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COAL-HYDROGASIFICATION PROCESS DEVELOPMENT

QUARTERLY TECHNICAL PROGRESS REPORT
FOR THE PERIOD
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1.0 OBJECTIVES AND SCOPE

The objectives of this project are to advance the development of the Rockwell single-stage, short-residence-time hydrogasifier and the CS/R* hydrogasification process which uses that gasifier along the path to commercial application via the following action:

- 1) Design, construct, and operate a 3/4-TPH (ton-per-hour) coal feed rate integrated process development unit (IPDU); demonstrate same in a 30-day test (continuous operation).
- 2) Develop process data and operating experience to support design, economic evaluation, and optimization of a viable commercial process.
- 3) Prepare a preliminary design of a practical commercial plant for producing substitute natural gas (SNG) from coal.

The scope of work involves an integrated combination of design, construction, and operation to demonstrate the large-scale, long-term feasibility of applying the Rockwell hydrogasifier reactor in a viable SNG-from-coal process. After completion of the IPDU facility, lengthy tests will demonstrate system operability, component durability, and product quality, while shorter runs will evaluate process factors. Strongly caking bituminous coal and noncaking subbituminous coal will be tested; char from each will be characterized. Process, material, and operational problems shall be defined and resolved to the extent necessary to warrant low-risk go-ahead with a large-scale pilot plant or demonstration plant venture following completion of this project. A preliminary design for a commercial-scale plant, of such quality and detail as to be directly useful to an architect-engineer (A-E) firm in the final design of an actual commercial unit, is to be the ultimate output of the project.

*The "CS/R" designation is derived from the joint development of the process by Cities Service Company and Rockwell International Corporation.

While designing and beginning construction of the IPDU facility, some hydrogasifier testing was carried out at the 3/4-TPH coal feed rate in a short-duration, engineering-scale test unit (ETU). The purpose of that testing was to refine and improve the hydrogasification data base established under predecessor Contract EX-77-01-2518 (Reference 1) by generating essential information outside the scope of that contract. A majority of the ETU tests used Kentucky No. 9 hvA bituminous coal (Reference 2). Most of the remaining tests were made with Minnesota peat (Reference 3).

A program schedule delineating the breakdown of the overall program into tasks and logical subtasks and time-phased relationships among them is shown in Figure 1. This schedule has become progressively more out-dated with each passing month of FY 1982, because DOE has not yet provided funding for this fiscal year. The major tasks are summarized below.

Task I concerned the engineering-scale testing. ETU testing was completed in June 1980. In general, ETU test results were consistent with data from other flash hydropyrolysis (FHP) work. The combined data base was considered to be adequate to warrant proceeding with Tasks II and III without further testing. Since completing Task I, work on more generalized correlation of the data base and development of an analytical FHP reactor model was continued as a low level of effort under Task II (Reference 4).

Task II is concerned primarily with IPDU design, construction, and testing. Design of the facility was completed in May 1980. A subcontract for installation of concrete footings, foundations and pads, and for erection of the IPDU structural steel was completed in February 1981. A second construction subcontract, for installation of a propane storage and supply system, was completed in March 1981. Two other major construction subcontracts were postponed in the autumn of 1980, when the project was rescheduled to respond to DOE funding changes. IPDU construction was scheduled to be resumed early in FY 1982. Completion of the facility near the end of FY 1982 was anticipated, followed by approximately 7 months of testing in FY 1983. However, this schedule will have to be revised when the extent and timing of DOE funding for FY 1982 are established.

Figure 1. Coal Hydrogasification Process Development Program Schedule

Task III provides for process optimization studies and for preliminary design of a commercial SNG plant, performed under subcontract by the Lummus Company, a division of Combustion Engineering, supported by process and reactor operation analyses by Rockwell/ESG and Cities Service personnel. Lummus also will participate as a consultant in the direction of the long-duration experimental program.

Task IV encompasses program management and administration of the program.

Task V provides for a materials surveillance program in conjunction with the IPDU experimental effort. This includes maintaining archive records and specimens of construction materials, exposure and evaluation of alternative materials at key locations in the facility, periodic monitoring of pressure components' wall thicknesses, and inservice monitoring of certain components for stress corrosion cracking by acoustic emission (AE) techniques.

2.0 SUMMARY OF PROGRESS

Principal activities during this quarter related to the ongoing receipt and acceptance test monitoring of advance procured components for the 3/4-TPH IPDU facility. Also continued were engineering contacts with two valve suppliers experiencing manufacturing problems with advance procured components. Both of these manufacturers appear to have solved their problems, with acceptance testing scheduled to be initiated during the early part of next quarter.

Some previously-ordered equipment was received during this quarter. The integral orifice delta-P flow transmitters and pressure gages were received.

Final system configuration checkout of the Beckman MV-8000 microprocessor controller for the IPDU has been initiated and is rescheduled to be completed in the latter part of April 1982.

Preparation of graphic control drawings has been completed by Rockwell Engineering, and a purchase order for the graphic configuration has been submitted to Beckman Instruments.

Assembly and checkout of the acoustic emission (AE) monitoring equipment for the IPDU was resumed during the quarter. All individual components and subassembly chassis were checked out, and assembly of the AE system was approximately 95 percent completed within the reporting period.

3.0 DESCRIPTION OF TECHNICAL PROGRESS

3.1 TASK II: 3/4-TPH IPDU FACILITY

Activities associated with the construction of the 3/4-TPH hydrogasification integrated process development unit (IPDU) at the ESG Energy Bowl are described in this section.

3.1.1 Advance Procurement

The status of advance procured equipment for the IPDU is summarized in Table 1.

Advance procured components continued to be received during this quarter. The integral orifice delta-P flow transmitters and pressure gages were received and have been stored.

Items which have been ordered for a considerable length of time, but have not been received yet, are the severe-service letdown valves and the lock hopper valves. Engineering contact with these suppliers has been maintained on a weekly basis. The lock hopper valve manufacturer appears to have resolved all of their problems; acceptance testing of these valves is scheduled to start on April 20, 1982. The severe-service letdown valves have continued to experience manufacturing problems in the coating of the 17-PH4 plugs and seats; the problems are expected to be resolved within the next several weeks. The plug and seat-coating manufacturer has repeatedly erred in the final grinding of the boron-silicide-coated plugs and seats, which has necessitated new plugs to be machined and submitted for recoating. The valve manufacturer now is tooling up to perform their own grinding and lapping of the boron-silicide-coated plug and seat components in-house.

TABLE 1
IPDU ADVANCE PROCUREMENT STATUS
(Sheet 1 of 2)

Equipment Items Received

Coal Crusher (L-103)	Cooling Tower (X-241)
Coal Hopper (H-101)	Char Vent Gas Blower (C-621)
Coal Feeder (L-101)	Char Surge Hopper (H-623)
Coal Conveyor (L-104)	Char Lock Hopper (H-123)
Pulverized Mill (L-105)	Char Lock Hopper (H-122)
Pulverized Hopper (H-103)	Coal Main Feeder (H-124)
Mill Blower (C-101)	Substation - 1000 kVA
Recirculating Gas Heater (X-101)	Wash Water Pump (P-661)
Rotary Feeder (FX-103)	Sliding Gate Valves
Cyclone Separator (S-102)	Swirlmeters
Dust Filter (S-101)	Coal Mass Flowmeter
Coal Storage Silo (H-121)	GN ₂ Metering Section
Vibrator (L-121)	Load Cells (Coal)
Cooling Water Recirculating Pump (P-421)	Turbine Flowmeters
Product Gas Combustor (L-681)	LOX System Valves
Pressure Regulating Valves	Load Cells (Char)
Pressure Switches	Injector Coolant Pump (P-602)
Char Vent Gas Filters	Contaminated Water Pump (P-683)
Scrubber Solution Pump (P-681)	Pressure Relief Valves
Motor Control Center	GN ₂ Heater (X-622)
Restriction Orifice Flanges	Product Gas Scrubber (J-681)
Hydrogen Heater (X-302)	Char Moistener (J-621)
Solids Collectors (J-623, T-624, T-625, T-627)	Thermometers
Deionized Water Cooler (X-603)	Dust Filter Elements
LOX Vaporizers (X-201, X-202)	Thermocouple Assemblies
Char Receiver Vessel (H-621)	LH ₂ Vaporizer
Char Lock Hopper (H-622)	Vent Gas Cooler (X-621)
	Product Gas Cooler (X-661)
	Gas/Liquid Separators (S-624, X-661)

TABLE 1
IPDU ADVANCE PROCUREMENT STATUS
(Sheet 2 of 2)

<u>Equipment Items Received (Continued)</u>	<u>Deferred Procurements Continuing on Hold</u>
Vortex Shedding Meter	Level Controls (Capacitance Type)
Pressure Regulator Pilot Valves	Product Gas Cyclones (S-621, S-622, S-623, S-625)
Thermocouple Transmitters	Char Cyclone (S-626)
Microprocessor Controller	Dust Filter Assemblies
Lock Hopper Valves - Partial	Contaminated Water Storage Tank (T-664)
Pulsing Solenoid Valves	Electric Crane Hoist
Safety Relief Valves	Benzene Recovery Loop Equipment Items
Pressure and ΔP Transmitters	
Hydrogen Sulfide Monitoring System	
Oxygen Analyzers	
Plug Block Valves	
On/Off Control Valves	
Pressure and ΔP Transmitters	
LH ₂ Pumping System (PS-300)	
Deionized Water Pump (P601)	
Letdown Valves (Nonsevere Service)	
Thermal Conductivity Analyzers	
Hydrogen Control Console	
Hydrogen System Control Valves	
Integral Orifice ΔP Flow Transmitters	
Pressure Gages	
<u>Equipment Items in Fabrication</u>	
Letdown Valves (Severe Service)	
Lock Hopper Valves	

3.1.2 Microprocessor Controller

Acceptance testing of the system configuration of the Beckman MV-8000 microprocessor controller for the 3/4-TPH IPDU has been initiated and is scheduled to be completed in late April.

Preparation of the graphic display layouts by Rockwell Engineering has been completed. A purchase order has been submitted to Beckman for graphic configuration, and this work is scheduled to be completed in May 1982.

3.2 TASK V: CONSTRUCTION MATERIALS AND COMPONENT SURVEILLANCE

3.2.1 Acoustic Emission Monitoring of Components

Completing assembly of the acoustic emission (AE) equipment was postponed for several months while key personnel were temporarily reassigned to other projects. AE components' verification and assembly were resumed in late January and were continued through the quarter with the following accomplishments:

- 1) The disc assembly unit was tested, verified, and made operational.
- 2) Checkout of all individual AE components and chassis was completed.
- 3) Modification and verification of all 106 amplifiers were completed.
- 4) A connector panel for the assembly rack was designed, and fabrication of the connector panel was initiated.

In summary, assembly of the AE system is about 95 percent complete with the following activities remaining: complete fabrication of the connector panel, final assembly, and system checkout.

4.0 REFERENCES

1. Rockwell International, "Development of a Single-Stage, Entrained-Flow, Short-Residence-Time Hydrogasifier," FE-2518-24, Final Report, National Technical Information Service, Springfield, Virginia (1979)
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3. K. M. Sprouse and J. K. Rosemary, "Coal Hydrogasification Process Development: Volume II: Peat Studies," ET-3125-24, Second Annual Technical Progress Report, Government Fiscal Year 1980, Rockwell International Corporation, Environmental & Energy Systems Division, Canoga Park, California (October 1980)
4. L. P. Combs et al., "Coal Hydrogasification Process Development," ET-10328-36, Third Annual Technical Progress Report, Government Fiscal Year 1981, Rockwell International Corporation, Environmental & Energy Systems Division, Canoga Park, California (October 1981)

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