

DOE/FE/05121--T2

The Design, Construction, and Operation
of a
Process-Development Unit
for the
High-Rate Entrained-Flow Coal-Gasification Process

DOE/FE/05121--T2

DES2 014622

Quarterly Technical Progress Report No. 1
April - June 1981

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Prepared for the
United States Department of Energy
Under Contract DE-AC01-81FE05121

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Quarterly Technical April - June 1981
Progress Report

Contract DE-AC01-81FE05121

INTRODUCTION

Mountain Fuel Resources, Inc., a subsidiary of Mountain Fuel Supply Company, Salt Lake City, Utah is under contract with the U.S. Department of Energy for a program to design, construct and operate a high-rate, entrained-flow coal gasification process development unit (PDU). The objective of the program is to develop a process for gasification of coal to form a clean, intermediate-Btu fuel gas or a synthesis gas that may be converted to methyl alcohol, gasoline, synthetic natural gas or many other desirable products. Ford, Bacon & Davis Utah, Inc., is a major subcontractor on the program, and will be largely responsible for design, construction and operation of the PDU. Program costs are being shared with eighty percent of these costs to be paid by DOE and the balance of the costs being shared equally between Mountain Fuel Resources and Ford, Bacon & Davis.

The coal gasification process being developed is based on work done at the Eyring Research Institute, Provo, Utah. Pulverized coal is fed to an entrained flow reactor where it is gasified by reaction with steam and oxygen. The ash in the coal may be removed as an inert slag and the product gas may be cleaned to remove sulfur-containing compounds and carbon dioxide to yield a clean fuel gas with a heating value near 300 Btu/standard cubic foot.

To develop the process, construction and testing of an experimental unit, the PDU, is planned. The PDU is to be located adjacent to a brick plant operated by Interstate Brick Company in West Jordan, Utah. Interstate Brick is also a subsidiary of Mountain Fuel Supply Company. Because of the developmental nature of the program, the PDU will contain only those components and features necessary to develop the gasifier and operate it safely. The PDU will be operated intermittently, with test durations ranging from a few hours up to a maximum of four weeks. During most of the testing the product gas will not be used but will be simply burned in a flare. During later tests the gas will be used in firing the brick kilns in the brick plant.

Most of the testing will be done with a low-sulfur, Utah bituminous coal. Near the end of the planned effort, several tests, up to 100 hours each, will be made with alternate coals: a high-sulfur bituminous coal, a low-sulfur subbituminous coal, a lignite and a coal char or residue.

DISCUSSION OF PROGRESS DURING QUARTER

Current effort on the program is directed toward design and specification of the PDU. Flow diagrams and material balances have been developed. A request for environmental permits has been prepared and submitted. Piping and instrument diagrams (P&ID's) and most of the equipment specifications have been prepared and reviewed.

Description of the Process Development Unit

The PDU will be located on a 6.3 acre section of land east of the Interstate Brick plant with the approximate arrangement shown in Figure 1.

For purposes of process design, the PDU has been divided into three process sections or units:

Coal Handling (Unit 100)

Coal Gasification (Unit 200)

Water Treating and Utilities (Unit 300)

Coarse coal (2" x 0) will be delivered to the site via truck and stored in a pile containing a maximum of about 1,800 tons. During PDU operation, coal will be removed from the storage pile and loaded into the coal crushing and pulverizing system as shown in Figure 2 (Drawing No. D-369-D-002), Unit 100. The coal will be pulverized to a size of 75% <200 mesh and dried by flash-drying in equipment similar to that used to prepare coal for combustion in a pulverized coal-fired boiler. Drying heat will be supplied by combustion of natural gas. Excess gas will be vented through a bag filter. The pulverized coal will be transported from Unit 100 into the coal feeder in the gasification system in Unit 200 with nitrogen.

In Unit 200, shown in Figure 3 (Drawing No. D-369-D-003), the pulverized coal will be fed into a reactor and gasified by reacting with steam and oxygen at a temperature and pressure of 2850°F and 300 psig, respectively. The reaction products will be cooled and steam generated by passing the reaction products through a series of heat exchangers. Entrained ash and char particles will be removed by water scrubbing in a venturi scrubber followed by a packed column. The cleaned product gas will be burned in the flare (Unit 300) generally or, if conditions are suitable, in a brick kiln at the adjacent brick plant. Ash and char will be removed as a water slurry to the pond. Surplus steam will be vented to the atmosphere.

The pond system is illustrated in Figure 4 (Drawing No. D-369-D-004), Unit 300. Two ponds will be used, which will allow total containment of the water and ash. Water will be recycled from one of the ponds for use in the scrubber and for ash removal. All process-contaminated water will be collected in the ponds.

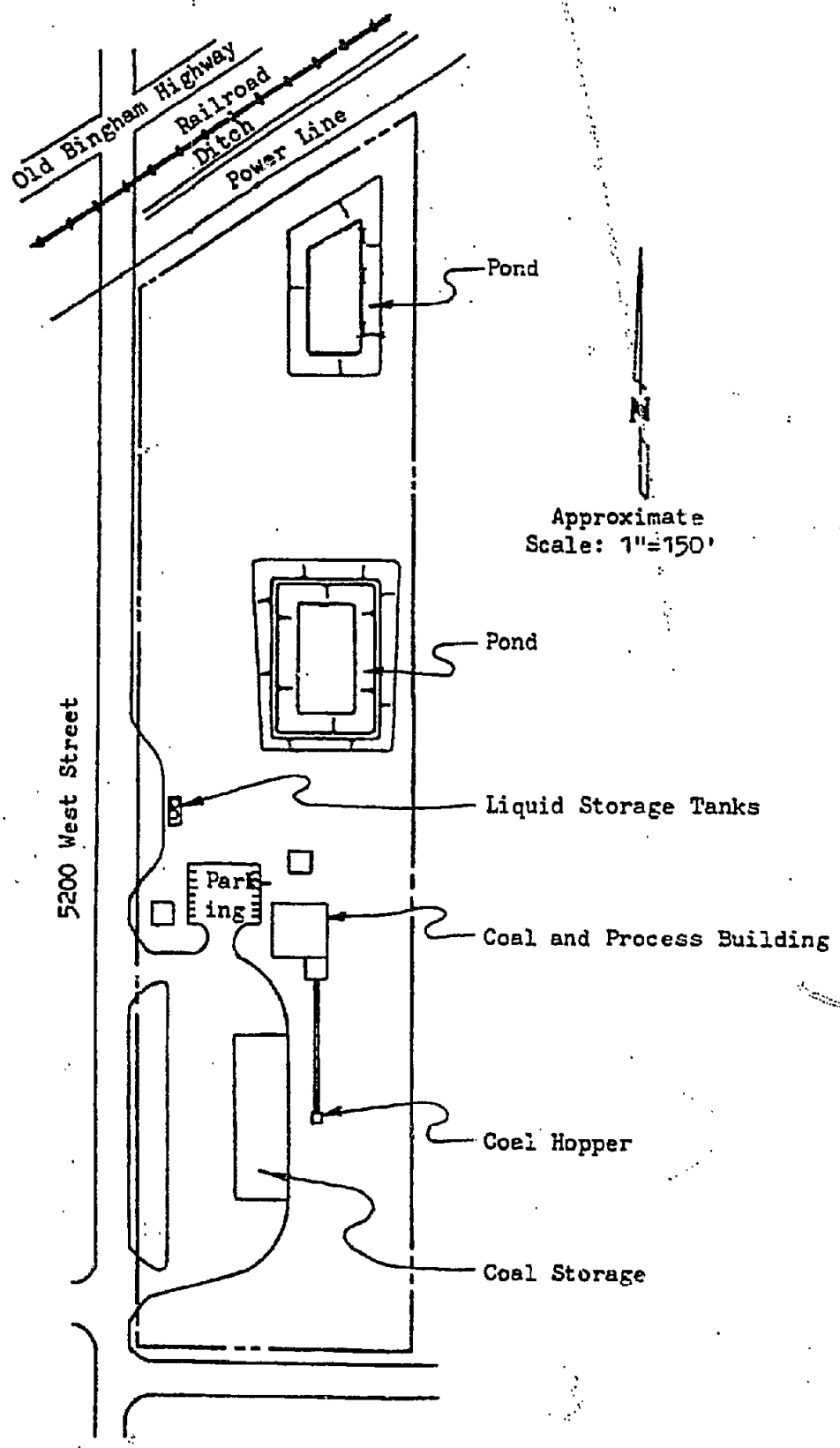


Figure 1
 Plot Plan for Process Development Unit

City water will be treated in a water softener and deaerator before use in the steam generation system.

Liquid oxygen and nitrogen will be delivered to the site and stored at cryogenic temperatures until needed for use, when it will be vaporized and heated to the required temperatures.

Environmental Considerations

In accordance with the environmental regulations for the State of Utah, application for permits for construction of the PDU has been made by submitting a Notice of Intent to the Utah Department of Health, Division of Environmental Health. The Notice of Intent was submitted on March 27, 1981 after reviewing the proposed effort at a Predesign Conference with representatives of the Division of Environmental Health on January 23, 1981. The approval procedure is still underway.

The estimated air emissions from the PDU are summarized in Table 1. Other than fugitive emissions and wind erosion from the coal pile, all air emissions will come from either the flare or the vent from the coal pulverization system.

All of the solid and liquid wastes will be collected and retained in two clay-lined ponds. At the end of the program, after the water has evaporated, the pond areas will be covered with a clay cap and with local soil. The types and quantities of waste materials that will remain in the ponds at the end of the program are summarized in Table 2.

Drawings and Specifications

The following specifications have been completed and have been reviewed and approved by both Ford, Bacon and Davis Utah (FBDU) and Mountain Fuel Resources (MFR). Upon consolidation of all the comments, final issues will be generated for quotations:

<u>Title</u>	<u>Spec. No.</u>
Pumps	369-P-101
Steam Drum	369-P-102
Venturi Scrubber & Packed Column	369-P-103
Recycle Gas Cooler	369-P-104
Ash Lock Hopper & Slurry Discharge Tank	369-P-105
Separator Drum	369-P-106
Recycle Gas Compressor & Surge Tank	369-P-107
Chemical Systems	369-P-108
Water Softener System	369-P-109
Deaerator	369-P-110
Blowdown Flash Tank & Deaerator Feed Tank	369-P-111
Flare & Knockout Drum	369-P-112
Cyclone Separator	369-P-113

Table 1
Summary of Air Emissions

	<u>Emission Rate (lb./hr.)</u>	<u>Annual⁽¹⁾ Total (ton)</u>	<u>Concentration At Source (ppm by vol.)</u>
PARTICULATES			
Wind Erosion		0.05	
Coal Drying System	0.02	0.02	0.002 grains/SC
Flare	3.0	3.0	0.08 grains/SCF
SO₂			
Flare (High Sulfur Feed)	34 (170)	48	800 3800
NO_x			
Flare	≤ 2	≤ 2	≤ 50
Coal Drying System	≤ 0.1	≤ 0.1	≤ 10
CO			
Flare	15	15	800
Coal Drying System	≤ 1.0	≤ 1.0	≤ 200
FUGITIVE EMISSIONS			
CO	0.75	0.75	
H ₂ S	0.6	0.6	
H ₂ S	0.002	0.002	
COS	0.0002	0.0002	

(1) 2,000 Hours of Operation During Year

Table 2

Summary of Materials Collected in Ponds

	<u>Collection Rate (lb./hr.)</u>	<u>Annual⁽²⁾ Total (tons)</u>
Coal Ash	310	310
Unreacted Coal (Essentially Only Carbon)	102	102
Sodium Sulfide	2.4	3.4
Sodium Carbonate	16.8	16.8
Sodium Hydroxide	0.8	0.8
Water Treatment Chemicals ⁽²⁾	0.4	0.4

(1) 2,000 hours of operation during year.

(2) Includes scale inhibitor (a polyphosphate), an oxygen scavenger (sodium sulfite), a sludge conditioner (lignin sulfonate) and neutralizing amines.

<u>Title</u>	<u>Spec. No.</u>
Instrument Air Compressor	369-P-114
Air Dryer	369-P-115
Oxygen Superheater	369-P-116
Oxygen & Nitrogen Systems	369-P-117
Steam Vent Silencer	369-P-118
Oxygen Preheater	369-P-125

The following specifications are nearing completion for FBDU review and MFR approval:

<u>Title</u>	<u>Spec. No.</u>
Natural Gas Compressor	369-P-126
Coal Pulverizing System	369-M-2
Legal Survey	369-C-101
Motor Control Center & Control Building	369-S-100

The following drawings have been reviewed and approved by MFR. All comments have been resolved and are currently being incorporated into the drawings.

<u>Title</u>	<u>Drawing No.</u>
Environmental Emission Block Diagram	D-369-D-001
Process Flow Diagram - Coal Handling	D-369-D-002
Process Flow Diagram - Pilot Plant Gasifier	D-369-D-003
Process Flow Diagram - Water Treating & Utilities	D-369-D-004
Piping & Instrument Diagram - Sheet 2	D-369-D-102
Piping & Instrument Diagram - Sheet 3	D-369-D-103
Piping & Instrument Diagram - Sheet 4	D-369-D-104
Piping & Instrument Diagram - Sheet 5	D-369-D-.05
Piping & Instrument Diagram - Sheet 6	D-369-D-106
Plot Plan	D-369-C-001

The following drawings have been completed and have been reviewed by FBDU. After consolidation of all comments, they will be issued for MFR's approval.

<u>Title</u>	<u>Drawing No.</u>
Site Preparation, Plans & Sections	D-369-C-002
Motor Control Center & Control Building	D-369-A-001

The following drawings are nearing completion in preparation for review.

<u>Title</u>	<u>Drawing No.</u>
Piping & Instrument Diagram - Legend & Symbols	D-369-D-100
Piping & Instrument Diagram - Sheet 1	D-369-D-101
Electrical One-Line Diagram	D-369-D-401
General Arrangement - Elevations	D-369-M-001
General Arrangement - Elevations	D-369-M-002
General Arrangement - Plans	D-369-M-003
General Arrangement - Plans	D-369-M-004

SCHEDULE

The current program schedule is shown in Figure 5. During the coming quarter the design and specification effort will be basically completed and a major portion of the orders and subcontracts will be placed. The environmental permits are expected to be issued. Initiation of site work is scheduled for early September. Field construction effort to that time will relate to specification, bidding and award of construction subcontracts.

Figure 5. PROGRAM SCHEDULE

