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TYPE III EXTENDED PILOT PLANT EVALUATION OF A PELLETIZED
AND GROUND KERR MC GEE MINERAL ASH RESIDUE FROM
SRC-1 COAL LIQUEFACTION PROCESS

By
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Allen M. Robin

February 1984
Date Published

Work Performed Under Contract No. AC01-76ET10137

Texaco, Inc.
Montebello, California

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GASIFICATION OF RESIDUAL MATERIALS
FROM COAL LIQUEFACTION

Type III Extended Pilot Plant Evaluation of a
Pelletized and Ground Kerr McGee
Mineral Ash Residue From SRC-I
Coal Liquefaction Process

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Date Published - February 1984

PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Under Contract No. DEAC 01-76ET-10137 (EX-76-C-01-2247)

Delivery Order Number 9

ABSTRACT

A Type III extended pilot plant evaluation of pelletized and ground Kerr McGee mineral ash residue, which was obtained from the liquefaction of Illinois No. 6 coal at the SRC-I coal liquefaction process pilot plant at Wilsonville, Alabama, was successfully completed at Texaco's Montebello Research Laboratory (MRL).

A total of 60 tons of residue was gasified during three runs which were carried out at 950 psig in the MRL High Pressure Solids Gasification Unit II gasifier. The oxygen-to-residue ratio was varied to determine optimum operating conditions. The runs lasted from 6.9 hours to 56.3 hours and a total of 72.9 hours of on-stream time was accumulated.

This work was authorized by DOE Delivery Order Number 9 under DOE contract DEAC-01-76ET-10137. It is part of a continuing project to evaluate residual materials from various DOE sponsored coal liquefaction projects to determine their suitability for conversion to hydrogen using one of the Texaco gasification processes.

TYPE III EXTENDED PILOT PLANT EVALUATION OF
A PELLETIZED AND GROUND KERR MCGEE MINERAL ASH RESIDUE
FROM SRC-I COAL LIQUEFACTION PROCESS

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I. SUMMARY

A Type III extended pilot plant evaluation of pelletized and ground Kerr McGee mineral ash residue was successfully completed at Texaco's Montebello Research Laboratory (MRL). The residue, which was produced from the liquefaction of Illinois No. 6 coal at the SRC-I coal liquefaction process pilot plant at Wilsonville, Alabama, was fed to the MRL pilot plant gasifier as a water slurry.

Approximately 60 tons of residue were gasified during three runs which were carried out between October 4 and October 13, 1983. The runs lasted from 6.9 hours to 56.3 hours, and a total of 72.9 hours of on-stream time was accumulated. Six test periods were completed during which the oxygen-to-residue ratio was varied. The gasifier pressure was held constant at 950 psig.

On the average, the residue contained 52.2 (wt) percent carbon, 37.5 (wt) percent ash and 3.1 (wt) percent sulfur.

The conversion of carbon in the feed to syngas varied from 96.9 (wt) percent to 99.5 (wt) percent. An average of 24.0 standard cubic feet of hydrogen plus carbon monoxide was produced per pound of residue gasified.

The unit operated well. Only two intermediate shut downs occurred and both were due to non process related causes. During the last run, the gasifier was operated continuously and satisfactorily for 56.3 hours. The unit was shut down when all of the slurry supply had been consumed.

The SRC-I Kerr McGee pelletized and ground mineral ash residue is an excellent feedstock for the Texaco Coal Gasification Process. Carbon conversion efficiencies obtained with this material were comparable to those previously obtained with other coal liquefaction residues when fed to the gasifier as a water slurry.

Based on the data obtained, it is estimated that a conceptual Texaco residue gasifier, when operated at a pressure of 950 psig, is capable of producing 120 million standard cubic feet per day of hydrogen plus carbon monoxide from 3,118 tons per day of the SRC-I pelletized and ground Kerr McGee mineral ash residue.

II. INTRODUCTION

A. Objectives

The objectives of a Type III extended pilot plant evaluation of coal liquefaction residues are to collect unit performance data, to determine the effects of pertinent design variables, to define optimum operating conditions and to obtain sufficient operating time to demonstrate unit operability.

The Type III evaluation consists of a series of pilot plant runs totaling 3-5 days of operation during which at least 40 tons of a coal liquefaction residue are gasified at a gasifier pressure between 350 and 1200 psig.

B. Background

Almost all coal liquefaction processes require hydrogen to solubilize the coal. It is desirable to produce the needed hydrogen primarily from the non-liquefied fraction of the coal. This material, together with the inorganic ash and some fraction of the unconverted coal, may be recovered in various forms depending on the particular process. Many of these streams will make excellent feedstocks for gasification using one of the Texaco gasification processes to produce synthesis gas, a mixture of hydrogen and carbon monoxide, which can readily be converted to pure hydrogen.

Texaco developed the non-catalytic partial oxidation process in the late 1940's to convert natural gas to synthesis gas which then was reacted with steam to form additional hydrogen. Further developments enabled the use of light oils, residual oils and asphalts as feedstocks. This process, known as the Texaco Synthesis Gas Generation Process, has been licensed for use in more than 90 plants throughout the world using a variety of liquid feedstocks. Molten coal liquefaction residues are gasified using a modification of the Texaco Synthesis Gas Generation Process.

The process which has been modified to handle slurries of high ash feedstocks such as coal and coal liquefaction residue, has been designated the Texaco Coal Gasification Process.

In the last few years, the Texaco coal gasification process has been widely accepted as one of the few second generation coal gasification processes which is ready for full commercialization.

To determine the suitability of various residual materials from DOE sponsored coal liquefaction projects as feedstocks to the Texaco gasification processes, DOE is sponsoring a series of tests to be conducted at Texaco's Montebello Research Laboratory.

Four levels of testing liquefaction residues are defined in the contract with DOE. The four types of tests are listed below followed by a brief description of each.

Test Description

<u>Test Type</u>	<u>Description</u>	<u>Max Sample Size</u>
I	Laboratory Evaluation	20 lbs
II	Preliminary Pilot Plant Evaluation	20 bbls (4 tons)
III	Extended Pilot Plant Evaluation	200 bbls (40 tons)
IV	Sustained Pilot Plant Evaluation	500 bbls (100 tons)

The Type I evaluation will determine the chemical composition and physical properties of each material using laboratory scale tests. On the basis of these results, the mode of feeding each material to a Texaco gasifier will be selected and the gasification conditions, yields and product gas composition will be estimated. An assessment of the suitability of the material for further testing will be made.

The Type II evaluation will consist of a preliminary pilot plant test in which approximately 20 barrels (4 tons) of the candidate feedstock will be gasified. This short pilot plant evaluation will confirm the operability of the process on the candidate feedstock and permit refining the estimates of preferred processing conditions, syngas production rate and composition. Unexpected operating problems will be identified.

The Type III evaluation will consist of an extended series of runs in which approximately 200 barrels (40 tons) of the candidate feedstock will be gasified. Operating conditions will be varied to further define the optimum. Definitive heat and material balance data will be obtained. The testing will provide information which will serve as the basis for an analysis of the thermal efficiency and operability of the particular liquefaction process from which the material is derived.

The Type IV evaluation will consist of a single sustained run of 7 to 10 days duration during which approximately 500 barrels (100 tons) of the candidate feedstock will be gasified. The objective is to prove operability, reach steady state conditions and obtain environmental analyses when requested. Operating conditions will be held substantially constant throughout the run.

All materials received will be given a Type I evaluation. Each succeeding type of evaluation will be performed only on the most promising materials from the preceding evaluation.

Only the first three levels of testing have been completed with the SRC-I Kerr McGee mineral ash residue.

Two Type I Laboratory Evaluations of Kerr McGee mineral ash residue were completed.

A sample of SRC-I Kerr McGee Mineral Ash Residue was first evaluated in the laboratory at MRL in 1977. This material was judged to be only a marginal feedstock for the Texaco Coal Gasification Process, because of its very fine particle size which produced a maximum pumpable slurry concentration of only 55 percent (see DOE report Fe 2247-12).

In order to increase the average particle size of this material, DOE arranged to have a sample of mineral ash residue (obtained from the liquefaction of Kentucky No. 9 Coal) pelletized then re-ground to a more desirable particle size distribution. This material was evaluated in the laboratory at MRL in 1980 (see DOE report Fe 2247-25) and found to be a much improved feedstock (pumpable concentrations greater than 60 percent could be obtained).

A Type II preliminary pilot plant evaluation of extruded SRC-I Kerr McGee mineral ash residue from Illinois No. 6 coal was completed in September, 1983. The residue, which was pretreated by extruding and grinding, was fed to the pilot plant gasifier as a water slurry. It was judged to be an acceptable feedstock for the Texaco Coal Gasification Process. Approximately 16 tons of residue were gasified at 950 psig during three runs. A total of 19.1 hours of on-stream time was accumulated (see DOE Report Fe 2247-34).

The residue tested and described in this report was pelletized and ground to obtain a larger average particle size. This procedure resulted in a significant increase in the maximum pumpable slurry concentration.

C. Scope

This report covers the results of a Type III Extended Pilot Plant Evaluation of pelletized and ground Kerr McGee mineral ash residue which was performed at Texaco's Montebello Research Laboratory under contract EX-76-C-01-2247 and amendment DEAC-01-76ET-10137 with the United States Department of Energy (DOE), during October 4-13, 1983. The work was authorized by DOE Delivery Order Number 9.

About 60 tons of the mineral ash residue, which were obtained from the SRC-I coal liquefaction process pilot plant in Wilsonville, Alabama during the liquefaction of Illinois No. 6 coal, were gasified in three separate runs. The total on-stream time was 72.9 hours and the longest continuous run lasted about 56.0 hours. The residue was fed to the pilot plant gasifier as a water slurry.

III. EXPERIMENTAL WORK

A. Charge Stock Analysis

1. SRC-I Pelletized and Ground Kerr McGee Mineral Ash Residue

The residue was received in one ton capacity plastic super sacks from Allis Chalmers' Process Research and Test Center in Oak Creek, Wisconsin. This material was originally obtained during the liquefaction of Illinois No. 6 coal from the SRC-I coal liquefaction process pilot plant at Wilsonville, Alabama. Because the residue cannot be melted, it must be fed to the Texaco gasifier as a slurry in water or other suitable carrier. DOE subcontracted with Allis Chalmers Company to treat the as-produced material by pelletizing and grinding to increase its average particle size. This resulted in a significant increase in the maximum pumpable solids concentration obtained as a water slurry. The maximum pumpable slurry concentration obtained with the untreated mineral ash residue was less than 55 wt. percent, while the maximum pumpable slurry concentration obtained with the treated mineral ash residue was greater than 65 wt. percent. Several key properties of the treated residue are summarized in Table I.

The as-received SRC-I pelletized and ground Kerr McGee mineral ash residue contained 53.3 wt. percent carbon, 37.1 wt. percent ash and 3.1 wt. percent sulfur and had a gross heating value of 9030 BTU per pound (moisture free basis). The ash fluid temperature in a reducing atmosphere was determined to be 2,340°F.

2. Oxygen

The oxygen used in this work was purchased from the Linde Division of Union Carbide. The oxygen is stored as a liquid and is pumped to the desired pressure. The oxygen is then vaporized by heat exchange with steam. The purity of the oxygen was 99.5 vol.%.

3. Process Water

Soft Water was used to make the slurry and to fill the pilot unit vessels prior to the run.

B. Pilot Plant Process Flow

1. Introduction

The Texaco Coal Gasification Process is a non-catalytic partial oxidation process that is based on certain reactions between oxygen and hydrocarbons that take place at high temperature to produce a synthesis gas composed primarily of carbon monoxide and hydrogen. The high temperature reactions occur when the hydrocarbon and a deficiency of oxygen are introduced under pressure into a refractory lined gasifier.

The details of the process are outlined on the following pages.

Table I

Analysis of SRC-I Pelletized and Ground Kerr
McGee Mineral Ash Residue As-Received

Ultimate Analysis (dry basis), Wt. %

Carbon	53.28
Hydrogen	2.92
Sulfur	3.14
Nitrogen	1.15
Ash	37.10
Oxygen (by difference)	2.41
Chloride, wppm	1540

Gross Heating Value, Btu/Lb	9030
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Ash Fusion Temperatures (Reducing Atmosphere), °F

Initial Deformation	1995
Softening	2160
Hemispherical	2225
Fluid	2340

Particle Size Distribution
Wt. % Solids Retained on U.S.
Sieve No.

20	0.64
40	9.28
60	20.92
100	16.67
200	18.19
325	10.12
-325	24.18

2. Residue-Water Slurry Preparation and Gasifier Feed System

Figure 1 shows the schematic diagram of the unit as it was used for this work. For the preparation of the residue-water slurry, the residue from the plastic sacks was mixed batchwise with soft water in the agitated mix tank. The slurry in the mix tank was then pumped to a stirred holding tank where final slurry concentration adjustments were made. The slurry was then pumped to the run tank. The run tank is mounted on a scale to allow monitoring the slurry charge rate. The slurry charge rate was controlled by adjusting the speed of the slurry charge pump.

The residue-water slurry and oxygen were fed through a proprietary Texaco burner into the top of the pilot plant gasifier. The residue-water slurry was pumped to the burner under pressure at a constant rate using a positive displacement feed pump.

3. Pilot Plant Gasifier

The pilot plant gasifier is a pressure vessel which is divided internally into two sections. The top section, combustion chamber, is lined with a special refractory material designed to withstand severe operating conditions. The mixed feed streams are ignited in this preheated gasifier combustion chamber where the partial oxidation reactions take place.

The lower section, quench chamber, is an unlined chamber containing a reservoir of water which is maintained at all times. In the quench chamber, the synthesis gas and slag are cooled by direct contact with the quench water. The quenched synthesis gas exits the quench chamber and is water scrubbed to remove residual particulates. After cooling and removal of condensed water, the dry syngas is metered and then routed to downstream sulfur removal units before being flared. Water is continuously injected into the quench chamber to replace water lost by evaporation and solids removal.

4. Slag Removal System

Slag and part of any char that is formed settle in the quench chamber and are removed periodically through the lockhopper system. The lockhopper blowdown solids are screened into coarse and fine fractions. The fines, after concentrating in the lockhopper fines settler, are periodically transferred to a transport receptacle for weighing, sampling and disposal. The coarse slag from the lockhopper is separately collected, weighed, sampled, and discarded.

5. Char Recovery and Water Recycle System

Quench water, used for cooling the hot syngas, exits the gasifier quench chamber and is combined with the scrubbing water and the condensate removed from the gas stream. The combined water streams (blowdown water)

Figure 1 High Pressure Solids Gasification Pilot Unit

are cooled and then routed to the clarifier where any particulate matter (char) in the water settles and is collected as a sludge from the bottom of the clarifier. This material is weighed, sampled and discarded. The clarified water flows to the flash tank where dissolved gases, evolved from depressuring the water, are removed as a flash gas stream which is metered and flared. The flash tank water is recycled back to the quench chamber and gas scrubber. Any water not required to maintain the flash tank level is removed from the system as a waste water stream.

C. Sampling and Data Collection

1. Samples

Process streams sampled at appropriate times throughout the test runs were: the residue-water slurry, synthesis gas, flash gas, coarse slag, lockhopper fines, clarifier bottoms, lockhopper fines water, clarifier overhead (waste water) and quench blowdown water. The averaged analytical data for the residue, synthesis gas, flash gas, coarse slag, lockhopper fines and clarifier bottoms are shown for each run in Appendices A and B.

Analytical data from the various water streams for each test run are available on request on a confidential basis only.

2. Operating Data

All pertinent operating data from the pilot unit were recorded on log sheets. Observations made during the runs are recorded in log books. These data are on file at MRL.

D. Calculations and Adjustment of Data

Material and energy balances were calculated using the MRL BESC-1 Material and Energy Balance Computer Program. Averaged data from slurry composites, and averages of gas analyses, test results on solids removed from the gasifier and operating data were used as input to the program. Raw data weight recoveries of the major components (carbon, oxygen and hydrogen) are shown below.

Run No.	1	2	3-A	3-B	3-C	3-D
Carbon	99.58	99.18	99.30	99.89	99.65	99.90
Oxygen	100.31	100.38	100.53	100.47	100.56	100.26
Hydrogen	99.42	99.31	99.05	99.15	99.01	99.53

All of the material balance data reported in the following section have been processed by computer to obtain 100 percent recoveries for each of the major elements. Each stream and the analysis of each stream is varied in relation to its known standard error until closure of all major elemental balances is obtained with a minimum total deviation. This usually results in very minor changes to the measured variables.

It is assumed that the measured amounts and concentrations of char-water slurry and lockhopper fines water slurry are relatively accurate. Any significant correction to the ash balance required was made to the

recovered coarse slag. Since the coarse slag contains very little carbon, this material has no effect on any of the other material balances.

Many of the variables that are used as input to each material balance are measured by at least two separate devices and then compared for redundancy before being used in the material balances. The syngas analyses were performed by an on-line mass spectrometer and an off-line chromatograph that analyzed gas bomb samples. These results agreed to within about 2% for each major component.

The raw pilot plant data are included in Appendix A and the computer balanced data are included in Appendix B.

IV. RESULTS AND DISCUSSION

A. Gasification of SRC-I Pelletized and Ground Kerr McGee Mineral Ash Residue-Water Slurry

1. Pilot Plant Operations

Three runs with six test periods were completed in the MRL High Pressure Solids Gasification Unit II (HPSGU-II). The runs lasted from 6.9 hours to 56.3 hours, and a total of 72.9 hours of on-stream time was accumulated. About 60 tons of the mineral ash residue were gasified during this work. The runs were carried out at a constant gasifier pressure of 950 psig and the gasifier temperature was controlled within the range of 2400-2600°F. A brief description for each test period is given below.

Run 1

The gasifier was charged with a water slurry of Kerr McGee mineral ash residue at a rate of 2405 lbs/hr. The oxygen feedrate was controlled to achieve an oxygen-to-residue ratio of 0.787 lb/lb. The unit was operated under steady conditions for 9.7 hours and was shut down by a power failure. No other operational problems had been encountered during the run. The carbon conversion was 99.3 percent.

Run 2

The gasifier was restarted at a slurry feedrate of 2388 lbs/hr. The oxygen-to-residue ratio was 0.775 lb/lb. The run lasted 6.9 hours and was manually shut down because of a coupling failure on the slurry booster pump. The carbon conversion was 99.2 percent.

Run 3

The gasifier was restarted after repairing the slurry booster pump and it operated continuously for 56.3 hours. It was manually shut down when all of the residue slurry supply had been consumed. The run was divided into four test periods each with a different oxygen-to-residue ratio.

Test Period A

The slurry rate was 2418 lbs/hr and the oxygen-to-residue ratio was 0.730 lb/lb. The carbon conversion was 98.8 percent. The overall performance of the unit was smooth and satisfactory during this 15 hour test period.

Test Period B

The oxygen-to-residue ratio was increased to 0.743 lb/lb during this 15 hour test period. The slurry feedrate was 2414 lbs/hr. The carbon conversion was 98.8 percent. No operational problems were encountered.

Test Period C

The oxygen-to-residue ratio was lowered to 0.706 lb/lb during this 16 hour test period. The slurry feedrate was 2393 lb/hr. Because of the low oxygen-to-residue ratio which resulted in a low gasifier temperature, a large quantity of lockhopper fines and clarifier bottoms (and a correspondingly small quantity of coarse slag) were obtained. The carbon conversion was 96.9 percent.

Test Period D

During this test period the oxygen-to-residue ratio was increased to 0.776 lb/lb. The slurry feed rate was 2398 lbs/hr. This test period was characterized by a large production of coarse slag attributable to the high oxygen-to-residue ratio. The unit operated smoothly for 10.25 hours. The run was terminated when all of the slurry supply had been consumed. The carbon conversion was 99.5 percent.

2. Discussion of Results

Table II summarizes the operating data obtained from the runs. Detailed results from the material balances which were based on raw data and computer balanced data are in Appendices A and B.

Depending on the operating condition, 96.9-99.5 percent conversion of carbon in the feed to syngas was achieved and 23.5-24.3 standard cubic feet of dry syngas per pound of residue gasified were produced. The dry syngas contained 77.4-79.2 (vol.) percent hydrogen plus carbon monoxide.

The dry product syngas analysis from each run is shown in Table II. The dry syngas had an average gross heating value of 319 BTU/SCF.

The composition of the dry syngas was influenced by the oxygen-to-residue ratio; this effect can be seen from Figures 2 through 4.

The CO₂ concentration in the dry syngas is plotted against the oxygen-to-residue ratio in Figure 2. The CO₂ concentration is seen to increase with increasing oxygen-to-residue ratio. The slope of the curve increases at high ratios of oxygen-to-residue when essentially complete conversion of carbon in the residue to syngas is achieved.

Figure 3 shows that the CO concentration in the dry syngas decreased as the oxygen-to-residue ratio was increased.

Figure 4 indicates that there was a slight decrease in the H₂ content of the dry syngas as the oxygen-to-residue ratio was increased.

A small amount of dissolved gases is flashed off when the pressure of the quench and scrubber blowdown water is lowered to atmospheric. The flash gas contained the same components as syngas with augmented amounts of CO₂ and H₂S due to the high relative solubilities of these two components. A detailed laboratory analysis of the flash gas for each run is in Appendices A and B. The flash gas was released at a rate of about 1.8-2.1 (vol) percent of the syngas produced.

Table II
Operating Data Summary *

Run No.	1	2	3-A	3-B	3-C	3-D
<u>INPUT STREAMS</u>						
Residue Rate, Lb/Hr	1613	1611	1619	1621	1609	1619
Water Rate, Lb/Hr	792	777	799	793	784	780
Oxygen Rate, Lb/Hr	1259	1248	1182	1205	1136	1251
Total Input	3664	3636	3600	3619	3529	3656
<u>PRODUCT STREAMS</u>						
Dry Syngas, Lb/Hr	2384	2377	2320	2348	2256	2394
Water (Calculated), Lb/Hr	595	580	599	590	577	582
Flash Gas, * Lb/Hr	69	68	55	60	54	68
Coarse Slag, Lb/Hr	479	454	318	348	336	492
Lockhopper Fines, Lb/Hr	125	148	275	253	268	109
Char, Lb/Hr	7	8	30	18	34	8
Total Out	3659	3635	3597	3617	3525	3653
<u>Residue Analysis, Wt%</u>						
C	52.72	52.75	51.55	52.11	51.54	52.46
H	3.00	3.00	2.95	2.96	2.86	2.98
N	1.24	1.11	1.13	1.12	1.15	1.21
S	3.14	3.05	2.93	2.98	2.98	3.07
Ash	37.38	37.33	37.72	37.44	37.91	37.20
O (By Diff)	2.51	2.76	3.71	3.39	3.56	3.08
Higher Heating Value, BTU/Lb	9085	9085	9045	9115	9065	9045
<u>Dry Product Gas Analysis</u>						
H ₂	31.61	31.79	31.95	31.93	32.29	31.45
CO	46.37	46.58	47.25	47.06	47.33	45.98
CO ₂	20.10	19.77	18.97	19.19	18.51	20.67
N ₂	0.57	0.53	0.52	0.54	0.57	0.56
H ₂ S	1.06	1.05	1.06	1.03	1.05	1.07
COS	0.08	0.08	0.05	0.05	0.04	0.07
CH ₄	0.01	0.02	0.02	0.02	0.03	0.01
A	0.19	0.19	0.18	0.18	0.18	0.19
SCF Syngas/Lb Residue	24.26	24.32	23.80	24.03	23.47	24.14
SCF (H ₂ +CO) /Lb Residue	18.92	19.06	18.85	18.98	18.69	18.69
Carbon Conversion, Wt%	99.3	99.2	98.8	98.8	96.9	99.5
Data Period, Hrs.	9.7	6.9	15.0	15.0	16.0	10.2

* Computer Balanced Data - Coarse Slag Forced to 100% Ash Recovery

FIGURE 2

SYNGAS CARBON DIOXIDE CONTENT VS. OXYGEN-TO-RESIDUE RATIO

FIGURE 3

SYNGAS CARBON MONOXIDE CONTENT VS. OXYGEN-TO-RESIDUE RATIO

FIGURE 4

SYNGAS HYDROGEN CONTENT VS. OXYGEN-TO-RESIDUE RATIO

3. Comparison of Predicted Vs. Actual Performance For The Gasification of Kerr McGee Mineral Ash Residue-Water Slurry

Table III includes predicted data and actual performance data for the gasification of Kerr McGee mineral ash residue-water slurry. The actual performance data were slightly adjusted by computer to yield 100 percent recoveries of the elements C, H, and O.

The predicted data are based on a previous Type II preliminary pilot plant evaluation of SRC-I extruded Kerr McGee mineral ash residue-water slurry (DOE Report Fe-2247-34, see Appendix E). The actual data are from the computer balance for Run 3-B. In general, the agreement between the two data sets is acceptable. The main differences are due to a lower than predicted carbon + hydrogen content of the residue.

B. Solids Discharged From the Gasifier

Three types of solids were discharged from the gasifier: coarse slag and lockhopper fines from the lockhopper, and clarifier bottoms (char) from the clarifier. The lockhopper solids were separated into coarse and fine fractions using a vibrating 11 mesh trapezoidal screen (0.078 inch opening). Table IV shows the properties of the discharged solids. Basis the raw pilot plant data, the recovery of input ash varied from 81.0 percent to 91.1.

The particle size distributions of coarse slag, lockhopper fines and char recovered during a typical high conversion run period (3D) are shown in Figure 5.

1. Coarse Slag

Coarse slag is characterized by its large particle size (generally about 50% retention on a 14 mesh screen) and rapid settling rate. Typically, the carbon content of the coarse slag is less than 1 wt% and the ash content is over 99 wt%.

The coarse slag recovered during these runs contained 0.26-3.21 wt% carbon, and 27-77 wt% of the solids were retained on a 14 mesh screen. The average bulk density of the coarse slag was 1.2 g/cc.

2. Lockhopper Fines

Lockhopper fines are generally characterized by a 2-10 wt% carbon content, with 60 wt% or more passing through a 40 mesh screen. The slag fines from the pelletized and ground Kerr McGee mineral ash residue-water slurry runs contained 2.85-8.16 wt% carbon, and 56-67 wt% of the solids passed through a 40 mesh screen. The low carbon content of the total lockhopper fines indicates that carbon recovery for recycle by settling may not be practical or economical.

Basis the raw pilot plant data, approximately 1.1-4.1 pounds of coarse slag were recovered per pound of lockhopper fines. The amount of lockhopper fines produced tends to decrease as the gasifier temperature is

Table III

Comparison of Predicted vs. Actual Performance
For the Gasification of Kerr McGee
Mineral Ash Residue-Water Slurry

	Predicted Data From DOE Report Fe-2247-34 Figure 6 Adjusted to the Same Residue Feed Rate as Run 3-B	Actual Data From Run 3-B
<u>Charge to Gasifier</u>		
Residue, Pounds per Hour	1621	1621
Oxygen, Pounds per Hour	1287	1205
Water, Pounds per Hour	798	793
Total Input	3706	3619
<u>Output From Gasifier</u>		
Dry Product Syngas, Pounds per Hour	2527	2348
Flash Gas, Pounds per Hour	0	60
Char, Pounds per Hour	155	18
Coarse Slag, Pounds per Hour	453	348
Lockhopper Fines, Pounds per Hour	-	253
Forced Water, Pounds per Hour	572	590
Total Output	3707	3617
<u>Analytical</u>		
Charge Residue Analysis, Weight Percent		
C	53.56	52.11
H	3.12	2.96
N	1.13	1.12
S	2.98	2.98
O (By Diff)	1.94	3.39
Ash	37.27	37.44
Higher Heating Value, BTU per Pound	9387	9115

Table III

(Continued)

Comparison of Predicted vs. Actual Performance
For the Gasification of Kerr McGee
Mineral Ash Residue-Water Slurry

Product Syngas Composition,
Mole Percent

H ₂	32.93	31.93
CO	44.27	47.06
CO ₂	20.66	19.19
N ₂	0.59	0.54
H ₂ S	1.28	1.03
COS	0.08	0.05
CH ₄	0.01	0.02
A	0.18	0.18
Carbon on Coarse Slag, Weight Percent	0	0.72
Carbon on Lockhopper Fines, Weight Percent	0	3.31
Carbon on Char, Weight Percent	2.8	8.10
Percent Carbon Conversion	99.5	98.8
Gasifier Pressure, psig	950	950
Dry Product Gas, Standard Cubic Feet per Hour	41,900	38,900
Hydrogen Plus Carbon Monoxide, Standard Cubic Feet per Hour	32,500	30,800

Table IV

Properties of Gasifier Discharged Solids

	Run No. 1				Run No. 2			
	Coarse Slag	Lockhopper Fines	Char	Total	Coarse Slag	Lockhopper Fines	Char	Total
% of Input Ash Recovered	60.9	19.1	1.0	81.0	63.3	22.1	1.1	86.5
Ultimate Analysis (wt%)								
C	1.10	4.32	13.40		0.52	4.08	7.37	
H	0.13	0.09	0.41		0	0.02	0.24	
N	0.26	0.06	0.13		0.03	0.06	0.12	
S	0.13	0.58	2.64		0.27	0.74	1.96	
Ash	98.38	94.85	83.37		99.18	95.10	90.31	
Total	100.00	100.00	100.00		100.00	100.00	100.00	
Bulk Density	1.19	1.24	-		1.39	1.20	-	
True Density	2.20	2.24	-		2.59	2.25	-	
Particle Size Distribution								
Wt% Solids Retained on U.S. Sieve No.								
8	11.76	-	-		52.53	-	-	
14	29.49	-	-		24.25	1.50	-	
20	24.15	10.65	-		13.80	9.38	0.42	
40	20.28	33.30	-		6.30	29.05	4.05	
100	9.71	35.65	-		2.11	32.18	5.51	
200	2.52	8.75	-		0.20	9.22	10.75	
325	0.00	2.79	-		0.05	6.23	25.10	
-325	2.09	8.86	-		0.76	12.44	54.17	

Table IV
(Continued)

	Run No. 3-A				Run No. 3-B			
	Coarse Slag	Lockhopper Fines	Char	Total	Coarse Slag	Lockhopper Fines	Char	Total
% of Input Ash Recovered	43.6	39.4	4.0	87.0	49.0	37.9	2.6	89.5
Ultimate Analysis (wt%)								
C	1.96	2.85	8.16		0.72	3.31	8.10	
H	0.10	0.11	0.23		0.02	0.18	0.23	
N	0.06	0.03	0.03		0.11	0.06	0.09	
S	0.26	0.51	1.61		0.33	0.86	1.54	
Ash	97.62	96.50	89.97		98.82	95.59	90.04	
Total	100.00	100.00	100.00		100.00	100.00	100.00	
Bulk Density	1.11	1.01	-		1.07	1.00	-	
True Density	2.40	2.01	-		2.03	2.11	-	
Particle Size Distribution								
Wt% Solids Retained on U.S. Sieve No.:								
8	22.32	-	-		16.34	-	-	
14	25.04	-	-		23.32	0.86	-	
20	24.64	9.52	0.03		21.64	5.01	0.81	
40	16.11	34.66	6.00		15.07	33.33	9.42	
100	7.12	29.43	1.03		17.63	45.11	15.36	
200	2.08	10.15	7.60		3.51	8.43	7.36	
325	0.34	4.82	23.71		1.01	1.88	8.24	
-325	2.35	11.42	61.61		1.48	5.38	58.81	

Table IV
(Continued)

	Run No. 3-C				Run No. 3-D			
	Coarse Slag	Lockhopper Fines	Char	Total	Coarse Slag	Lockhopper Fines	Char	Total
% of Input Ash Recovered	45.6	35.9	4.3	85.8	72.9	17.1	1.1	91.1
Ultimate Analysis (wt%)								
C	3.21	8.16	12.42		0.26	3.12	7.87	
H	0.08	0.02	0.25		0.16	0.42	0.27	
N	0.09	0.06	0.14		0.07	0.08	0.14	
S	0.56	0.50	1.44		0.37	1.34	1.80	
Ash	96.06	91.26	85.75		39.14	95.04	89.92	
Total	100.00	100.00	100.00		100.00	100.00	100.00	
Bulk Density	1.17	0.89	-		1.20	0.79	-	
True Density	2.00	1.63	-		2.27	1.57	-	
Particle Size Distribution								
Wt% Solids Retained on U.S. Sieve No.								
8	12.24	-	-		35.23	-	-	
14	14.41	-	1.24		19.00	-	1.45	
20	20.01	8.58	3.29		14.52	6.05	3.90	
40	23.66	37.10	11.95		18.10	26.96	14.82	
100	19.24	38.02	14.25		10.35	31.82	16.91	
200	4.71	9.10	7.20		1.81	12.12	4.61	
325	1.44	2.92	17.15		0.47	9.96	12.09	
-325	4.29	4.28	44.92		0.52	13.19	46.22	

FIGURE 5

PARTICLE SIZE DISTRIBUTION OF GASIFIER DISCHARGED SOLIDS FROM RUN 3-D

CUMULATIVE PERCENT THROUGH MESH

increased. On the average, 3.3 pounds of coarse slag per pound of lock-hopper fines were recovered at a carbon conversion level of about 99 percent. This ratio is strongly affected by the size and geometry of the gasifier and quench section and would be expected to change in a commercial sized plant.

3. Clarifier Bottoms (Char)

Clarifier bottoms are solids that have been entrained in the blowdown water system. They settle out in the clarifier and are periodically removed for weighing and sampling before being discarded. The clarifier bottoms are normally characterized by 50-60 wt% solids passing through a 325 mesh screen, a carbon content of 10-40 wt%, and a slower settling rate than lockhopper fines.

The clarifier bottoms solids obtained during the runs contained 7.4-13.4 wt% carbon and 45-62 wt% of the solids passed through a 325 mesh screen.

C. Water Quality

Samples of quench and scrubber blowdown water and clarifier overhead water were taken for analysis during each test period. The results of the laboratory analyses of these samples are available upon request on a confidential basis. Based on the water quality data, the water does not appear to have any unusual components that would cause problems during treatment for disposal.

V. ESTIMATED PERFORMANCE OF A COMMERCIAL GASIFIER

Based on the data obtained during this program, it is estimated that a conceptual residue gasifier, when operated at 950 psig, is capable of producing 120 million standard cubic feet per day of hydrogen plus carbon monoxide from 3118 tons per day of the SRC-I pelletized and ground Kerr McGee mineral ash residue. Table V summarizes the estimated material balance for commercial operation at 950 psig with the residue. It was assumed that 99 percent of the feed carbon will be gasified. The remaining one percent of the feed carbon will be recovered as a char and disposed of with the slag.

The residue will be fed to the gasifier as a water slurry with about 0.76 pounds of pure oxygen per pound of residue to produce 19.3 standard cubic feet of hydrogen plus carbon monoxide per pound of residue gasified.

Following gasification, water gas shift conversion and acid gas cleanup will be required to produce pure hydrogen for the liquefaction reactors. These processes are commercially available.

Table V

Estimated Performance of a Commercial Texaco
Gasifier with SRC-I Pelletized and Ground
Kerr McGee Mineral Ash Residue-Water Slurry

Residue Feed Rate, Lb/Hr	259,800
Water Feed Rate, Lb/Hr	128,000
Pure Oxygen Feed Rate, Lb/Hr	197,000
Ultimate Analysis of Residue Feed	
Wt. Percent, Moisture Free	
Carbon	52.24
Hydrogen	2.96
Nitrogen	1.16
Sulfur	3.02
Oxygen (By Diff)	3.16
Ash	37.46
Higher Heating Value, BTU/Lb	9070
Product Gas Composition, Mole Percent	
Dry Gas	
CO	43.82
H ₂	32.80
CO ₂	21.14
H ₂ O	-
CH ₄	0.01
A	0.18
N ₂	0.63
H ₂ S	1.33
COS	0.09
H ₂ +CO Production, MSCFH	5,000
Dry Syngas Production, MSCFH	6,530
Slag, Lb/Hr	77,860
Char, Lb/Hr	20,820
Carbon Content of Char, Wt. Pct.	6.52

VI. CONCLUSIONS

1. The SRC-I pelletized and ground Kerr McGee mineral ash residue from Illinois No. 6 coal is an excellent feedstock for the Texaco Coal Gasification process when fed to the gasifier as a water slurry. Higher slurry solids concentrations were achieved with this material than are possible to achieve with the as-produced residue.
2. About 60 tons of the residue were successfully gasified during three runs at 950 psig.
3. The most efficient run (Run 3-B) was carried out at an oxygen-to-residue ratio of 0.74 lb/lb. Under these conditions, the dry syngas contained 79 vol.% CO+H₂ (dry basis), the carbon conversion was 98.8 wt% and 19.0 SCF of CO+H₂ were produced per pound of residue gasified.
4. The results from this study are comparable to the results obtained with other coal liquefaction residues which were fed to the Texaco gasifier as a water slurry.

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APPENDIX A

Raw Data

RAW DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER

1

RUN PERIOD HOURS

9.73

DATE

10/4/83

FUEL TYPE

SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	27.33	.07	0.00	0.00	.17	.02
H2	12354.78	31.64	0.00	0.00	169.76	20.29
CO	18126.07	46.42	0.00	0.00	181.81	21.73
CO2	7868.17	20.15	0.00	0.00	437.41	52.28
N2	222.57	.57	0.00	0.00	5.44	.65
CH4	3.90	.01	0.00	0.00	.08	.01
H2S	413.91	1.06	0.00	0.00	41.42	4.95
COS	31.24	.08	0.00	0.00	.59	.07
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	23.11		0.00		31.43	

RECOVERED SOLIDS DATA

DRY FUEL ANALYSIS

O2/AIR ANALYSIS

				WTPCT	MOLPCT		
LH	SLAG	LB/HR	368.06	C	52.76	O2	99.50
LH	FINES	LB/HR	121.15	H	3.00	A	.50
SETTLER FINES		LB/HR	7.04	N	1.24	H2	0.00
FINES ANAL		LH	SETTLER	S	3.14	CO	0.00
PCT	C	4.32	13.40	ASH	37.35	CO2	0.00
PCT	S	.68	2.64	O	2.51	N2	0.00
PCT	H	.09	.41	CL	0.00	TOT	100.00
PCT	ASH	94.91	83.55	TOT	100.00	AMWT	32.04

CHARGE DATA

PRODUCT DATA

COAL SLURRY LBS/HR 2410.00

INT SYN GAS, SCFH 39047.98

PCT COAL WT PCT 67.10

EXT SYN GAS, SCFH 0.00

COAL RATE LBS/HR 1617.11

FLASH GAS, SCFH 836.67

O2/AIR RATE SCFH 14979.02

SOLIDS, LBS/HR 496.25

H2O, FORCED, LB/HR 601.53

PERFORMANCE PARAMETERS

PER LB COAL FEED PER LB C FEED

SCF SYNGAS	24.147	45.767
SCF FLASH GAS	.517	.981
LBS OXYGEN INPUT	.781	1.480
LBS WATER INPUT	.490	.929
SCC =	53.053	

RAW DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER RUN PERIOD HOURS DATE
2 6.90 10/5/83
FUEL TYPE
SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	35.17	.09	0.00	0.00	.74	.09
H2	12420.01	31.78	0.00	0.00	160.05	19.51
CO	18211.84	46.60	0.00	0.00	185.32	22.59
CO2	7757.62	19.85	0.00	0.00	427.81	52.15
N2	207.13	.53	0.00	0.00	3.86	.47
CH4	7.82	.02	0.00	0.00	0.00	0.00
H2S	410.35	1.05	0.00	0.00	41.84	5.10
COS	31.26	.08	0.00	0.00	.74	.09
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	23.02		0.00		31.63	

RECOVERED SOLIDS DATA				DRY FUEL ANALYSIS		O2/AIR ANALYSIS	
				WTPCT		MOLPCT	
LH	SLAG	LB/HR	382.06	C	52.83	O2	99.50
LH	FINES	LB/HR	140.25	H	3.00	A	.50
SETTLER FINES		LB/HR	7.36	N	1.11	H2	0.00
FINES ANAL		LH	SETTLER	S	3.04	CO	0.00
PCT	C	4.08	7.37	ASH	37.27	CO2	0.00
PCT	S	.74	1.96	O	2.75	N2	0.00
PCT	H	.02	.24	CL	0.00	TOT	100.00
PCT	ASH	95.16	90.43	TOT	100.00	AMWT	32.04

CHARGE DATA		PRODUCT DATA	
COAL SLURRY LBS/HR	2400.00	INT SYN GAS,SCFH	39081.19
PCT COAL WT PCT	67.50	EXT SYN GAS,SCFH	0.00
COAL RATE LBS/HR	1620.00	FLASH GAS,SCFH	820.35
O2/AIR RATE SCFH	14814.33	SOLIDS,LBS/HR	529.67
		H2O, FORCED, LB/HR	586.05

PERFORMANCE PARAMETERS
PER LB COAL FEED PER LB C FEED

SCF SYNGAS	24.124	45.664
SCF FLASH GAS	.506	.959
LBS OXYGEN INPUT	.771	1.460
LBS WATER INPUT	.481	.911
SCC =	52.886	

RAW DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER	RUN PERIOD HOURS	DATE
3-A	15.00	10/11/83
FUEL TYPE		
SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION-TEST PERIOD 1		

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	23.10	.06	0.00	0.00	.07	.01
H2	12288.00	31.92	0.00	0.00	160.40	22.95
CO	18201.03	47.28	0.00	0.00	168.86	24.16
CO2	7348.93	19.09	0.00	0.00	331.22	47.37
N2	200.18	.52	0.00	0.00	3.10	.73
CH4	7.70	.02	0.00	0.00	.14	.02
H2S	408.06	1.06	0.00	0.00	32.57	4.66
COS	19.25	.05	0.00	0.00	.56	.08
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	22.85		0.00		29.93	

RECOVERED SOLIDS DATA				DRY FUEL ANALYSIS		O2/AIR ANALYSIS	
				WTPCT			MOLPCT
LH	SLAG	LB/HR	267.52	C	51.63	O2	99.50
LH	FINES	LB/HR	249.98	H	2.95	A	.50
SETTLER FINES		LB/HR	27.61	N	1.13	H2	0.00
FINES ANAL		LH	SETTLER	S	2.93	CO	0.00
PCT	C	2.85	8.16	ASH	37.66	CO2	0.00
PCT	S	.51	1.61	O	3.70	N2	0.00
PCT	H	.11	.23	CL	0.00	TOT	100.00
PCT	ASH	96.53	90.00	TOT	100.00	AMWT	32.04

CHARGE DATA		PRODUCT DATA	
COAL SLURRY LBS/HR	2430.00	INT SYN GAS,SCFH	38496.26
PCT COAL WT PCT	67.00	EXT SYN GAS,SCFH	0.00
COAL RATE LBS/HR	1628.10	FLASH GAS,SCFH	698.93
O2/AIR RATE SCFH	14020.07	SOLIDS,LBS/HR	545.11
		H2O, FORCED, LB/HR	603.73

PERFORMANCE PARAMETERS			
PER LB COAL FEED		PER LB C FEED	
SCF SYNGAS	23.645	45.797	
SCF FLASH GAS	.429	.831	
LBS OXYGEN INPUT	.726	1.406	
LBS WATER INPUT	.493	.954	
SCC =	53.400		

RAW DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER	RUN PERIOD HOURS	DATE
3-B	15.00	10/12/83
FUEL TYPE		
SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION-TEST PERIOD 2		

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	23.38	.06	0.00	0.00	.15	.02
H2	12430.66	31.90	0.00	0.00	165.27	21.98
CO	18353.73	47.10	0.00	0.00	185.95	24.73
CO2	7520.74	19.30	0.00	0.00	356.40	47.40
N2	210.42	.54	0.00	0.00	4.96	.56
CH4	7.79	.02	0.00	0.00	.08	.01
H2S	401.37	1.03	0.00	0.00	38.42	5.11
COS	19.48	.05	0.00	0.00	.68	.09
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	22.89		0.00		30.22	

RECOVERED SOLIDS DATA				DRY FUEL ANALYSIS		O2/AIR ANALYSIS	
				WTPCT			MOLPCT
LH SLAG	LB/HR	298.04		C	52.14	O2	99.50
LH FINES	LB/HR	240.56		H	2.96	A	.50
SETTLER FINES	LB/HR	17.40		N	1.12	H2	0.00
FINES ANAL	LH	SETTLER		S	2.98	CO	0.00
PCT C	3.31	8.10		ASH	37.41	CO2	0.00
PCT S	.86	1.54		O	3.39	N2	0.00
PCT H	.18	.23		CL	0.00	TOT	100.00
PCT ASH	95.65	90.13		TOT	100.00	AMWT	32.04

CHARGE DATA

COAL SLURRY LBS/HR	2420.00
PCT COAL WT PCT	67.15
COAL RATE LBS/HR	1625.03
O2/AIR RATE SCFH	14311.75

PRODUCT DATA

INT SYN GAS, SCFH	38967.59
EXT SYN GAS, SCFH	0.00
FLASH GAS, SCFH	751.90
SOLIDS, LBS/HR	556.00
H2O, FORCED, LB/HR	590.52

PERFORMANCE PARAMETERS

PER LB COAL FEED PER LB C FEED

SCF SYNGAS	23.980	45.991
SCF FLASH GAS	.463	.887
LBS OXYGEN INPUT	.743	1.424
LBS WATER INPUT	.489	.938
SCC =	52.787	

RAW DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER 3-C RUN PERIOD HOURS 16.00 DATE 10/12/83
FUEL TYPE
SRC-I KERR MCGEE RESIDUE-TYPE III EVALUTION-TEST PERIOD 3

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	18.90	.05	0.00	0.00	.49	.07
H2	12190.99	32.25	0.00	0.00	165.62	23.82
CO	17906.59	47.37	0.00	0.00	167.42	24.08
CO2	7046.20	18.64	0.00	0.00	323.52	46.53
N2	215.47	.57	0.00	0.00	5.01	.72
CH4	11.34	.03	0.00	0.00	.35	.05
H2S	396.92	1.05	0.00	0.00	32.40	4.66
COS	15.12	.04	0.00	0.00	.49	.07
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	22.69		0.00		29.57	

RECOVERED SOLIDS DATA				DRY FUEL ANALYSIS		O2/AIR ANALYSIS	
				WTPCT		MOLPCT	
LH	SLAG	LB/HR	278.97	C	51.58	O2	99.50
LH	FINES	LB/HR	240.63	H	2.86	A	.50
SETTLER FINES		LB/HR	30.42	N	1.15	H2	0.00
FINES ANAL		LH	SETTLER	S	2.98	CO	0.00
PCT	C	8.16	12.42	ASH	37.88	CO2	0.00
PCT	S	.50	1.44	O	3.55	N2	0.00
PCT	H	.02	.25	CL	0.00	TOT	100.00
PCT	ASH	91.32	85.89	TOT	100.00	AMWT	32.04

CHARGE DATA
COAL SLURRY LBS/HR 2400.00
PCT COAL WT PCT 67.25
COAL RATE LBS/HR 1614.00
O2/AIR RATE SCFH 13480.74

PRODUCT DATA
INT SYN GAS, SCFH 37801.53
EXT SYN GAS, SCFH 0.00
FLASH GAS, SCFH 695.29
SOLIDS, LBS/HR 550.02
H2O, FORCED, LB/HR 577.45

PERFORMANCE PARAMETERS
PER LB COAL FEED PER LB C FEED
SCF SYNGAS 23.421 45.407
SCF FLASH GAS .431 .835
LBS OXYGEN INPUT .704 1.365
LBS WATER INPUT .487 .944
SCC = 53.626

RAW DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER RUN PERIOD HOURS DATE
 3-D 10.25 10/13/83
 FUEL TYPE
 SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION-TEST PERIOD 4

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	27.32	.07	0.00	0.00	.44	.05
H2	12285.90	31.48	0.00	0.00	198.69	22.81
CO	17964.43	46.03	0.00	0.00	226.30	25.98
CO2	8082.63	20.71	0.00	0.00	398.17	45.71
N2	218.55	.56	0.00	0.00	5.92	.68
CH4	3.90	.01	0.00	0.00	.09	.01
H2S	417.60	1.07	0.00	0.00	40.77	4.68
COS	27.32	.07	0.00	0.00	.70	.08
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	23.24		0.00		29.71	

RECOVERED SOLIDS DATA				DRY FUEL ANALYSIS		O2/AIR ANALYSIS	
				WTPCT		MOLPCT	
LH	SLAG	LB/HR	439.13	C	52.47	O2	99.50
LH	FINES	LB/HR	108.09	H	2.98	A	.50
SETTLER FINES		LB/HR	7.73	N	1.21	H2	0.00
FINES ANAL		LH	SETTLER	S	3.07	CO	0.00
PCT	C	3.12	7.87	ASH	37.19	CO2	0.00
PCT	S	1.34	1.80	O	3.08	N2	0.00
PCT	H	.42	.27	CL	0.00	TOT	100.00
PCT	ASH	95.12	90.06	TOT	100.00	AMWT	32.04

CHARGE DATA			PRODUCT DATA		
COAL SLURRY	LBS/HR	2400.00	INT SYN GAS, SCFH	39027.65	
PCT COAL	WT PCT	67.50	EXT SYN GAS, SCFH	0.00	
COAL RATE	LBS/HR	1620.00	FLASH GAS, SCFH	871.07	
O2/AIR RATE	SCFH	14975.78	SOLIDS, LBS/HR	554.95	
			H2O, FORCED, LB/HR	586.59	

PERFORMANCE PARAMETERS			
PER LB COAL FEED		PER LB C FEED	
SCF SYNGAS	24.091	45.914	
SCF FLASH GAS	.530	1.025	
LBS OXYGEN INPUT	.780	1.486	
LBS WATER INPUT	.481	.918	
SCC =	53.553		

APPENDIX B

Computer Balanced Data

COMPUTER BALANCED DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER 1 RUN PERIOD HOURS 9.73 DATE 10/4/83
FUEL TYPE
SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	74.86	.19	0.00	0.00	.17	.02
H2	12371.52	31.61	0.00	0.00	169.76	20.29
CO	18147.45	46.37	0.00	0.00	181.80	21.73
CO2	7866.87	20.10	0.00	0.00	437.40	52.28
N2	222.77	.57	0.00	0.00	5.44	.65
CH4	3.91	.01	0.00	0.00	.08	.01
H2S	414.28	1.06	0.00	0.00	41.41	4.95
COS	31.27	.08	0.00	0.00	.59	.07
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	23.12		0.00		31.43	

RECOVERED SOLIDS DATA				DRY FUEL ANALYSIS		O2/AIR ANALYSIS	
				WTPCT		MOLPCT	
LH	SLAG	LB/HR	478.69	C	52.72	O2	99.50
LH	FINES	LB/HR	124.53	H	3.00	A	.50
SETTLER FINES		LB/HR	7.23	N	1.24	H2	0.00
FINES ANAL		LH	SETTLER	S	3.14	CO	0.00
PCT	C	4.32	13.40	ASH	37.38	CO2	0.00
PCT	S	.68	2.64	O	2.51	N2	0.00
PCT	H	.09	.41	CL	0.00	TOT	100.00
PCT	ASH	94.91	83.55	TOT	100.00	AMWT	32.04

UNACCOUNTED FOR H2S .264 M/HR
UNACCOUNTED FOR NH3 .226 M/HR

CHARGE DATA			PRODUCT DATA	
COAL SLURRY	LBS/HR	2404.53	INT SYN GAS, SCFH	39132.92
PCT COAL	WT PCT	67.08	EXT SYN GAS, SCFH	0.00
COAL RATE	LBS/HR	1613.03	FLASH GAS, SCFH	836.64
O2/AIR RATE	SCFH	15005.47	SOLIDS, LBS/HR	610.46
			H2O, FORCED, LB/HR	594.60

PERFORMANCE PARAMETERS
PER LB COAL FEED PER LB C FEED

SCF SYNGAS 24.261 46.015
SCF FLASH GAS .519 .984
LBS OXYGEN INPUT .784 1.488
LBS WATER INPUT .491 .931
SCC = 52.853

METERED TO CALCULATED FLOW RATIOS

O2= .998 SLURRY=1.002 UNC CARBON= .973 TOT SYNGAS= .998 FLASH GAS=1.000
INT SYNGAS- PCT N2=1.00 PCT H2S=1.00 EXT SYNGAS- PCT N2=1.00 PCT H2S=1.00

COMPUTER BALANCED DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER 2 RUN PERIOD HOURS 6.90 DATE 10/5/83
FUEL TYPE
SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	73.64	.19	0.00	0.00	.74	.09
H2	12453.53	31.79	0.00	0.00	159.97	19.51
CO	18249.31	46.58	0.00	0.00	185.22	22.59
CO2	7745.94	19.77	0.00	0.00	427.59	52.15
N2	207.46	.53	0.00	0.00	3.85	.47
CH4	7.83	.02	0.00	0.00	0.00	0.00
H2S	411.01	1.05	0.00	0.00	41.82	5.10
COS	31.31	.08	0.00	0.00	.74	.09
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	23.02		0.00		31.63	

RECOVERED SOLIDS DATA				DRY FUEL ANALYSIS		O2/AIR ANALYSIS	
				WTPCT			MOLPCT
LH	SLAG	LB/HR	453.66	C	52.75	O2	99.50
LH	FINES	LB/HR	148.00	H	3.00	A	.50
SETTLER FINES LB/HR 7.76				N	1.11	H2	0.00
FINES ANAL LH SETTLER				S	3.05	CO	0.00
PCT	C	4.08	7.37	ASH	37.33	CO2	0.00
PCT	S	.74	1.96	O	2.76	N2	0.00
PCT	H	.02	.24	CL	0.00	TOT	100.00
PCT	ASH	95.16	90.43	TOT	100.00	AMWT	32.04

UNACCOUNTED FOR H2S .214 M/HR
UNACCOUNTED FOR NH3 .165 M/HR

CHARGE DATA		PRODUCT DATA	
COAL SLURRY	LBS/HR 2388.39	INT SYN GAS, SCFH	39100.03
PCT COAL WT	PCT 67.46	EXT SYN GAS, SCFH	0.00
COAL RATE	LBS/HR 1611.31	FLASH GAS, SCFH	819.92
O2/AIR RATE	SCFH 14874.89	SOLIDS, LBS/HR	609.42
		H2O, FORCED, LB/HR	579.63

PERFORMANCE PARAMETERS		
	PER LB COAL FEED	PER LB C FEED
SCF SYNGAS	24.316	46.093
SCF FLASH GAS	.509	.965
LBS OXYGEN INPUT	.778	1.476
LBS WATER INPUT	.482	.914
SCC =	52.481	

METERED TO CALCULATED FLOW RATIOS

O2= .996 SLURRY=1.005 UNC CARBON= .948 TOT SYNGAS= .997 FLASH GAS=1.001
INT SYNGAS- PCT N2=1.00 PCT H2S=1.00 EXT SYNGAS- PCT N2=1.00 PCT H2S=1.00

**COMPUTER BALANCED DATA
MONTEBELLO COAL GASIFICATION GENERATOR**

RUN NUMBER 3-A **RUN PERIOD HOURS** 15.00 **DATE** 10/11/83
FUEL TYPE
SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION-TEST PERIOD 1

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	70.40	.18	0.00	0.00	.07	.01
H2	12313.77	31.95	0.00	0.00	160.18	22.95
CO	18210.70	47.25	0.00	0.00	168.62	24.16
CO2	7311.30	18.97	0.00	0.00	330.76	47.39
N2	200.30	.52	0.00	0.00	5.10	.73
CH4	7.70	.02	0.00	0.00	.14	.02
H2S	408.31	1.06	0.00	0.00	32.52	4.66
COS	19.26	.05	0.00	0.00	.56	.08
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	22.84		0.00		29.93	

RECOVERED SOLIDS DATA

LH	SLAG	LB/HR	318.37
LH	FINES	LB/HR	274.62
SETTLER	FINES	LB/HR	30.33
FINES ANAL	LH	SETTLER	
PCT	C	2.85	8.16
PCT	S	.51	1.61
PCT	H	.11	.23
PCT	ASH	96.53	90.00

DRY FUEL ANALYSIS

WTPCT	
C	51.55
H	2.95
N	1.13
S	2.93
ASH	37.72
O	3.71
CL	0.00
TOT	100.00

O2/AIR ANALYSIS

MOLPCT	
O2	99.50
A	.50
H2	0.00
CO	0.00
CO2	0.00
N2	0.00
TOT	100.00
AMWT	32.04

UNACCOUNTED FOR H2S .209 M/HR
UNACCOUNTED FOR NH3 .226 M/HR

CHARGE DATA

COAL SLURRY	LBS/HR	2418.02
PCT COAL WT	PCT	66.97
COAL RATE	LBS/HR	1619.23
O2/AIR RATE	SCFH	14093.53

PRODUCT DATA

INT SYN GAS	SCFH	38541.74
EXT SYN GAS	SCFH	0.00
FLASH GAS	SCFH	697.95
SOLIDS	LBS/HR	623.32
H2O, FORCED	LB/HR	598.81

PERFORMANCE PARAMETERS

PER LB COAL FEED PER LB C FEED

SCF SYNGAS	23.802	46.171
SCF FLASH GAS	.431	.836
LBS OXYGEN INPUT	.734	1.424
LBS WATER INPUT	.493	.957
SCC =	53.047	

METERED TO CALCULATED FLOW RATIOS

O2= .995 SLURRY=1.005 UNC CARBON= .910 TOT SYNGAS= .999 FLASH GAS=1.001
INT SYNGAS- PCT N2=1.00 PCT H2S=1.00 EXT SYNGAS- PCT N2=1.00 PCT H2S=1.00

COMPUTER BALANCED DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER 3-B RUN PERIOD HOURS 15.00 DATE 10/12/83

FUEL TYPE

SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION-TEST PERIOD 2

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	71.68	.18	0.00	0.00	.15	.02
H2	12433.80	31.93	0.00	0.00	164.93	21.98
CO	18327.33	47.06	0.00	0.00	185.56	24.73
CO2	7472.04	19.19	0.00	0.00	355.67	47.40
N2	210.25	.54	0.00	0.00	4.95	.66
CH4	7.79	.02	0.00	0.00	.08	.01
H2S	401.04	1.03	0.00	0.00	38.34	5.11
COS	19.47	.05	0.00	0.00	.68	.09
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	22.88		0.00		30.22	

RECOVERED SOLIDS DATA

DRY FUEL ANALYSIS
WTPCT

O2/AIR ANALYSIS
MOLPCT

LH SLAG LB/HR	348.27	C	52.11	O2	99.50
LH FINES LB/HR	252.95	H	2.96	A	.50
SETTLER FINES LB/HR	18.30	N	1.12	H2	0.00
FINES ANAL LH	SETTLER	S	2.98	CO	0.00
PCT C	3.31	ASH	37.44	CO2	0.00
PCT S	.86	O	3.39	N2	0.00
PCT H	.18	CL	0.00	TOT	100.00
PCT ASH	95.65	TOT	100.00	AMWT	32.04

UNACCOUNTED FOR H2S .220 M/HR
UNACCOUNTED FOR NH3 .163 M/HR

CHARGE DATA

COAL SLURRY LBS/HR 2414.01
PCT COAL WT PCT 67.13
COAL RATE LBS/HR 1620.62
O2/AIR RATE SCFH 14366.63

PRODUCT DATA

INT SYNGAS, SCFH 38943.41
EXT SYNGAS, SCFH 0.00
FLASH GAS, SCFH 750.35
SOLIDS, LBS/HR 619.52
H2O, FORCED, LB/HR 589.54

PERFORMANCE PARAMETERS

PER LB COAL FEED PER LB C FEED
SCF SYNGAS 24.030 46.118
SCF FLASH GAS .463 .889
LBS OXYGEN INPUT .748 1.435
LBS WATER INPUT .490 .940
SCC = 52.684

METERED TO CALCULATED FLOW RATIOS

O2= .996 SLURRY=1.002 UNC CARBON= .951 TOT SYNGAS=1.001 FLASH GAS=1.002
INT SYNGAS- PCT N2=1.00 PCT H2S=1.00 EXT SYNGAS- PCT N2=1.00 PCT H2S=1.00

COMPUTER BALANCED DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER

3-C

RUN PERIOD HOURS

16.00

DATE

10/12/83

FUEL TYPE

SRC-I KERR MCGEE RESIDUE-TYPE III EVALUTION-TEST PERIOD 3

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	67.23	.18	0.00	0.00	.49	.07
H2	12193.46	32.29	0.00	0.00	165.21	23.82
CO	17870.21	47.33	0.00	0.00	167.02	24.08
CO2	6988.94	18.51	0.00	0.00	322.73	46.53
N2	215.22	.57	0.00	0.00	4.99	.72
CH4	11.33	.03	0.00	0.00	.35	.05
H2S	396.46	1.05	0.00	0.00	32.32	4.66
COS	15.10	.04	0.00	0.00	.49	.07
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	22.67		0.00		29.57	

RECOVERED SOLIDS DATA

DRY FUEL ANALYSIS
WTPCT

O2/AIR ANALYSIS
MOLPCT

LH SLAG LB/HR	336.25	C	51.54	O2	99.50
LH FINES LB/HR	267.87	H	2.86	A	.50
SETTLER FINES LB/HR	33.87	N	1.15	H2	0.00
FINES ANAL LH SETTLER		S	2.98	CO	0.00
PCT C 8.16	12.42	ASH	37.91	CO2	0.00
PCT S .50	1.44	O	3.56	N2	0.00
PCT H .02	.25	CL	0.00	TOT	100.00
PCT ASH 91.32	85.89	TOT	100.00	AMWT	32.04

UNACCOUNTED FOR H2S .269 M/HR
UNACCOUNTED FOR NH3 .161 M/HR

CHARGE DATA

COAL SLURRY LBS/HR 2393.08
PCT COAL WT PCT 67.23
COAL RATE LBS/HR 1608.91
O2/AIR RATE SCFH 13542.84

PRODUCT DATA

INT SYN GAS, SCFH 37757.97
EXT SYN GAS, SCFH 0.00
FLASH GAS, SCFH 693.59
SOLIDS, LBS/HR 637.98
H2O, FORCED, LB/HR 576.76

PERFORMANCE PARAMETERS

PER LB COAL FEED PER LB C FEED

SCF SYNGAS 23.468 45.534
SCF FLASH GAS .431 .836
LBS OXYGEN INPUT .710 1.377
LBS WATER INPUT .487 .946
SCC = 53.517

METERED TO CALCULATED FLOW RATIOS

O2= .995 SLURRY=1.003 UNC CARBON= .898 TOT SYNGAS=1.001 FLASH GAS=1.002
INT SYNGAS- PCT N2=1.00 PCT H2S=1.00 EXT SYNGAS- PCT N2=1.00 PCT H2S=1.00

COMPUTER BALANCED DATA
MONTEBELLO COAL GASIFICATION GENERATOR

RUN NUMBER RUN PERIOD HOURS DATE
3-D 10.25 10/13/83
FUEL TYPE
SRC-I KERR MCGEE RESIDUE-TYPE III EVALUATION-TEST PERIOD 4

DRY PRODUCT GAS STREAMS FROM COAL GASIFICATION

COMPONENTS	INTERNAL SYNGAS		EXTERNAL SYNGAS		FLASH GAS	
	SCFH	MOLPCT	SCFH	MOLPCT	SCFH	MOLPCT
C6H6	0.00	0.00	0.00	0.00	0.00	0.00
A	74.50	.19	0.00	0.00	.44	.05
H2	12290.03	31.45	0.00	0.00	198.67	22.81
CO	17967.79	45.98	0.00	0.00	226.28	25.98
CO2	8078.38	20.67	0.00	0.00	398.12	45.71
N2	218.59	.56	0.00	0.00	5.92	.68
CH4	3.90	.01	0.00	0.00	.09	.01
H2S	417.66	1.07	0.00	0.00	40.76	4.68
COS	27.32	.07	0.00	0.00	.70	.08
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00		0.00		100.00	
AVG MOL WT	23.25		0.00		29.71	

RECOVERED SOLIDS DATA				DRY FUEL ANALYSIS		O2/AIR ANALYSIS	
				WTPCT		MOLPCT	
LH	SLAG	LB/HR	491.50	C	52.46	O2	99.50
LH	FINES	LB/HR	108.94	H	2.90	A	.50
SETTLER	FINES	LB/HR	7.79	N	1.21	H2	0.00
FINES ANAL	LH	SETTLER		S	3.07	CO	0.00
PCT	C	3.12	7.87	ASH	37.20	CO2	0.00
PCT	S	1.34	1.80	O	3.08	N2	0.00
PCT	H	.42	.27	CL	0.00	TOT	100.00
PCT	ASH	95.12	90.06	TOT	100.00	AMWT	32.04

UNACCOUNTED FOR H2S .218 M/HR
UNACCOUNTED FOR NH3 .215 M/HR

CHARGE DATA			PRODUCT DATA	
COAL SLURRY	LBS/HR	2398.27	INT SYN GAS, SCFH	39078.17
PCT COAL	WT PCT	67.49	EXT SYN GAS, SCFH	0.00
COAL RATE	LBS/HR	1618.71	FLASH GAS, SCFH	870.96
O2/AIR RATE	SCFH	14906.27	SOLIDS, LBS/HR	608.23
			H2O, FORCED, LB/HR	581.62

PERFORMANCE PARAMETERS
PER LB COAL FEED PER LB C FEED
SCF SYNGAS 24.142 46.020
SCF FLASH GAS .538 1.026
LBS OXYGEN INPUT .781 1.488
LBS WATER INPUT .482 .918
SCC = 53.497

METERED TO CALCULATED FLOW RATIOS

O2= .999 SLURRY=1.001 UNC CARBON= .992 TOT SYNGAS= .999 FLASH GAS=1.000
INT SYNGAS- PCT N2=1.00 PCT H2S=1.00 EXT SYNGAS- PCT N2=1.00 PCT H2S=1.00

APPENDIX C

Results From Type I Laboratory Evaluation
of SRC Ash Concentrate From Kerr-McGee Corp.

From DOE Report Fe 2247-12,
December, 1977

**GASIFICATION OF RESIDUAL MATERIALS
FROM COAL LIQUEFACTION**

**Evaluation of SRC Ash Concentrate from Kerr-McGee Corp. as Feedstock
to the Texaco Coal Gasification Process**

Allen M. Robin

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Montebello Research Laboratory
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Date Published - December 1977

PREPARED FOR THE DEPARTMENT OF ENERGY

Under Contract No. EX-76-C-01-2247

ABSTRACT

A laboratory evaluation of a 12-pound sample of ash concentrate derived from the SRC process with a solvent deashing operation completed at Texaco's Montebello Research Laboratory. The sample supplied by Kerr-McGee Corporation.

The material cannot be melted and, therefore, must be mixed to a Texaco gasifier as a water slurry. A 55 percent (wt.) slurry was judged to be pumpable.

Operating conditions and yields were estimated for gasifying 10 pounds per hour of residue at 350 psig. Because of its high ash content (~41 wt. pct.) only about 15 standard cubic feet of hydrogen and carbon monoxide would be produced per pound of residue gasified.

It may be possible to increase the slurry concentration if residue with a coarser particle size distribution can be obtained.

A Type II preliminary pilot plant evaluation is feasible if required by DOE.

Figure 1

Analytical & Physical Properties of Kerr-McGee
Sample 619-118-1 Ash Concentrate
Data From Kerr McGee

Ultimate Analysis

C 48.0%
H 2.7%
N 1.2%
S 6.67%

Proximate Analysis

105°C loss 0.77%
Volatile Matter 13.6%
Fixed Carbon 43.5%
Ash 42.1%

Pour density 0.40 g/cm³
Tap density 0.60 g/cm³
Apparent density 1.69 g/cm³

Sieve Analysis

Mesh (U.S.)

Wt. %

+20	1.3
20-40	2.1
40-60	3.1
60-100	6.5
100-200	22.9
200-325	41.4
-325	22.7
	<u>100.0</u>

Figure 2

Texaco Coal Gasification Process
Estimate of Operation

DOE Contract E(49-18)2247
Location: Montebello Research Laboratory Pilot Plant
Feed Stock: SRC Ash Concentrate From Kerr-McGee
Feed Product: Hydrogen

File No.	2247-6-1
Feed to Generator	
Feed Carbon (Fresh, Dry), Pounds per Hour	1000
Feed Analysis, Weight Percent, Moisture Free	
Carbon	48.44
Hydrogen	2.85
Nitrogen	1.35
Sulfur	6.40
Oxygen	0.00
Ash	40.96
Feed Heating Value, BTU per Pound	9000.
Feed Oxygen, Pounds per Hour	842
Feed Air, Pounds per Hour	818
Product Composition, Mole Percent	
Carbon Monoxide	20.3
Hydrogen	19.1
Carbon Dioxide	19.5
Water	38.6
Methane	0.00
Argon	0.03
Nitrogen	0.48

Figure 2 (Cont'd)

Texaco Coal Gasification Process
Estimate of Operation

Hydrogen Sulfide	1.90
Carbonyl Sulfide	0.10
Dry Product Gas, Standard Cubic Feet per Hour	23,300
Hydrogen plus Carbon monoxide, Standard Cubic Feet per Hour	14,900
Slag, Pounds per Hour	348
Carbon Content, Weight Percent	0
Soot Discharge, Pounds per Hour	66
Carbon Content, Weight Percent	7
Unconverted Carbon, Percent of Carbon in Feed	1
Generator Pressure, PSIG	350

APPENDIX D

Results From Type I Laboratory Evaluation of
Pelletized Kerr McGee Ash Concentrate
From DOE Report Fe 2247-25
May, 1980

GASIFICATION OF RESIDUAL MATERIALS
FROM COAL LIQUEFACTION

Evaluation of Pelletized Kerr McGee Ash Concentrate as a Feedstock
for the Texaco Coal Gasification Process

Final Report on Type I Laboratory Test

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May, 1980

PREPARED FOR THE DEPARTMENT OF ENERGY

Under Contract No. EX-76-C-01-2247(M003)

Abstract

A Type I Laboratory Evaluation of a sample of pelletized Kerr McGee Ash Concentrate from Kentucky No. 9 coal was completed at Texaco's Montebello Research Laboratory.

This material is a suitable feedstock for the Texaco Coal Gasification Process. It may be fed to the gasifier as a water slurry with a solids concentration greater than 60 (wt) percent.

At 1200 psig, 1500 pounds per hour of ash concentrate are estimated to yield about 44,000 standard cubic feet per hour of hydrogen plus carbon monoxide.

Figure 1

Analytical & Physical Properties of Kerr-McGee Ash Concentrates

Sample	18941 Std. Mtl. From Report Fe-2247-12	20173 Pelletized Mtl From Current Evaluation
Ultimate Analysis, Wt. Pct.		
C	48.44	55.62
H	2.85	3.17
N	1.35	0.94
S	6.40	3.40
Ash	40.96	33.49
O (By diff)	0.00	3.38
Sieve Analysis		
% on US Mesh No.		
14	0	0
20	1.3	15.5
40	2.1	28.3
100	9.6	24.5
200	22.9	11.1
325	41.4	3.8
-325	22.7	16.8

Figure 2

Texaco Coal Gasification Process Estimate of Operation

For: DOE Contract EX-76-C-01-2247-M003

Location: Montebello Research Laboratory Pilot Plant

Charge Stock: Pelletized Kerr McGee Ash Concentrate From
Kentucky No. 9 Coal

Ultimate Product: Hydrogen

Sample No.	2017
Gasifier Pressure, psig	1200

Charge to Gasifier

Dry Ash Concentrate, lbs/hr	1500
Pure Oxygen, lbs/hr	1193
Water, lbs/hr	919

Ultimate Analysis of Ash Concentrate, Wt. Pct.

C	55.62
H	3.17
N	0.94
S	3.40
Ash	33.49
O (By diff)	3.38

Higher Heating Value, Btu/lb	9700
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Products From Gasifier

Dry Product Gas, Standard Cubic Feet per Hour	40,400
Slag, lbs/hr	401
Char, lbs/hr	117
Carbon Content of Char, Wt. Pct.	14.0

Product Gas Composition, Mole Percent

CO	30.73
H ₂	25.38
CO ₂	16.73
H ₂ O	25.66
CH ₄	0.01
A	0.03
N ₂	0.35
H ₂ S	1.05
COS	0.06
Carbon Conversion, Pct.	98.0
H ₂ +CO, Standard Cubic Feet per Hour	30,500

APPENDIX E

Results From Type II Preliminary Pilot Plant Evaluation
of SRC-I Extruded Kerr McGee Mineral Ash
Residue-Water Slurry

From DOE Report FC 2247-35
January, 1984

GASIFICATION OF RESIDUAL MATERIALS
FROM COAL LIQUEFACTION

Type II Preliminary Pilot Plant Evaluation of
SRC-I Extruded Kerr McGee Mineral Ash
Residue-Water Slurry

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Date Published - January 1984

PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Under Contract No. DEAC 01-76-ET10137 (EX-76-C-01-2247)

Delivery Order No. 10

ABSTRACT

A Type II preliminary pilot plant evaluation of SRC-I extruded Kerr McGee mineral ash residue as a water slurry feed to the Texaco Coal Gasification Process was conducted at Texaco's Montebello Research Laboratory (MRL).

Approximately 16 tons of residue were gasified during three test runs which were carried out at 950 psig in MRL's High Pressure Solids Gasification Unit I. The runs lasted from 4.8 hours to 7.2 hours, and a total of 19.1 hours of on-stream time was accumulated.

This work was authorized by DOE Delivery Order Number 10 under DOE contract EX-76-C-01-2247 and amendment DEAC-01-76ET-10137. It is part of a continuing effort to evaluate residual materials from various DOE sponsored coal liquefaction projects to determine their suitability for conversion to hydrogen using one of the Texaco gasification processes.

Figure 3

SRC-I Extruded Kerr McGee Mineral Ash Residue Properties

Ultimate Analysis Wt%

	<u>Dry</u>
C	53.56
H	3.12
S	2.98
N	1.13
Ash	37.27
O(by difference)	1.94

Higher Heating Value, Btu/Lb

9,387

Ash Fusion Temperature, °F

(Reducing Atmosphere)

Initial Deformation Temperature	2,000
Softening Temperature	2,145
Hemispherical Temperature	2,185
Fluid Temperature	2,340

Figure 4
Comparison of Predicted Vs. Actual Performance
For Gasification of SRC-I Kerr McGee Mineral
Ash Residue-Water Slurry

	Predicted Data From DOE Report (Fe-2247-25 Figure 2)	Actual Data	
		Run 1	Run 2
<u>Charge to Gasifier</u>			
Residue (Dry, Fresh), Lbs/Hr	1500	1869	1597
Water, Lbs/Hr	919	965	796
Pure Oxygen, Lbs/Hr	1193	1495	1252
Total Input:	3612	4329	3645
<u>Output From Gasifier</u>			
Dry Product Syngas, Lbs/Hr	2434	2845	2457
Flach Gas, Lbs/Hr	-	12	9
Char, Lbs/Hr	117	10	9
Coarse Slag, Lbs/Hr	401	481	377
Lockhopper Fines, Lbs/Hr	-	245	223
Missing Ash, Lbs/Hr	-	8	4
Forced Water, Lbs/Hr	660	728	566
Total Output:	3612	4329	3645
<u>Analytical</u>			
<u>Charge Residue Analysis, Wt%</u>			
Carbon	55.62	52.32	52.90
Hydrogen	3.17	3.12	3.05
Nitrogen	0.94	1.11	1.11
Sulfur	3.40	2.89	2.89
Oxygen (by difference)	3.38	1.51	2.31
Ash	33.49	39.05	37.73
Higher Heating Value, Btu/Lb	9700	9136	9149
<u>Product Syngas Composition, Mole% (Dry)</u>			
H ₂	34.14	32.69	32.89
CO	41.35	43.71	43.43
CO ₂	22.50	21.69	21.61
N ₂	0.47	0.60	0.58
H ₂ S	1.41	1.08	1.13
COS	0.08	0.02	0.04
CH ₄	0.02	0.02	0.14
A	0.04	0.19	0.18
Carbon on Coasre Slag, Wt%	-	0.50	0.60
Carbon on Lockhopper Fines, Wt%	-	1.71	2.13
Carbon on Char, Wt%	14.0	8.32	8.32
Percent Carbon Conversion	98.0	99.5	99.4
Gasifier Pressure, psig	1200	950	950
Dry Product Syngas, SCFH	40400	46800	40500
H ₂ +CO in Product Syngas, SCFH	30500	35800	30900
SCF Syngas/lb Residue	26.93	25.04	25.38
Percent CO+H ₂ in Dry Product Syngas	75.49	76.40	76.32
Oxygen/Residue, lb/lb	0.795	0.800	0.793
Original Coal	Kentucky No. 9	Illinois No. 6	