

JUL 22 1968

# Mobil Research and Development Corporation

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APPLIED RESEARCH & DEVELOPMENT	

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July 18, 1968

*lit. Big*

- K. L. Berry - Pan American Petroleum Corp. *1513023003*
- G. A. Blaine - Sinclair Research, Inc.
- F. R. Conley - Continental Oil Company
- H. P. Dengler - Esso Research & Engineering Co.
- R. T. Ellington, Jr. - Sinclair Gas and Oil Company
- K. M. Elliott - Mobil Research & Development Corp.
- R. Mungen - Pan American Petroleum Corp.
- D. C. Smith - Phillips Petroleum Company
- J. H. Smith - Continental Oil Company
- R. V. Smith - Phillips Petroleum Company
- W. O. Taff - Humble Oil & Refining Company

Gentlemen:

Attached is a copy of the Final Report on Anvil Points to the Secretary of the Interior.

*S. L. Meisel*  
S. L. Meisel

ses  
Attachment

COLORADO SCHOOL OF MINES RESEARCH FOUNDATION, INC.

GOLDEN, COLORADO 80401

1513023-003

Office of the Director

July 8, 1968

Refer to

The Honorable Stewart L. Udall  
Secretary of the Interior  
Washington DC 20240

Dear Mr. Secretary:

This letter will constitute our Final Report required under Article III, Appendix I of the Lease Agreement, relating to the Anvil Points Demonstration facility near Rifle, Colorado.

Pursuant to Section 2.09 of Appendix I of the Lease Agreement, each of the Parties is separately responsible to report to the government all patent applications based on primary inventions made by it in the course of work on the Initial Program. The Research Foundation has no reason to believe that these reports have not been timely made.

Mobil Oil Corporation has advised the Research Foundation that Mobil will furnish the government information relative to any Subject Inventions made in the course of the Mobil mining program.

The Research Foundation hereby certifies that to the best of its knowledge and belief no Inventions have been made by employees, agents, or sub-contractors assigned by the Research Foundation to work on the Initial Program or the Mobil mining program.

On December 1, 1967 the Participating Parties began a comprehensive engineering evaluation of retorting results of the Initial Program. This work was performed under an extension of the Initial Program of the joint Anvil Points research agreement executed April 29, 1964. Participating Parties in the extension agreement were Mobil, Humble, Continental, Pan American and Sinclair. Phillips chose not to participate in this study. During this evaluation the Anvil Points facilities

were held on a standby basis.

The extension agreement limited potential expenditures for the engineering evaluation to \$150,000. The parties to the agreement concluded that the objectives had been met after an expenditure of only about \$88,000. These costs were divided into about \$67,600 for maintaining Anvil Points in standby and about \$20,400 for the engineering evaluation work itself.

An engineering evaluation team studied the impact of the progress made during Stage II and whether modifications of the basic shaft retorting process offer possibilities of significant advantages. The team studied five cases of vertical kiln retorting, including a basic gas combustion retort, as shown in the attached schematic flow diagram.

Case 1 is the gas combustion retort (Base Case) as developed at Anvil Points. A constant production of mine run shale was assumed for all cases. The amount was sufficient to yield about 50,000 barrels of oil per day. Operating conditions were based on the best operations achieved in Retort 3 at Anvil Points.

Case 2, or upflow, utilizes a rock pump to move the shale upward as contrasted to downward moving beds in the other cases. Case 2 may be thought of as an upside-down gas combustion retort. The advantage to upflow of shale would be to reduce refluxing of any oil that wets the incoming raw shale particles.

Case 3 was designated the isolated combustion case. The retort is physically divided into three zones. Retorting is accomplished with hot recycle gas in the upper zone, spent shale is burned with air in the center zone, and recycle gas is reheated in the bottom zone. This arrangement eliminates mixing of flue gas with the recycled gas stream.

Case 4 is a version of indirect retorting where an external fired heater is used to supply the hot gas needed to retort the shale with the object of improving temperature control in the retort. It is called the external heating case. It is the only case which does not utilize combustion of carbon on the spent shale as the heat source. Consequently, this process must burn some of the retort gas for its fuel.

Case 5 has been designated external condensing because hot oil vapors are withdrawn from the retort, thus eliminating the possibility of condensing any oil

vapors in the shale bed. As in Case 3, gas sealing devices are required to separate the retort vessel into three zones. The external heat exchangers add considerably to the process investment.

Cases 2, 3, 4, and 5 represent conceptual schemes for which no experimental data on Colorado shale are available. The engineering appraisal team judged that all of these processes were technically feasible. The determination of economic feasibility will require an experimental program to determine oil yields and operability for the various retorting schemes.

We wish to express our appreciation to all Government personnel for the splendid cooperation we have received during the life of this project. We feel that the project accomplished its objectives of research in mining, crushing, and retorting of oil shale.

Sincerely,

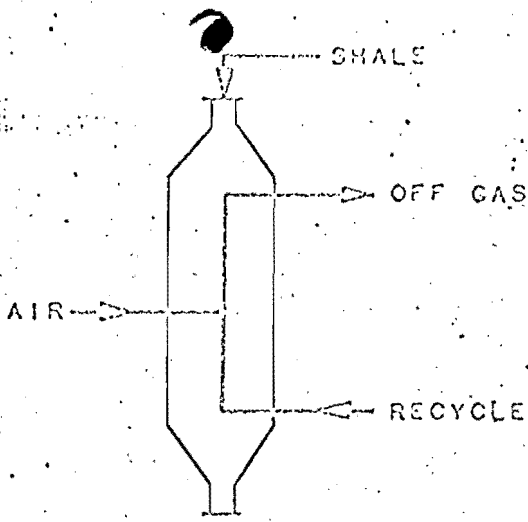


E. H. Crabtree  
Director

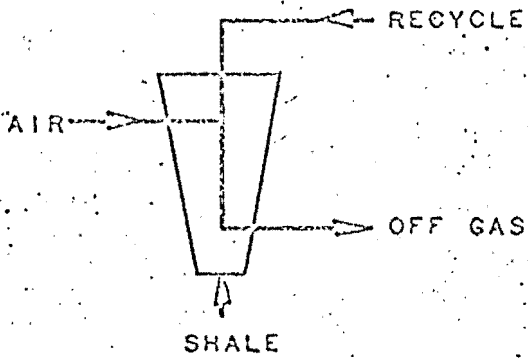
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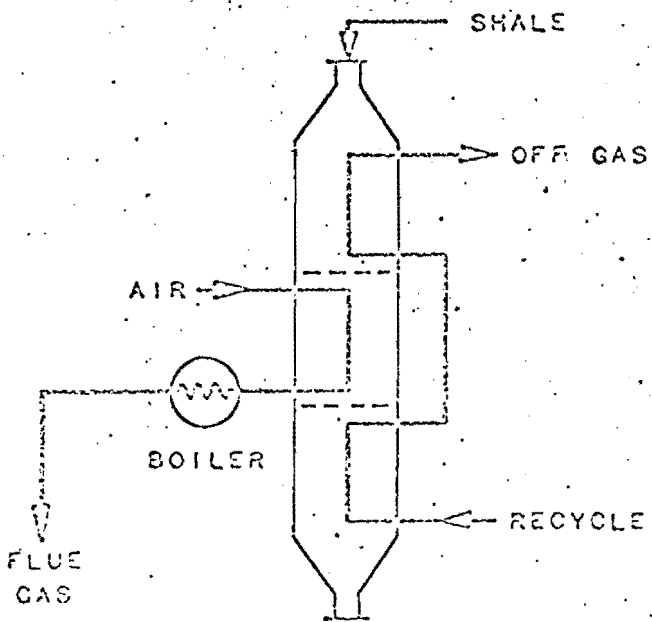
FIGURE 1



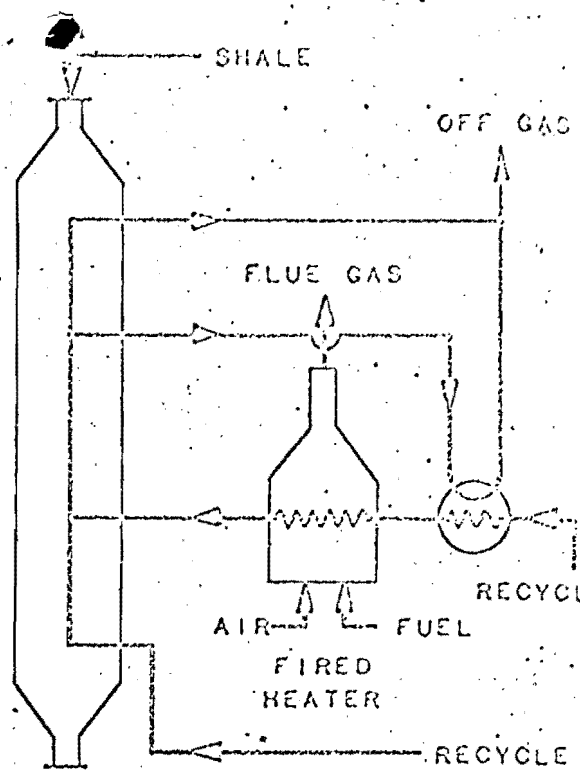
CASE 1 -- BASE GC



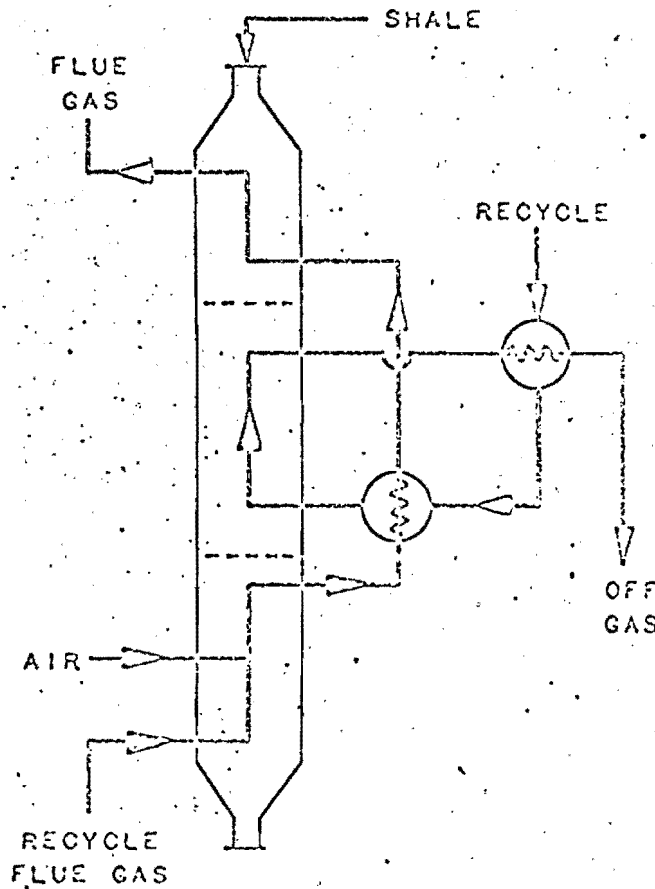
CASE 2 - UPFLOW



CASE 3 - ISOLATED COMBUSTION



CASE 4 -- EXTERNAL HEATING



CASE 5 -- EXTERNAL CONDENSING