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PROTOTYPE PILOT PLANT OPERATION
SYNTHANE PROCESS

MASTER

CONTRACTOR MONTHLY ACTIVITY REPORT NO. 36
FOR THE PERIOD
AUGUST 1 - AUGUST 31, 1977

THE LUMMUS COMPANY
BLOOMFIELD, N.J. 07003
LUMMUS JOB NO. 7848

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September 10, 1977
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Mr. Harold N. Miller, Director
Contracts Management Office
U. S. Energy Research and
Development Administration
9800 South Cass Avenue
Chicago, Illinois 60439

Dear Mr. Miller:

SUBJECT: CONTRACTOR MONTHLY ACTIVITY REPORT NO. 36
for the period covering August 1-31, 1977

Report No. C00-0003-10 covers activities conducted by The Lummus Company at the Synthane Prototype Pilot Plant in Bruceton, Pa., under ERDA Contract No. EY-76-C-02-0003.*000.

Very truly yours,

S. E. Carson
S. E. Carson,
Plant Manager

/ce

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✓ I. ABSTRACT

This report presents progress achieved during August 1977 at the Synthane Pilot Plant located in Brucefon, Pennsylvania.

The Plant operated from August 5 to August 16 during which time 465 tons of Rosebud coal were gasified. During this period, oxygen and coal were fed for 190 hours, 98 hours of which were without interruption. The run produced ten steady state periods. Bed temperatures and feed rates were varied to study the effect of these variables on conversions. Carbon conversions of 75% to 78% were achieved for extended periods of operation at feed rates of 2 to 3 tons per hour. The successful completion of this run finishes studies of Western subbituminous coal. The Plant is presently preparing for the gasification of Illinois No. 6 coal.

II. INTRODUCTION, PROJECT OBJECTIVE, AND ACTIVITY SUMMARY

This report is a presentation of the work accomplished during August 1977 at the Synthane Prototype Research Pilot Plant. The Plant is operated by The Lummus Company for the U. S. Energy Research and Development Administration which was initiated under Contract H036030 by the U. S. Department of Interior, U. S. Bureau of Mines, and was transferred to ERDA as Contract (36-2)-0003 and subsequently renumbered to Contract EY-76-C-02-0003.*000. This report represents the 36th month of progress.

The objective of this Contract is to obtain definitive process information sufficient for commercial design purposes on the conversion of coal to pipeline quality gas. This objective is to be accomplished through the execution of experimental and developmental operation programs in the Government-owned Synthane Pilot Plant, located in South Park Township, Allegheny County, Pennsylvania.

The following is a summary of activities during August:

1. Rosebud coal was successfully gasified to a carbon conversion of 75% to 78% during the period from August 5 to August 16. Coal and oxygen were fed at 2 to 3 tons per hours for a total of 190 hours, 98 hours of which the gasifier ran continuously.
2. The pretreater was placed in service during the August run to test controls and operating procedures before being required in the gasification of Illinois No. 6 coal. Despite the fact that a clinker formed in the bottom section, the pretreater operated successfully throughout the run at controlled temperatures.

3. The Benfield Unit, which is used for removal of carbon dioxide from the raw gas produced from the gasifier, was commissioned. Due to poor tower level control, the unit was placed in service for only a short period of time. Revisions are currently underway to resolve the level control problems.

III. ACTIVITIES DURING THE MONTH

OPERATIONS

1. Run 1-DB-N was terminated on May 28 because a crack developed in an Incoloy 800 nozzle on the gasifier. The Plant remained down from May 29 through August 5 for replacement of all the Incoloy 800 nozzles on the gasifier with monel clad carbon steel nozzles.

Modifications which were also completed during this outage included:

- a) increasing char cooler standpipe from 2 inches to 3 inches.
- b) replacing the char cooler standpipe trickle valve with a slot valve.
- c) converting the char cooler standpipe purges from steam to CO₂.
- d) installing a steam heater to heat the CO₂ transfer gas.
- e) installing steam purges in bottom eight nozzles of the distributor cone.
- f) installing the pretreater.
- g) installing two ceramic plug valves in the pretreater outlet line between the pretreater and gasifier.
- h) installing a new fuel gas burner in the thermal oxidizer and rebricking the bottom section of the oxidizer.

2. Run 1-DB-O began on August 5 when coal and oxygen were admitted to the gasifier. The general operating philosophy for this run was to determine how to operate and control the pretreater and to gasify Rosebud coal to 70% carbon conversion.

A bed was established in the gasifier but oxygen was soon taken out because solids could not be moved from the gasifier. After the stroke on the newly installed slot valve was adjusted, solids movement was established and oxygen was again started. Oxygen and coal remained in for four hours when high temperatures in the pretreater tripped the oxygen again.

Oxygen was restarted to the pretreater one hour later after the temperature instrumentation problems were resolved, and remained in for an addition of four hours. Feed was then stopped due to a failure of RD-262 which is a rupture disc that was installed between the plenum zone and the char cooler. Over the next four days, oxygen was in the gasifier for a total of 42 hours but 10 outages occurred due to the continued loss of RD-262. On August 9, it was determined that the rupture disc holders themselves were cutting the teflon in the rupture discs and causing them to fail. Repairs to the holders were completed thus ending the failure problems. The gasifier was restarted and the temperature was stabilized at

1300°F. Coal feed was held at 2.0 tons per hour. This condition was maintained until the purges were adjusted in the dip leg of the gasifier and the slot valve was placed on automatic control.

On August 10, gasifier temperature was raised to 1400°F and on August 11, the bed temperature was increased to 1500°F. At temperatures of 1500°F, carbon conversions of over 70% were achieved. Coal and oxygen feed remained in from August 9 until August 13 for a total time of 98 hours. The feed was stopped on August 13 because of low CO₂ header pressure which disrupted the Petrocarb feed system. A malfunction of the level controller on the CO₂ gas holder caused loss of CO₂ header pressure.

Oxygen and coal were again started to the pretreater on August 14 but were removed immediately thereafter due to plugging in the char slurry transfer lines. Feed was started four hours later and remained in for four more hours when it was removed due to loss of the high pressure filtrate recycle pump. Since the pump is not spared and repairs were extensive, a hydroblast truck was rented and connected into the system as replacement. After water circulation was established, oxygen and coal feed was reintroduced.

On August 15, the coal feed rate was raised to 3.0 tons per hour and gasifier temperature was raised to 1550°F. On August 16, coal feed became erratic for a period of 6 hours. During this period, bed temperatures varied between 1500°F and 1610°F as the feed rate changed. The feed rate problem was finally resolved, but four hours later oxygen and coal feed was stopped due to the inability to move char from the gasifier. The gasifier was then shut down terminating Run 1-DB-0. The Plant continued to try to move char until August 17 unsuccessfully. A decision was then made to depressure the gasifier and open the system for inspection.

3. The inspection of equipment revealed that a clinker had formed in the bottom section of the pretreater but this clinker had not hindered the operation of the pretreater. A pyramid shaped clinker was also found in the bottom of the gasifier cone which had stopped the removal of char. A welding rod and a small piece of flat metal were found in the Petrocarb venturi. The obstruction in the Petrocarb System probably caused the erratic coal feed rate which was experienced during the last few hours of this run. It is surmised that the fluctuation in feed and resulting high bed temperature in the gasifier caused the formation of the clinker and the eventual shutdown of the Plant.

TECHNICAL

1. During Run 1-DB-0, the Plant processed 465 tons of Rosebud coal and produced 19 million standard cubic feet of raw gas. The gasifier produced gas for approximately 190 hours. Two long and continuous operating periods of 98 and 45 hours were achieved. For data evaluation, a total of 10 steady state periods at different operating temperatures provided meaningful data on the gasifier for material and equilibrium balances. The overall operating conditions and run

performance of the gasifier during this period was the best to date. Carbon conversions between 75% and 78% were achieved throughout most of the run.

The gasifier internal cyclone operated with some indication of problems during various stages of the run. Differential pressures across the cyclone from 70 inches to 100 inches of water were recorded. There were indications that the cyclone was "puffing," probably because of overloading with fines. At times, there was a heavy carryover of solids into the gas scrubbing system.

The scrubber system operated well during the entire run. No severe blockage of equipment from fines carryover occurred. As has been noted in previous gasifier deep bed injection runs, the condensed water leaving the scrubber surge tank generally showed a phenolic content less than 2 ppm which is considered excellent water quality.

Attempts to commission the Benfield Unit were unsuccessful because we were unable to control the levels in the Benfield Unit absorber and regenerator. Other Benfield Units known to be operating have switched their level control devices from a differential pressure type to displacer type controls. This change will be incorporated at the Plant for the next run.

2. Progress is being made in preparing a final report for the gasifier runs which were completed from between July, 1976 to December, 1977. Graphs of the various operating variables measured during the run are now being prepared by the computer. Plots of many variables versus time are being established. The technical portion of this report will be issued to Lummus Management for review in September.
3. Because of the success and importance of the recent gasifier run every effort is being expended to release an early report of the 1-DB-0 run. Preliminary information on the operating variables requested by ERDA has already been released. A final report on the run will be issued in the early part of September.
4. In preparation for the processing of Illinois No. 6 coal, modifications are underway to change the vent system on the decanter and waste water receiver. Both of these vessels presently vent to the atmosphere and during periods of low gasifier operating temperatures, have a tendency to give off obnoxious odors. The vents from these vessels will be piped directly to the thermal oxidizer. Steps are also being actively pursued to increase the cooling of the hot condensate draw-off to these vessels. This should further minimize the production of vapors and flash gas.
5. The computer ran successfully during the month of August. Only a minor problem with CRT hangup occurred during the gasifier operation. The new peripherals, mag tape and disc drives, were installed in the computer. A new system generation will be done as soon as possible so that these new devices can be used.

ENGINEERING

1. The contract package for the installation of the condensate collection system was issued to New Construction.
2. The final package for enclosing the structure was approved. A Structural Designer from Bloomfield has been on site to assist in structural detail work and to make as built corrections on the drawings as required.
3. The final package for the installation of the Petrocarb check valves was issued to Maintenance.
4. The final package to connect a vent line from the decanter to the thermal oxidizer was issued to Maintenance for fabrication.
5. Drawings for the reinforcement of the structure for the raw coal and dry coal storage bins have been issued.
6. The final package for the replacement of the new thermocouple assembly for nozzle 35B on the gasifier was released to Maintenance.
7. A work order was issued to Maintenance to connect a high pressure steam supply line into the Petrocarb feed line to the gasifier. This will allow the use of steam as a substitute for CO₂ as the transport media.
8. The final package for the modification of the sulfur slurry overflow weir in the Stretford Unit was issued to Maintenance.
9. The catalyst chambers for the inert gas system were received. All drawings required for the piping of the inert gas generating system were completed in Bloomfield. The project is now ready for execution.
10. The final approved package for the modification to the flare tip was issued to Maintenance. Flare tip modifications were required because of noise complaints during operation.
11. The preliminary package for the fuel oil unloading pump is complete.
12. A complete set of instrument loop sheets was given to the Maintenance Department for verification of the drawings.

MAINTENANCE

1. During the month of August, 436 work orders were issued and 298 work orders were completed. A backlog of 220 work orders was carried through to September.
2. Major jobs worked on during August were as follows:
 - a) LT-206, level transmitter for DA-202, and LT-207, level transmitter for DA-203, are to be changed from differential pressure

to displacer type transmitters in order to achieve better control of the levels.

- b) The thermocouple flange mounting on nozzle 35B of the gasifier was modified because of the failure of the vendor's flange during pressurization. A new design for improving the present configuration has been completed and will be installed next month.
- c) The refractory lined ceramic plug valves which were installed between the gasifier and the pretreater failed during operation. Cracks and splitting of the plugs resulted. These valves have been removed and have been returned to the factory for failure analysis and modification.
- d) The base station radio antenna was moved from behind the control panel to the top of the pipe rack outside the control room. The analyzers and the BLH weighing system in the Petrocarb improved as a result of this move.
- e) GA-401, char slurry recycle pump, failed during the August run. An inspection revealed excessive wear in all stages. The newly installed spare which is a positive displacement piston pump will be placed in service prior to the next run. The centrifugal, GA-401, will be rebuilt and will be used as a standby.
- f) Repeated failures occurred in the pump shaft seals in GA-207 and GA-207S, Venturi scrubber recycle pumps. A double bellows seal has been installed in GA-207. It will be tested during the next operation.
- g) A bearing on the impact mill failed and required replacement during operation. The new bearing was inspected upon completion of the run and no abnormal wear was evident.
- h) The bottom thermocouple in the pretreater failed during August due to overheating. The thermocouple was replaced.
- i) Venturi scrubber flow control valve, FA-206, failed during the run and the valve had to be temporarily bypassed. The valve stem backed out of the valve plug causing the plug to remain closed. A new borafused plug and cage have been installed for evaluation. The stem and plug were pinned to correct the separation problem.
- j) LCV-201, level control valve for scrubber surge tank, completed this run with satisfactory results for the first time. Tungsten carbide trim was used in the valve and this appears to be a successful application for this material.
- k) The cause of the rupture disc failures which were experienced during the run was found and the problem was resolved. Sharp edges were left on the faces of the holders after they were

machined to prevent external leakage and these sharp edges cut the discs during installation. The sharp edges have now been rounded as per the original design.

SAFETY

1. There were no reportable or lost time injuries to report for C-E Lummus employees for this period.
2. Industrial hygiene procedures for showering and updating showering facilities and "dirty" rooms have been revised. Eight-hour air samples for dust, coal tar pitch and benzene were taken during the August run. The samples were sent to Combustion Engineering for analysis.
3. Three fire drills were held, one on each shift.

PLANT VISITOR DURING THE MONTH

Mr. E. L. Clark	ERDA Headquarters
Mr. John O'Connor	ERDA Headquarters
Mr. S. Canja	ERDA Headquarters
Mr. Gene Kight	ERDA Headquarters
Mr. J. McGee	Morgantown, West Va.
Mr. H. Hartman	Exxon
Mr. T. Newhard	Exxon
Mr. L. Brunt	Exxon
Mr. D. Guttard	Exxon
Mr. D. Gregg	Exxon
Mr. M. Gurevich	Exxon
Dr. Dieter Haak	North Rhine-Westphalia State Parliament (LANDTAG)
Dr. Ottman Pohl	LANDTAG
Dr. Franz Joseph Antwerps	LANDTAG
Dr. Christopher Zoepel	LANDTAG
Mr. Hans George Weiss	LANDTAG
Mr. Weinz Soenius	LANDTAG
Mr. Helmut Weikart	LANDTAG
Mr. Klaus Lanterman	LANDTAG
Prof. G. Jimbo	Dept. of C-E, Nagoya, Japan
Mr. R. Yamazaki	Dept. of C-E, Nagoya, Japan
Mr. N. Azai	Dept. of C-E, Nagoya, Japan
Mr. Watanabe	Mitsubishi MHI, Japan
Mr. Shirakawa	Mitsubishi MHI, Japan
Mr. Ogawa	Mitsubishi MHI, Japan
Mr. Kaneko	Mitsubishi MHI, Japan
Mr. Yeng	University of Pittsburgh
Mr. J. Hancock	C-E Windsor
Mr. B. Mahre	Northern Propane
Mr. T. Williams	Northern Propane
Mr. B. Satterly	Northern Propane

IV. PROBLEMS

1. Controlling gasifier bed levels continues to be a problem. The new slot valve which was installed in the gasifier dip leg controlled well on automatic. However, whenever attempts are made to lower bed levels by decreasing the bed level inventory, the bed density also decreases which results in essentially the same calculated bed height. The bed appears to be non-uniform with the finer particles in the upper portion of the bed and the larger particles in the lower section. The inability to remove fines out of the bottom of the gasifier with the char is believed to be the major cause of the accumulation of fines in the bed.

In future runs, attempts will be made to achieve improved bed level control. It is planned to again attempt to reduce purge rates in the dip leg to a minimum. This should allow more fines to be withdrawn with the char. Also, it is planned to extend the cyclone dip leg to the cone line from its present position which is 3'6" above the cone. This should also aid in getting the fines further down into the bed.

V. PLANS

Plans for the month of September are as follows:

1. Operate the pretreater on Illinois No. 6 coal.
2. Gasify Illinois No. 6 coal to carbon conversion of greater than 67%.
3. Operate the Benfield Unit and commission the Stretford Unit.
4. Continue to work to complete the enclosure of the structure before winter.