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Scaleup of Mild Gasification to Be a Process Development

Quarterly Report
February - May 1995

Elliott P. Doane
R. H. Carty
H. Foster

June 1995

Work Performed Under Contract No.: DE-FC21-92MC27391

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
Kerr-McGee Coal Corporation
Oklahoma City, Oklahoma

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PROCESS DEVELOPMENT

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Morgantown Energy Technology Center
P.O. Box 880
Morgantown, West Virginia 26507-0880**

**By
Kerr-McGee Coal Corporation
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Oklahoma City, Oklahoma 73102**

June 1995

SUMMARY

The work performed during the Fourteenth quarterly reporting period (February 21 through May 20, 1995) on the research program, "Scale-Up of Mild Gasification to a Process Development Unit" is presented in this report. The overall objective of this project is to develop the IGT Mild-Gasification (MILDGAS) process for near-term commercialization. The specific objectives of the program are to:

- design, construct, and operate a 24-tons/day adiabatic process development unit (PDU) to obtain process performance data suitable for further design scaleup
- obtain large batches of coal-derived co-products for industrial evaluation
- prepare a detailed design of a demonstration unit
- develop technical and economic plans for commercialization of the MILDGAS process.

The project team that is performing the initial phases of the PDU development are: Kerr-McGee Coal Corporation (K-M Coal), the Institute of Gas Technology (IGT), Bechtel Corporation (Bechtel), and Southern Illinois University at Carbondale (SIUC).

The MILDGAS process is a continuous closed system for producing liquid and solid (char) co-products at mild operating conditions up to 50 psig and 1300°F. It is capable of processing a wide range of both eastern caking and western noncaking coals.

The 1 ton/hr PDU facility that is to be constructed is comprised of a 2.5-ft ID adiabatic gasifier for the production of gases, coal liquids, and char; a three-stage condensation train to condense and store the liquid products; and coal feeding and char handling equipment. The facility will also incorporate support equipment for environmentally acceptable disposal of process waste.

This quarter, the formal HAZOP review was completed and a report detailing action items for resolution by the parties responsible was prepared. The final HAZOP document will be issued upon notification by individual parties that all action items have been resolved. Also, bid package specifications for the water treatment unit were reviewed and approved.

Line sizing calculations and the electrical load study were prepared by Roberts & Schaefer and reviewed by Bechtel. Work also began on preparation of the logic and control loop drawings and updating of equipment layouts based on firm equipment dimensions. The preliminary steel design and a list of prospective bidders for the erection of the steel structure and for the mechanical installation of the equipment were prepared.

Also this quarter, Roberts & Schaefer began computer programming and continued development of logic and loop drawings. Bid packages for the civil contract - second phase and the steel fabrication were received and analyzed.

This quarter, the bids for the gasifier vessel and cyclones and the coal preheater and char cooling screws were reviewed and orders were placed with the successful bidders. IGT and Bechtel visited Milwaukee Boiler to discuss construction of the cyclones and reactor vessel. An order for Milwaukee Boiler to perform the labor of construction was issued and material for construction of these items was ordered. The computer control hardware and software, and the coal heating and char cooling screws were ordered.

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INTRODUCTION

Commercialization of the Institute of Gas Technology's Mild Gasification (MLDGAS) technology introduces a new industry into an economically depressed area. It utilizes a marginally marketable coal to produce char, in an environmentally acceptable manner, that can be used to make form coke, which is vitally needed in our metallurgical industry. It produces coal liquids which address import problems, and it also addresses the use of char for our electric utility industry. The specific objectives of the program are to: design, construct, and operate a 24-tons/day adiabatic process development unit (PDU) to obtain process performance data suitable for further design scaleup; obtain large batches of coal-derived co-products for industrial evaluation; prepare a detailed design of a demonstration unit; and develop technical and economic plans for commercialization of the MLDGAS process.

The MLDGAS process is capable of processing both eastern caking and western non-caking coals. The MLDGAS process is designed to offer options in the product slate by varying the process conditions and by blending different feed coals. The liquids, which can be processed as feedstocks for chemicals (e.g., BTX, phenol, cresols, xylenols, naphthalene, and indene), pitch for use as a binder for electrodes in the aluminum industry, and fuels. Depending on the feed coal characteristics and the operating conditions, the char can be used as an improved fuel for power generation or briquetted hot to make form coke for steel-making blast furnaces or for foundry cupola operations. The hot briquetting process offers options for blending various chars, coals and other additives (like alloying agents) to tailor the properties of the form coke. The mild gasification and briquetting processes are done entirely within closed vessels which offer significant advantages over conventional coking practices for control of fugitive emissions.

The 1 ton/hr PDU facility that is to be constructed is comprised of a 2.5-ft ID adiabatic gasifier for the production of gases, coal liquids, and char; a three-stage condensation train to condense and store the liquid products; and coal feeding and char handling equipment. The facility will also incorporate support equipment for environmentally acceptable disposal of process waste.

Coal liquids from the PDU will be evaluated as feedstock for high-value chemicals and fuels by Reilly Industries, Inc. Reilly will also conduct separate modification operations such as thermal treatment with or without a Lewis Acid Catalyst, fractional distillation, and hydrotreating to produce specification-grade products. Reilly will take all the coal liquids produced at the PDU facility.

A major portion of the char produced will be used to make the form coke for blast furnaces and cupolas. The form coke for blast furnaces will be evaluated by several steel companies, including LTV and Armco. The form coke for use in a foundry cupola will be evaluated by General Motors

Research Laboratories. In addition, the form coke will also be tested for foundry use at Pellet Technology Corporation's 60-inch cupola. The char from the PDU will also be evaluated at Southern Illinois University at Carbondale (SIUC) for relative reactivity and for suitability as a boiler fuel in a fluidized-bed combustor.

The product testing to be conducted in the program will yield a realistic assessment of the quality and economic value of both the coal liquids and solids produced. This input is required to update the market potential of the co-products and determine the slate of products and the economics of the demonstration and commercial plants for the MILDGAS process. The project team for the PDU development are: K-M Coal, Institute of Gas Technology (IGT), Bechtel Corporation, SIUC, General Motors Corporation, Pellet Technology Corporation (PTC), LTV, Armco, Reilly and Auto Research.

K-M Coal, which has large reserves of both eastern and western coals, is very much interested in near-term commercialization of the MILDGAS process. K-M Coal is responsible for the overall management and technical direction of the program. IGT, as the originator of the MILDGAS technology, is responsible for technology development, product evaluation management, and overall technical supervision. Bechtel Corporation is the A&E firm responsible for the process and plant design and construction, development of a demonstration plant design, and input to the commercialization plan revision. SIUC operates the Illinois Coal Development Park at Carterville, Illinois, which will be the location of the PDU. SIUC is responsible for operation of the PDU facility and for evaluation of the char product as a boiler fuel.

The State of Illinois is the major contributor of the cost sharing portion of this program. Their contribution is being supplemented by K-M Coal, SIUC, and GM. Contributions of Reilly and the steel companies are gratefully acknowledged but are not considered part of the cost sharing. All acceptable grades of form coke produced will be sold by Hickman Williams Co., the largest brokers for coke in the midwest.

TECHNICAL DISCUSSION

Task 1.0 Work and Environmental Plans

Objective: The objective of this task is to develop work and environmental plans for the project.

Summary: The Environmental Plan and NEPA Documentation consist of the data that are required by DOE for compliance with the National Environmental Policy Act (NEPA). All of the work on this task was completed and the NEPA document submitted in April 1993.

The Environmental Assessment (EA) was prepared by DOE and submitted in September, 1993 to the State of Illinois and the Crab Orchard Wildlife Refuge for comments. Neither organization found any issue with the EA that would prevent construction of the PDU at the proposed site. They did submit comments which were taken into consideration in revising the EA.

The Finding of No Significant Impact (FONSI) for this project was received on February 10, 1994. This task is now complete.

Subtask 2.1 Design Engineering

Objective The objective of this task is to complete the detailed design and engineering for the PDU. This includes the process design, the civil/structural design, the electrical and controls design, the mechanical design, procurement, and definitive cost estimate.

Summary This quarter, the formal HAZOP review was completed and a report detailing action items for resolution by the parties responsible was prepared. The final HAZOP document will be issued upon notification by individual parties that all action items have been resolved. Also, bid package specifications for the water treatment unit were reviewed and approved.

Line sizing calculations and the electrical load study were prepared by Roberts & Schaefer and reviewed by Bechtel. Work also began on preparation of the logic and control loop drawings and updating of equipment layouts based on firm equipment dimensions. The preliminary steel design and a list of prospective bidders for the erection of the steel structure and for the mechanical installation of the equipment were prepared.

Also this quarter, Roberts & Schaefer began computer programming and continued development of logic and loop drawings. Bid packages for the civil contract - second phase and the steel fabrication were received and analyzed.

This quarter, the following items were completed:

IGT

- Participated in the second phase of the HAZOP review
- Visited Milwaukee Boiler to discuss their capabilities and construction of the cyclones and reactor vessel
- Consulted with Milwaukee Boiler to finalize shop drawings on the reactor vessel and cyclones
- Performed tests to confirm that there should not be a problem with carbon deposition during heating of the recycle product gas
- Reviewed and approved specifications for the water treatment unit
- Reviewed and approved the bid package specifications for the Air/Gas compressors
- Reviewed and approved the control philosophy
- Reviewed and approved preliminary computer control screens

Bechtel

- Conducted second phase of HAZOP review with Roberts & Schaefer, IGT, Callidus, and Reimelt
- Completed formal HAZOP review and prepared report detailing action items for resolution by responsible parties (Final HAZOP document will be issued upon notification by individual parties that action items have been resolved.)
- Prepared a list of prospective bidders for the erection of the steel structure and for the mechanical installation of the equipment (the same company may do both jobs)
- Reviewed electrical loads and line sizing calculations and sent comments to Roberts & Schaefer
- Prepared second phase civil construction bid package
- Order placed with Milwaukee Boiler for construction of the cyclones and reactor vessel
- Order placed with Christian Engineering for the coal heating and char cooling screws
- Reviewed and commented on Roberts & Schaefer's structural calculations
- Held design review meetings on the gasifier and cyclones
- Approved Reimelt flow diagrams
- Reassessed the design of the compressor for the recycle gas to prevent possible condensation of the MILDGAS liquids in the compressor which could lead to corrosion problems

Roberts & Schaefer

- Received and analyzed bids for the reactor vessel and cyclones and the coal heating and char cooling screws
- Recommended Milwaukee Boiler for construction of the gasifier vessel and the cyclones
- Recommended Christian Engineering to supply the coal heating and char cooling screws
- Prepared preliminary structural steel design for review by Bechtel

- Issued drawings for steel fabrication
- Prepared bid packages for the steel erection contract
- Prepared electrical line sizing calculations
- Issued electrical load study for Bechtel review
- Began development of logic and loop drawings
- Updated and issued equipment layouts for review based on firm equipment dimensions
- Started computer programming
- Prepared and sent to prospective vendors bid packages for the tar quencher, middle and light oil condensers, and miscellaneous product tanks and vessels
- Prepared list of PLC units including the I/O for the Allen Bradley controls system

Callidus

- Issued P&IDs for approval
- Submitted process flow diagrams for final approval

Reimelt

- Purchased baghouses for both the coal and char handling systems
- Submitted layout information on char storage system to Roberts & Schaefer
- Issued orders for remainder of mechanical equipment
- Submitted process flow diagrams for approval

Plans for Next Quarter During the next quarter, the design of all miscellaneous equipment will be completed, the P&IDs will be approved and issued for construction, and a draft of the operating manual will be prepared. In addition, programming of the PLC will begin.

Task 2.2 PDU Construction and Shakedown

Objective Now that the FONSI has been received, this task is being reactivated. In this task, the permit to construct will be obtained and the PDU designed in Task 2.1 will be constructed and shaken down.

Summary This quarter, the bids for the gasifier vessel and cyclones and the coal preheater and char cooling screws were reviewed and orders were placed with the successful bidders. IGT and Bechtel visited Milwaukee Boiler to discuss construction of the cyclones and reactor vessel. An order for Milwaukee Boiler to perform the labor of construction was issued and material for construction of these items was ordered. The computer control hardware and software, and the coal heating and char cooling screws were ordered.

This quarter, the following items were accomplished:

Bechtel

- Issued bid packages and received and analyzed bids for civil contract - second phase
- Awarded contract for second phase of the civil site work including the underground piping
- Issued bid packages and received and analyzed bids for steel fabrication
- Awarded contract for fabrication of the structural steel
- Placed order for computer hardware and software for process control and data acquisition
- Ordered material for construction of the reactor vessel
- Prepared for the second phase of the site work including installation of the underground piping which will occur early in the next quarter

Plans for Next Quarter During the next quarter, the steel superstructure will be erected and major equipment items will be installed including the reactor vessel, and the coal loading and char storage hoppers.

Tasks 2.3 through Task 6.

No work was scheduled on these tasks for this quarter.

Task 7.0 Project Management

Objective The objectives of this task include the normal project management functions of planning, control, and reporting of project progress.

Summary This quarter, project management consisted of preparation and submittal of the monthly and quarterly reports, reviewing various bid specifications, and participating in the process and instrumentation review.