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SCALE-UP OF MILD GASIFICATION TO A PROCESS DEVELOPMENT UNIT

Progress Report for the Period:
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SUMMARY

The work performed during the Thirteenth quarterly reporting period (November 21, 1994, through February 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, Roberts and Schaefer (R&S) of Salt Lake City, Utah was awarded the contract to perform the detailed design for the gasification, liquids recovery and overall plant design coordination. They began work in December of 1994 and a meeting was held between R&S, Bechtel, and IGT to discuss control methods, detailed equipment design, the heavy liquids filter, and possible modifications to the first and second stage cyclones. In addition, Reimelt Engineering was selected as the best choice for purchasing of the char handling and coal feeding systems.

Process development resulted in deleting the tar quench filtration, the light oil run tank and redundant instrumentation. Also, the recycle compressor options were evaluated, the design package was submitted to Roberts & Schaefer, and the process specification for the water treatment system was completed. In addition, the bid specifications were prepared, reviewed, and

sent out for the gasifier reactor vessel and cyclones, the feed coal preheater screws, and the char cooling screws. Callidus, the contractor for the emissions package, and Reimelt began purchase of various components for their systems this quarter.

TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Technical Discussion	3
Task 1.0 Work and Environmental Plans	3
Objective	3
Summary	3
Subtask 2.1 PDU Design Engineering	3
Objective	3
Summary	3
Plans for Next Quarter	5
Subtask 2.2 PDU Construction and Shakedown	5
Objective	5
Summary	5
Plans for Next Quarter	6
Task 2.3 through Task 6.0	6
Task 7.0 Project Management	6
Objective	6
Summary	6

INTRODUCTION

Commercialization of the Institute of Gas Technology's Mild Gasification (MILDGAS) 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 MILDGAS process.

The MILDGAS process is capable of processing both eastern caking and western non-caking coals. The MILDGAS 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 A meeting was held between R&S, Bechtel, and IGT to discuss control methods and equipment, the heavy liquids filter, and possible modifications to the first and second stage cyclones. IGT will explore modifications to the first and second stage cyclones to keep them at maximum efficiency during turndown. The modifications may either be a redesign of the units or injection of recycle gas to maintain the velocity through the cyclones when the throughput to the unit is reduced. This is important to reduce the amount of solids carryover to the first stage condensation unit and thus lessen the load on the heavy liquids filter.

Several types of filters that may be used to remove fine char particles from the recycled liquid of the first stage of the condensation train were discussed. Most of the filter units available have one or more disadvantages such as a large liquid holdup, an inability to operate at the temperature required, or very large size and high cost. The necessity of a filter at all was also explored. If the particulate loading can be minimized, a filter is not needed for proper operation of the PDU. The main reason for removing the particles from the PDU liquids is to meet the requirements of Reilly Industries. Since Reilly already processes coking oven liquids which contain some particulates, discussions were held with Reilly to determine if it is possible to do without the filter for the PDU.

Reilly said that they could accept the liquids that had the particulate spec that we had determined and it was decided to delete the filter from the design. Scaleup data to design the filter for the demonstration plant will be obtained from tests performed by filter manufacturers using the particulate laden liquid obtained in the PDU tests.

This quarter, the following items were completed:

IGT

- Reviewed the specifications for the coal preheater screws and the char cooling screws
- Reviewed the specifications for the gasifier reactor vessel and the cyclones
- Reviewed the specifications for the Air/Gas compressors
- Assisted in the process and instrumentation review

Bechtel

- Continued process development, deleting tar quench filtration, light oil run tank and redundant instrumentation
- Evaluated recycle compressor options and submitted design package to Roberts & Schaefer
- Completed process specification for water treatment system
- Conducted HAZOP meeting with Roberts & Schaefer, IGT, and Callidus

Roberts & Schaefer

- Prepared P&ID's for HAZOP
- Prepared preliminary equipment layouts
- Issued preliminary control screens and operating philosophy
- Provided typical control systems, structural and electrical drawings for comment
- Prepared gasifier heat loss calculation
- Prepared bid packages and obtained bids which are currently being analyzed for the coal heating and char cooling screws
- Prepared and sent to prospective suppliers bid packages for the gasifier reactor and cyclones.
- Prepared bid package specifications for the AIR/Gas compressors

Callidus

- Began preparation of emissions control PFD

Reimelt

- Provided equipment layout information to Roberts and Schaefer for char lock hopper system

Plans for Next Quarter In the next quarter, the detailed engineering will continue with preparation of the bid packages for the liquids recovery section, design of the structural steel and additional foundations, finalize equipment layouts and electrical design, and completion of the HAZOP analysis.

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, Reimelt Engineering was selected as the best choice for purchasing of both the coal and char handling systems.

This quarter, the following items were accomplished:

Bechtel

- Awarded subcontract to Reimelt for the Coal Feed System and Char Handling System
- Awarded subcontract to Callidus for the Emissions Control and Process Heater Systems

Roberts & Schaefer

- Issued the following equipment for bid: gasifier with cyclones, screw heaters and coolers, recycle and air compressors, and hot oil system

Callidus

- Placed orders for process heaters

Reimelt

- Placed orders for coal and char baghouses, char storage bins, char and coal lock hoppers, char supersac loading station and coal supersac unloading station

Plans for Next Quarter Next quarter, construction will continue with placement of purchase orders for: gasifier and cyclones; air and recycle gas compressors; hot oil system; tar quench condenser; air coolers; heat exchangers; liquids tanks; pumps; and the coal heating and char cooling screws.

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.