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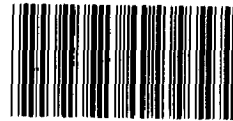
COMPTROLLER GENERAL OF THE UNITED STATES

WASHINGTON, D.C. 20548

B-199294

September 24, 1980

The Honorable Jim Sasser
Chairman, Subcommittee on
Legislative Branch
Committee on Appropriations
United States Senate



113617

Dear Mr. Chairman:

Subject: [Information on the 1949-54 Bureau of Mines
Coal Liquefaction Pilot Plants] (EMD-80-120)

This is in response to your letter of May 2, 1980, in which you requested information about the Bureau of Mines coal liquefaction pilot plant in Louisiana, Missouri, which operated from 1949 to 1954. You specifically asked

- for the facts about the project, particularly why it was abandoned;
- whether the process could be updated and implemented; and
- whether an updated version could be a part of the planned national synthetic fuels program.

To respond to your request, we reviewed Department of Energy correspondence, Bureau of Mines reports, the Congressional Record, and contacted industry officials. We did not independently evaluate the technical feasibility of the direct liquefaction process tested in the Louisiana, Missouri, plant. We were told by industry and Government officials with experience in the process that, although the direct liquefaction plant was closed in 1954, the information developed during the operation of the plant formed the basis for subsequent industry and Government efforts on direct liquefaction. However, based on the information we reviewed, we were not able to verify what information from the plant was used in subsequent processes.

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BACKGROUND

There are two basic types of coal liquefaction--direct and indirect. Direct liquefaction produces liquids through interaction of coal and hydrogen at high temperature and pressure. Indirect liquefaction involves the gasification of coal to a synthesis gas (hydrogen and carbon monoxide mixture) and the subsequent production of a liquid from that gas through the introduction of a catalyst.

These two methods of converting coal to liquids were developed in the early 1900s in Germany. Around 1911, Friedrich Bergius developed the forerunner to direct liquefaction. I.G. Farben did further work on this process and added a catalyst to the reaction. By 1943 Germany had 12 plants producing gasoline from coal using the Bergius-I.G. Farben process. These plants produced about 97,000 barrels a day annually and accounted for about 50 percent of the total hydrocarbon products consumed in Germany during the latter part of World War II. The indirect method was developed about the same time by Franz Fischer and Hans Tropsch. This method produced only about 10,000 barrels a day for the German effort during World War II.

Using variations of the Bergius-I.G. Farben process, coal was also converted to liquid fuels in France, Great Britain, and Japan beginning in the middle 1930s and continuing until the end of World War II. All these countries, including Germany, were short of petroleum reserves and anxious to be self-sufficient in liquid fuels. Therefore, even though the fuels from this liquefaction process were not cost competitive with those produced from crude oil, the production of gasoline from coal prospered during the war. After the war, liquefaction plants continued to operate only in countries such as East Germany and Russia, where the government controlled the industry and there was no competitive market.

The only commercial coal liquefaction plants in operation today are the SASOL I and II ¹/ _{plants in the Republic of South Africa. These plants, subsidized by the Government of South Africa, began operation in 1955 and 1980, respectively, and together produce about 70,000 barrels a day of liquid products using the Fischer-Tropsch indirect process.}

¹/South African acronym for South African Coal, Oil, and Gas Corporation.

EARLY COAL LIQUEFACTION
PLANTS IN LOUISIANA, MISSOURI

After the war, the United States sent teams of industrial and Government scientists and engineers to Germany to obtain all available information on their synfuels plants. This effort was known as the Technical Oil Mission. The information gathered during the Mission was available to industry and the public and was used by the Bureau of Mines as a basis for constructing two small pilot plants in Louisiana, Missouri, which operated from 1949 to 1954.

The one plant tested the Fischer-Tropsch indirect liquefaction process and provided cost data on the conversion of American coals to gasoline. This plant demonstrated how the process worked and highlighted the need for a better and less costly gasifier for indirect liquefaction plants. According to a Department of Energy official, industry and Government believed then that the economics of direct liquefaction were better for producing gasoline and, therefore, primarily pursued that process. However, further research in the United States and in other countries has resulted in improved gasifiers and three indirect processes are currently considered commercially available--Fischer-Tropsch, methanol from coal, and M-gasoline.

The other Bureau of Mines plant, which was referred to in your letter, tested a direct liquefaction process. It was designed and built by the Bechtel Corporation with a coal throughput of about 60 tons a day to produce about 200 barrels a day of synthetic gasoline. Its objectives were to provide Government and industry with information on the operability of the direct process with different American coals and an economic assessment of the process. The plant accomplished these objectives and was closed in 1954.

Why the direct liquefaction
plant was abandoned

The project was abandoned in 1954 because the direct liquefaction process was considered to be uneconomical and noncompetitive with crude-oil based products. In 1951 the Bureau of Mines estimated the cost of producing gasoline using this process was about 11 cents a gallon compared with the 10.6 cents a gallon for gasoline produced from crude oil. The National Petroleum Council, an industry group which then provided advice to the Department of the Interior, and Ebasco Services, a private consultant

firm, also estimated the cost of producing gasoline from this process. Their estimates were 41.4 cents and 28.1 cents a gallon respectively. The same three organizations revised their estimates in 1952-53. The Bureau's revised estimate for the cost of gasoline from this process was 19.1 cents a gallon, while Ebasco's was 21.8 cents a gallon, and the National Petroleum Council's was 34.8 cents a gallon. The revised estimates were from 8.5 to 24.2 cents a gallon above the cost of gasoline from crude oil. This wide range of cost estimates reflected the uncertainty of the costs of commercially producing gasoline from this process.

The direct liquefaction plant's
contributions to current
synthetic fuels efforts

Since 1954 industry and Government have been doing research to develop improved liquefaction processes in terms of trouble-free operation, safety, environmental acceptability, and cost competitiveness. The Department of Energy currently supports the advanced development of four direct coal liquefaction processes--two variations of Solvent Refined Coal (SRC-I and SRC-II), H-Coal, and Exxon Donor Solvent (EDS)--which are outgrowths of the Bergius-I.G. Farben process.

The initial work on these processes reportedly was based on information from the Technical Oil Mission and the Bureau's direct liquefaction pilot plant. For example, according to an official of Hydrocarbon Research, Inc., the developer of the H-Coal process, some of the founding fathers of this company participated in the Technical Oil Mission. They used that information, together with the data from the Bureau plant, to develop and subsequently commercialize their H-oil process, the forerunner of H-Coal. An Exxon official stated that Exxon used information gathered by the Technical Oil Mission as the basis for initially deciding to further research the Bergius-I.G. Farben process using U.S. coals. Data from the Bureau's plant was used for comparative analysis with data from Exxon's initial small test unit. This research formed the basis for the development of the EDS process.

During the development of their respective processes, Hydrocarbon Research, Inc., and Exxon have made improvements over the Bergius-I.G. Farben method. For example, the pressure requirement has dropped from 10,000 pounds per square inch for the Bergius-I.G. Farben process to 2,000 pounds per square inch for H-Coal and EDS, and the thermal

efficiency has improved from 30 percent to 70 percent. These changes have improved overall operability and reduced the cost of the product.

COMMERCIALIZATION POTENTIAL

Even though the current direct liquefaction processes under development are much improved when compared to Bergius-I.G. Farben, they are not ready for the commercial marketplace. Our August 1980 report on liquefaction points out that these processes have only been operated on a small scale and have technical and environmental problems to be resolved. ^{1/} However, the Department of Energy plans to address these issues through its direct liquefaction research, development, and demonstration program, and assuming successful operation of the program's pilot and demonstration plants, foresees no insurmountable constraints to eventual commercialization of the processes.

In contrast, three indirect liquefaction processes are commercially available now. However, industry officials believe that commercial plants have not been built in the United States because of the financial risk involved in building first-of-a-kind plants. Some companies are ready to commit resources to build commercial indirect liquefaction plants, but would like their risk reduced by financial incentives from the Government.

On June 30, 1980, the President signed the Energy Security Act which establishes a Synthetic Fuels Corporation to provide financial incentives for the development of domestic substitutes for imported oil. This act also sets national goals for synthetic fuel production of 500,000 barrels a day by 1987 and 2 million barrels a day by 1992. The Congress has thus far appropriated \$19 billion for use by the Corporation, of which the Department of Energy may use \$5.5 billion (before the Corporation is fully operational) to begin offering financial incentives to spur alternative fuels development.

You asked whether an updated version of the pilot plant could be part of the synthetic fuels program. These early efforts appear to have made contributions to the processes now under development, and in effect are "updated versions."

^{1/}"Liquefying Coal for Future Energy Needs," EMD-80-84, Aug. 12, 1980.

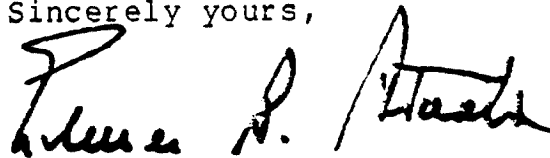
However, since these current processes have operated only in small test facilities, successful operations in large-scale plants are needed before commercialization is viable.

As a result, it is unlikely that any commercial direct liquefaction plants will be operating in the 1980s. Therefore, if any portion of the national goals of 500,000 barrels a day by 1987 and 2 million barrels a day by 1992 of crude oil equivalent is to be met with coal liquefaction, the bulk of the production is likely to come from the indirect processes.

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As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of the report. At that time we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Bruce S. Atack". The signature is written in a cursive style with a large initial "B".

Comptroller General
of the United States