS WITH OIL CONV.,N4 000510
45     N=228                                                            000520
N4=13                                                                000525
DATA IRAY/6*(-0)/                                                    000530
IRAY(4)=0                                                            000540
CALL SYSTEMC(115,IRAY)                                              000550
Y6N=0.                                                                000560
50     Y7N=0.                                                            000570
Z1N=0.                                                                000580
Y11N=0.                                                              000590
PRINT 400                                                            000600
400 FORMAT(1X,'*RUN NO.',3X,'*H2 VEL.',3X,'*TEMP.',4X,'*PRESSURE',2X, 000610
1*REACTOR',3X,'*% C CONV.',1X,'*% C CONV.',1X,'*% C CONV.',1X, 000620
1*% C CONV.',1X,'*% C CONV.',1X,'*% C CONV.',1X,'*COAL RES.',11X, 000630
1*FT/SEC',5X,'*DEG C',5X,'*PSI',7X,'*ENGTH,FT',1X,'*TO CH4',4X, 000640
1*TO C2H6',3X,'*TO C2H6',3X,'*TO C7H8',3X,'*TO C8H10',2X, 000650
1*TO OILS',3X,'*TIME,SEC'//) 000660

```


FUNCTION SUBROUTINE IN MINUIT (CONT'D)

60	DO 2 I=1,N	000670
	INPUT VARIABLES ARE READ IN	000680
	READ 101,Y1(I),Y2(I),Y3(I),Y4(I),Y5(I),Y6(I),Y7(I),Y8(I),Y9(I)	000690
	1,Y10(I),Y11(I),Y12(I)	000700
65	101 FORMAT(A4,10X,2F5.0,5X,F5.0,30X,F5.0/14X,F5.0,5X,4F5.0,5X,2F5.0)	000710
	WRITE 102,Y1(I),Y2(I),Y3(I),Y4(I),Y5(I),Y6(I),Y7(I),Y8(I),Y9(I)	000720
	1,Y10(I),Y11(I),Y12(I)	000730
	102 FORMAT(1X,A10,11G10.4)	000740
	Y4(I)=Y4(I)/14.7	000745
	Z1(I)=Y8(I)+Y9(I)+Y10(I)	000750
70	Y6M=Y6M+Y6(I)	000760
	Y7M=Y7M+Y7(I)	000770
	Z1M=Z1M+Z1(I)	000780
	Y11M=Y11M+Y11(I)	000790
	2 CONTINUE	000800
75	Y6M=Y6M/N	000810
	Y7M=Y7M/N	000820
	Z1M=Z1M/N	000830
	Y11M=Y11M/N4	000835
	W1=0,	000840
80	W2=0,	000850
	W3=0,	000860
	W4=0,	000870
	DO 4 K=1,N	000880
	W1=W1+(Y6(K)-Y6M)**2	000890
85	W2=W2+(Y7(K)-Y7M)**2	000900
	W3=W3+(Z1(K)-Z1M)**2	000910
	IF (Y11(K).EQ.-0.) GO TO 77	000920
	W4=W4+(Y11(K)-Y11M)**2	000924
	77 CONTINUE	000926
90	4 CONTINUE	000930
	20 CONTINUE	000940
	40 CONTINUE	000950
	F1=0,	000960
	F2=0,	000970
95	F3=0,	000980
	F4=0,	000990
	DO 3 J=1,N	001000
	Q2=(X(1)+X(2)+X(3)+X(4))*EXP(-X(9)/(2.+(Y3(J)+273.)))	001010
	Q5=X(5)*EXP(-X(10)/(2.+(Y3(J)+273.)))	001020
100	Q6=X(6)*EXP(-X(11)/(2.+(Y3(J)+273.)))	001030
	Q7=X(7)*EXP(-X(12)/(2.+(Y3(J)+273.)))	001040
	Q4=X(8)*EXP(-X(13)/(2.+(Y3(J)+273.)))	001050
	Q3=Y2(J)+Y12(J)/Y5(J)	001060
	Q4=Y4(J)+X(14)	001070
105	Q2=EXP(-X(9)/(2.+(Y3(J)+273.)))	001080
	Y0Q=100.+(X(1)*Q9/(Q3+Q2-Q5))*(EXP(-Q5*Q4+Y12(J)	001090
	1/Q3)-EXP(-Q2*Q4+Y12(J)))	001100
	Y7C=100.+(X(2)*Q9/(Q3+Q2-Q6))*(EXP(-Q6*Q4+Y12(J)	001110
	1/Q3)-EXP(-Q2*Q4+Y12(J)))	001120

FUNCTION SUBROUTINE IN MINUIT (CONT'D)

110	Z1C=100.*(X(3)*Q9/(Q3*Q2-Q7))*(EXP(-Q7*Q4*Y12(J)	001130
	1/Q3)-EXP(-Q2*Q4*Y12(J)))	001140
	Y11C=100.*(X(4)*Q9/(Q3*Q2-Q8))*(EXP(-Q8*Q4*Y12(J)	001150
	1/Q3)-EXP(-Q2*Q4*Y12(J)))	001160
	F1=F1+(Y6(J)-Y6C)**2	001170
115	F2=F2+(Y7(J)-Y7C)**2	001180
	F3=F3+(Z1(J)-Z1C)**2	001190
	IF(Y11(J).EQ,-0.) GO TO 7	001194
	F4=F4+(Y11(J)-Y11C)**2	001200
	/ CONTINUE	001204
120	5 CONTINUE	001210
	C AT THIS STAGE, F1,F2,F3,F4 ARE SUMS OF SQUARES OF DEVIATIONS OF	001220
	C EXPERIMENTAL VALUES FROM CALCULATED VALUES FOR % C CONV. TO CH4,	001230
	C C2H6,BTX AND OILS RESPECTIVELY,	001240
	FW1=F1/W1	001250
125	FW2=F2/W2	001260
	FW3=F3/W3	001270
	FW4=F4/W4	001275
	C FUNCTION F, BEING MINIMIZED, IS CALCULATED	001280
	F=N*(FW1+FW2+FW3)+N4*FW4	001290
130	RETURN	001320
	30 CONTINUE	001330
	GO TO 40	001340
	END	001350

TYPICAL OUTPUT

```
*****
* 0506 MINUIT *
* DIMENSIONS 15/ 30 *
* VERSION 2.77 *
* DATA BLOCK NO. 1 *
```

BHATT				TIME	
				.694	
1	K10	.700000E+07	.200000E+07	-0.	-0.
2	K20	.120000E+08	.400000E+07	-0.	-0.
3	K30	.700000E+07	.300000E+07	-0.	-0.
4	K40	.530000E+07	.200000E+07	-0.	-0.
5	K50	.390000E+03	.100000E+03	-0.	-0.
6	K60	.200000E+11	.800000E+10	-0.	-0.
7	K70	.300000E+10	.100000E+10	-0.	-0.
8	K80	.450000E+17	.200000E+17	-0.	-0.
9	E	.424000E+05	.500000E+04	-0.	-0.
10	E5	.240000E+05	.300000E+04	-0.	-0.
11	E6	.531000E+05	.500000E+04	-0.	-0.
12	E7	.505000E+05	.500000E+04	-0.	-0.
13	E8	.836000E+05	.600000E+04	-0.	-0.
14	M	.244000E-01	.100000E-01	-0.	-0.

FIRST ENTRY TO FCN		FCN VALUE		CALLS		TIME		EDM		INT,EXT. PARAMETER		VALUE		ERRCR		INTERN. VALUE		INT. STEP SIZE	
.2279462E+03		1		.95		0.				1 1	K10	.70000E+07	.20000E+07	.70000E+07	.20000E+07	.70000E+07	.20000E+07	.70000E+07	.20000E+07
										2 2	K20	.12000E+08	.40000E+07	.12000E+08	.40000E+07	.12000E+08	.40000E+07	.12000E+08	.40000E+07
										3 3	K30	.70000E+07	.30000E+07	.70000E+07	.30000E+07	.70000E+07	.30000E+07	.70000E+07	.30000E+07
										4 4	K40	.53000E+07	.20000E+07	.53000E+07	.20000E+07	.53000E+07	.20000E+07	.53000E+07	.20000E+07
										5 5	K50	.39000E+03	.10000E+03	.39000E+03	.10000E+03	.39000E+03	.10000E+03	.39000E+03	.10000E+03
										6 6	K60	.20000E+11	.80000E+10	.20000E+11	.80000E+10	.20000E+11	.80000E+10	.20000E+11	.80000E+10
										7 7	K70	.30000E+10	.10000E+10	.30000E+10	.10000E+10	.30000E+10	.10000E+10	.30000E+10	.10000E+10
										8 8	K80	.45000E+17	.20000E+17	.45000E+17	.20000E+17	.45000E+17	.20000E+17	.45000E+17	.20000E+17
										9 9	E	.42400E+05	.50000E+04	.42400E+05	.50000E+04	.42400E+05	.50000E+04	.42400E+05	.50000E+04
										10 10	E5	.24000E+05	.30000E+04	.24000E+05	.30000E+04	.24000E+05	.30000E+04	.24000E+05	.30000E+04
										11 11	E6	.53100E+05	.50000E+04	.53100E+05	.50000E+04	.53100E+05	.50000E+04	.53100E+05	.50000E+04
										12 12	E7	.50500E+05	.50000E+04	.50500E+05	.50000E+04	.50500E+05	.50000E+04	.50500E+05	.50000E+04
										13 13	E8	.83600E+05	.60000E+04	.83600E+05	.60000E+04	.83600E+05	.60000E+04	.83600E+05	.60000E+04
										14 14	M	.24400E-01	.10000E-01	.24400E-01	.10000E-01	.24400E-01	.10000E-01	.24400E-01	.10000E-01

```
*****
*** 1****          -0.00000    -0.00000    -0.00000    -0.00000    -0.00000    -0.00000    765000.00000
*****
*** 2****PRINTOUT          2.00000    -0.00000    -0.00000    -0.00000    -0.00000    -0.00000    766000.00000
*****
*** 3****SEFK          100.00000    -0.00000    -0.00000    -0.00000    -0.00000    -0.00000    767000.00000
*****
```

TYPICAL OUTPUT (CONT'D)

SEEK -- MONTE CARLO MINIMUM SEARCH

BEST VALUE FOUND IN SEEK IS

FCN VALUE	CALLS	TIME	EDM	INT.EXT.	PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE
.2279462E+03	103	2.88	8.	1	1	K10	.70000E+07	.20000E+07	.70000E+07
				2	2	K20	.12000E+08	.40000E+07	.12000E+08
				3	3	K30	.70000E+07	.30000E+07	.70000E+07
				4	4	K40	.53000E+07	.20000E+07	.53000E+07
				5	5	K50	.39000E+03	.10000E+03	.39000E+03
				6	6	K60	.20000E+11	.80000E+10	.20000E+11
				7	7	K70	.30000E+10	.10000E+10	.30000E+10
				8	8	K80	.45000E+17	.20000E+17	.45000E+17
				9	9	E	.42400E+05	.50000E+04	.42400E+05
				10	10	E5	.24000E+05	.30000E+04	.24000E+05
				11	11	E6	.53100E+05	.50000E+04	.53100E+05
				12	12	E7	.50500E+05	.50000E+04	.50500E+05
				13	13	E8	.83600E+05	.80000E+04	.83600E+05
				14	14	M	.24400E-01	.10000E-01	.24400E-01

 *** 4****SIMPLEX 300.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 7.68000,00000

START SIMPLEX MINIMIZATION CONVERGENCE CRITERION -- ESTIMATED DISTANCE TO MINIMUM (EDM) .LT. .10E+00

FCN VALUE	CALLS	TIME	EDM	INT.EXT.	PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE	
.2273233E+03	146	3.69	.10E+03	1	1	K10	.73200E+07	.14144E+07	.73200E+07	.32000E+06
				2	2	K20	.12640E+08	.28288E+07	.12640E+08	.64000E+06
				3	3	K30	.70000E+07	.21216E+07	.70000E+07	.48000E+06
				4	4	K40	.53000E+07	.14144E+07	.53000E+07	.32000E+06
				5	5	K50	.39000E+03	.70719E+02	.39000E+03	.16000E+02
				6	6	K60	.20000E+11	.56576E+10	.20000E+11	.12800E+10
				7	7	K70	.30000E+10	.70719E+09	.30000E+10	.16000E+09
				8	8	K80	.45000E+17	.14144E+17	.45000E+17	.32000E+16
				9	9	E	.42400E+05	.35360E+04	.42400E+05	.80000E+03
				10	10	E5	.24000E+05	.21216E+04	.24000E+05	.48000E+03
				11	11	E6	.53100E+05	.35360E+04	.53100E+05	.80000E+03
				12	12	E7	.50500E+05	.35360E+04	.50500E+05	.80000E+03
				13	13	E8	.83600E+05	.42432E+04	.83600E+05	.96000E+03
				14	14	M	.24400E-01	.70719E-02	.24400E-01	.16000E-02

FCN VALUE	CALLS	TIME	EDM	INT,EXT.	PARAMETER	VALUE	ERROR	INTERN.VALUE	INT,STEP SIZE	
.2261107E+03	210	4.90	.14E+01	1	1	K10	.71920E+07	.10601E+06	.71920E+07	.12800E+06
				2	2	K20	.12384E+08	.21203E+06	.12384E+08	.25600E+06
				3	3	K30	.68080E+07	.15902E+06	.68080E+07	.19200E+06
				4	4	K40	.56200E+07	.20337E+06	.56200E+07	.32000E+06
				5	5	K50	.45400E+03	.38054E+02	.45400E+03	.64000E+02
				6	6	K60	.19488E+11	.42415E+09	.19488E+11	.51200E+09

TYPICAL OUTPUT (CONT'D)

7	7	K70	.30000E+10	.54741E+08	.30000E+10	.66037E+08
8	8	K80	.45000E+17	.23984E+16	.45000E+17	.37735E+16
9	9	E	.42400E+05	.14600E+03	.42400E+05	.84473E+02
10	10	E5	.24000E+05	.84961E+02	.24000E+05	.48141E+02
11	11	E6	.53100E+05	.14430E+03	.53100E+05	.82190E+02
12	12	E7	.50500E+05	.14413E+03	.50500E+05	.79934E+02
13	13	E8	.83600E+05	.16127E+03	.83600E+05	.89178E+02
14	14	M	.24400E-01	.15077E-03	.24400E-01	.70055E-04

FCN VALUE	CALLS	TIME	EDM	INT,EXT.	PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE	
.2258368E+03	288	6.37	.16E+00	1	1	K10	.73201E+07	.27959E+06	.73201E+07	.12211E+06
				2	2	K20	.12252E+08	.40402E+06	.12252E+08	.97299E+05
				3	3	K30	.68005E+07	.23914E+05	.68005E+07	.25393E+05
				4	4	K40	.55530E+07	.35412E+06	.55530E+07	.87441E+05
				5	5	K50	.49309E+03	.10122E+03	.49309E+03	.44171E+02
				6	6	K60	.19446E+11	.82497E+09	.19446E+11	.20480E+09
				7	7	K70	.29439E+10	.11653E+09	.29439E+10	.26977E+08
				8	8	K80	.45763E+17	.76340E+16	.45763E+17	.18999E+16
				9	9	E	.42397E-05	.10293E+03	.42397E+05	.25126E+02
				10	10	E5	.23994E+05	.79591E+02	.23994E+05	.34512E+02
				11	11	E6	.53081E+05	.10716E+03	.53081E+05	.26464E+02
				12	12	E7	.50473E+05	.78229E+02	.50473E+05	.18793E+02
				13	13	E8	.83586E+05	.10471E+03	.83586E+05	.45678E+02
				14	14	M	.24398E-01	.49484E-03	.24398E-01	.27953E-03

SIMPLEX MINIMIZATION HAS CONVERGED

FCN VALUE	CALLS	TIME	EDM	INT,EXT.	PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE	
.2257965E+03	313	6.95	.80E-01	1	1	K10	.73381E+07	.22156E+06	.73381E+07	.64452E+05
				2	2	K20	.12254E+08	.29534E+05	.12254E+08	.85523E+05
				3	3	K30	.67977E+07	.71149E+05	.67977E+07	.20602E+05
				4	4	K40	.55758E+07	.22465E+06	.55758E+07	.65058E+05
				5	5	K50	.47497E+03	.12302E+03	.47497E+03	.36088E+02
				6	6	K60	.19535E+11	.74192E+09	.19535E+11	.21792E+09
				7	7	K70	.29607E+10	.10956E+09	.29607E+10	.32339E+08
				8	8	K80	.45483E+17	.81602E+16	.45483E+17	.23776E+16
				9	9	E	.42394E+05	.11022E+03	.42394E+05	.31905E+02
				10	10	E5	.23992E+05	.17704E+03	.23992E+05	.51265E+02
				11	11	E6	.53087E+05	.13895E+03	.53087E+05	.39722E+02
				12	12	E7	.50476E+05	.91273E+02	.50476E+05	.25863E+02
				13	13	E8	.83574E+05	.17732E+03	.83574E+05	.51374E+02
				14	14	M	.24369E-01	.10698E-02	.24369E-01	.31271E-03

ERRORS CORRESPOND TO FUNCTION CHANGE OF 1.0000

 *** START HIRAD -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 769000.00000

START HIRAD MINIMIZATION.

CONVERGENCE CRITERIA -- ESTIMATED DISTANCE TO MINIMUM (EDM) .LT. .10E-05
 OR EDM .LT. .10E+00 AND FRACTIONAL CHANGE IN VARIANCE MATRIX .LT. .10E-01

TYPICAL OUTPUT (CONT'D)

FCN VALUE	CALLS	TIME	EDH	INT.EXT.	PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE	
.2257500E+03	453	9.47	.17E+00	1	1	K10	.73381E+07	.29476E+06	.73381E+07	.44311E+04
				2	2	K20	.12254E+08	.55635E+06	.12254E+08	.59067E+04
				3	3	K30	.67977E+07	.27666E+06	.67977E+07	.14230E+04
				4	4	K40	.55758E+07	.80013E+06	.55758E+07	.44930E+04
				5	5	K50	.47497E+03	.74535E+02	.47497E+03	.24603E+01
				6	6	K60	.19535E+11	.10232E+10	.19535E+11	.14838E+08
				7	7	K70	.29607E+10	.14228E+09	.29607E+10	.21912E+07
				8	8	K80	.46217E+17	.14142E+01	.46217E+17	.36338E+14
				9	9	E	.42394E+05	.70278E+02	.42394E+05	.22043E+01
				10	10	E5	.23992E+05	.36125E+03	.23992E+05	.35409E+01
				11	11	E6	.53087E+05	.11048E+03	.53087E+05	.27790E+01
				12	12	E7	.50476E+05	.10315E+03	.50476E+05	.18255E+01
				13	13	E8	.83574E+05	.40699E+03	.83574E+05	.35463E+01
				14	14	M	.21369E-01	.10285E-01	.21369E-01	.21396E-04

FCN VALUE	CALLS	TIME	EDH	INT.EXT.	PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE	
.2257059E+03	456	9.52	.17E+00	1	1	K10	.73460E+07	.29476E+06	.73460E+07	.79738E+04
				2	2	K20	.12270E+08	.55635E+06	.12270E+08	.15663E+05
				3	3	K30	.67957E+07	.27666E+06	.67957E+07	-.20149E+04
				4	4	K40	.56099E+07	.80013E+06	.56099E+07	.34097E+05
				5	5	K50	.47617E+03	.74535E+02	.47617E+03	.11938E+01
				6	6	K60	.19479E+11	.10232E+10	.19479E+11	-.56115E+08
				7	7	K70	.29587E+10	.14228E+09	.29587E+10	-.19422E+07
				8	8	K80	.46217E+17	.14142E+01	.46217E+17	.93458E-20
				9	9	E	.42390E+05	.70278E+02	.42390E+05	-.43570E+01
				10	10	E5	.23977E+05	.36125E+03	.23977E+05	-.14571E+02
				11	11	E6	.53094E+05	.11048E+03	.53094E+05	.70001E+01
				12	12	E7	.50476E+05	.10315E+03	.50476E+05	.19016E+00
				13	13	E8	.83573E+05	.40699E+03	.83573E+05	-.15044E+01
				14	14	M	.25181E-01	.10285E-01	.25181E-01	.81248E-03

FCN VALUE	CALLS	TIME	EDH	INT.EXT.	PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE	
.2249175E+03	762	15.27	.36E-01	1	1	K10	.70637E+07	.66059E+06	.70637E+07	-.94467E+05
				2	2	K20	.10569E+08	.13508E+07	.10569E+08	-.36259E+06
				3	3	K30	.62276E+07	.45839E+06	.62276E+07	-.15590E+06
				4	4	K40	.77186E+07	.20327E+07	.77186E+07	.27669E+06
				5	5	K50	.28626E+03	.17575E+03	.28626E+03	-.41904E+02
				6	6	K60	.18214E+11	.13769E+10	.18214E+11	-.24316E+09
				7	7	K70	.25900E+10	.29709E+09	.25900E+10	-.92050E+08
				8	8	K80	.46217E+17	.14142E+01	.46217E+17	-.96534E-17
				9	9	E	.42466E+05	.82583E+02	.42466E+05	.21382E+02
				10	10	E5	.23127E+05	.66147E+03	.23127E+05	-.25142E+03
				11	11	E6	.53398E+05	.24799E+03	.53398E+05	.70879E+02
				12	12	E7	.50507E+05	.10043E+03	.50507E+05	.27894E+01
				13	13	E8	.82926E+05	.66674E+03	.82926E+05	-.51114E+02
				14	14	M	.44104E-01	.17916E-01	.44104E-01	.49647E-02

TYPICAL OUTPUT (CONT'D)

FCN VALUE	CALLS	TIME	EDH	INT.EXT.	PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE	
.2232670E+03	1072	21.07	.33E+00	1	1	K10	.59441E+07	.77874E+06	.59441E+07	.13107E+05
				2	2	K20	.93454E+07	.12854E+07	.93454E+07	.22944E+05
				3	3	K30	.52592E+07	.76007E+06	.52592E+07	.18412E+05
				4	4	K40	.48988E+07	.23141E+07	.48988E+07	.57903E+05
				5	5	K50	.11034E+03	.72503E+02	.11034E+03	.85632E+01
				6	6	K60	.18289E+11	.12472E+10	.18289E+11	.17704E+08
				7	7	K70	.20031E+10	.40463E+09	.20031E+10	.16375E+08
				8	8	K80	.46217E+17	.14142E+01	.46217E+17	.17065E+16
				9	9	E	.42594E+05	.97893E+02	.42594E+05	.35657E+01
				10	10	E5	.21238E+05	.12585E+04	.21238E+05	.56880E+02
				11	11	E6	.53749E+05	.27434E+03	.53749E+05	.43525E+01
				12	12	E7	.50423E+05	.11592E+03	.50423E+05	.47440E+00
				13	13	E8	.84072E+05	.10215E+04	.84072E+05	.23307E+02
				14	14	M	.94030E-01	.32473E-01	.94030E-01	.99155E-03

MIGRAD TERMINATED WITHOUT CONVERGENCE

FCN VALUE	CALLS	TIME	EDH	INT.EXT.		PARAMETER	VALUE	ERROR	INTERN. VALUE	INT. STEP SIZE
.2222827E+03	1318	25.70	.81E-01	1	1	K10	.50089E+07	.64033E+06	.50089E+07	-.27695E+03
				2	2	K20	.75311E+07	.14606E+07	.75311E+07	.61640E+05
				3	3	K30	.43980E+07	.68186E+06	.43980E+07	.52160E+05
				4	4	K40	.45733E+07	.16061E+07	.45733E+07	.17723E+06
				5	5	K50	.51943E+02	.28715E+02	.51943E+02	-.16011E+00
				6	6	K60	.17209E+11	.14897E+10	.17209E+11	.12344E+08
				7	7	K70	.15529E+10	.32237E+09	.15529E+10	.18033E+08
				8	8	K80	.46217E+17	.14142E+01	.46217E+17	.39327E+16
				9	9	E	.42675E+05	.80404E+02	.42675E+05	-.53949E+01
				10	10	E5	.20089E+05	.82948E+03	.20089E+05	.83363E+02
				11	11	E6	.54196E+05	.33881E+03	.54196E+05	-.10643E+02
				12	12	E7	.50336E+05	.10895E+03	.50336E+05	-.22427E+00
				13	13	E8	.84170E+05	.79341E+03	.84170E+05	-.59296E+02
				14	14	M	.13692E+00	.28932E-01	.13692E+00	-.91282E-03

ERRORS CORRESPOND TO FUNCTION CHANGE OF 1.0000

 *** 6***EXIT -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 770000.00000

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