

## **Scale-Up of Mild Gasification to a Process Development Unit**

**Quarterly Report  
November 1993 - February 1994**

**J. A. L. Campbell  
R. H. Carty  
H. Foster**

May 1994

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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**May 1994**

## SUMMARY

The work performed during the ninth quarterly reporting period (November 21, 1993 through February 20, 1994) 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.

A Finding of No Significant Impact (FONSI) was obtained on our NEPA submittal on February 10, 1994, allowing us to proceed with the project. The permitting documentation for the authority to construct was submitted to the Illinois EPA this quarter. Work to finalize the process design and obtain updated bids on the PDU was begun after the FONSI was obtained.

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

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.

### Tasks 2.1 Design Engineering

This quarter, the PDU process design was reviewed to evaluate the most cost effective methods to construct a unit that would allow us to accomplish the objectives of the project. The major change in the design has been the method of supplying heat to the gasifier. Originally, the heat was to be supplied by a combination of combustion of a portion of the product gas and recycle of the bed char which would be heated by partial combustion of the char. The recycle char heater design consisted of a unit approximately equal to the gasifier in size and cost and consumed up to 10% of the product char to produce the heat. For these reasons, the process design has been changed so that the heat input is supplied entirely by the fluidization gas (see Figure 1).

The fluidization gas for the gasifier is a combination of flue gas from a natural gas burner and product recycle gas. This combination allows flexibility in the amount of heat as well its distribution to the grid and central jet regions plus a simplification and shortening of the PDU test startup time. Preheaters may be utilized on the air and recycled product gas streams to reduce the burner size and product gas dilution. This method of supplying heat yields a product gas with a sufficiently high heating value to allow it to be used elsewhere for process heating. In a commercial plant, the preheaters may be fired with the product gas and the burners may be fired with pulverized coal.

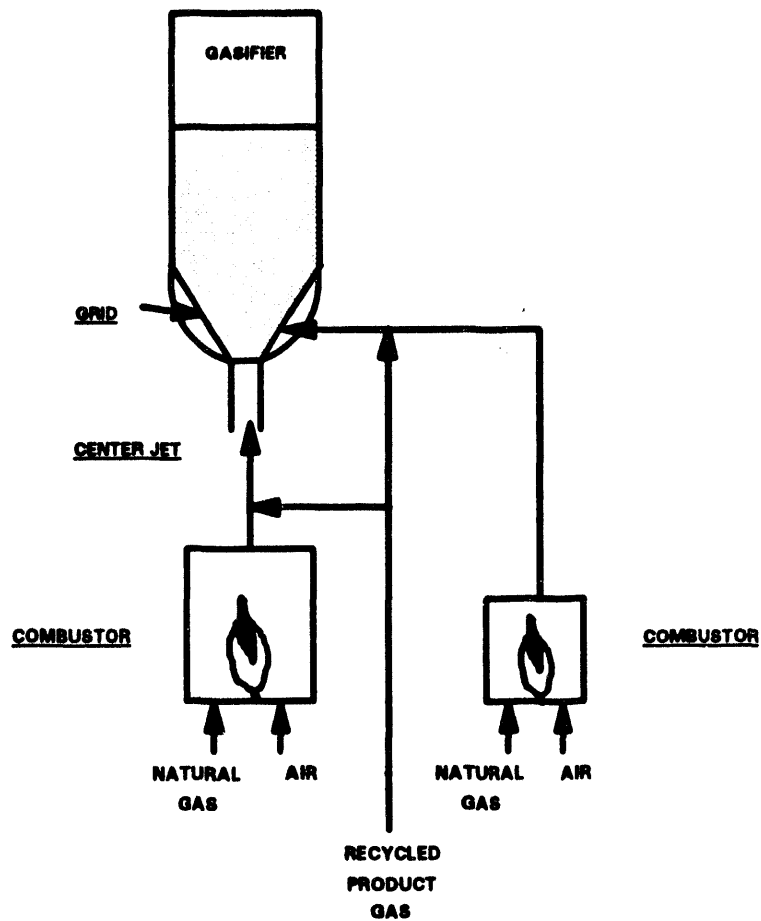


Figure 1. SCHEMATIC OF HEAT INPUT TO MILDGAS PDU

**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, we sent the document including the requisite forms, tables, drawings, and descriptive narrative that will be needed to describe the PDU in sufficient detail to allow the Illinois EPA to assess our application for the authority to construct.

**Plans for Next Quarter** In the next quarter, it is expected that we will receive the Authority to Construct from the Illinois EPA. In addition, bid package updates will be prepared and submitted to the bidders for recosting.



**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 usual monthly and quarterly reports.