

Paraho Oil Shale Project

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INTRODUCTION

The Paraho Oil Shale Project is a privately financed program to prove the Paraho retorting process and hardware on oil shale at Anvil Points, Colorado, near Rifle. The project was launched in late 1973 under the sponsorship of seventeen participants*, many of whom were active in earlier oil shale research. These companies earn the right to license the Paraho Oil Shale technology on favorable terms by participating. During 1975, these participants increased the funding for the project from \$7.5 million to \$9 million and extended the term from February to May 1976.

BACKGROUND

Why is there a Paraho Oil Shale Project? Why is it being conducted at Anvil Points? The answers to these questions go all the way back to 1964 and the Colony Development programs.

The first Colony Development program was organized by Sohio Petroleum (Sohio), The Cleveland-Cliffs Iron Company (Cliffs), and The Oil Shale Corporation (Tosco) in 1964. A mine was opened and a semi-works scale Tosco type plant was built near Parachute Creek, Colorado about 23 miles from Anvil Points. Operations were commenced in 1965 and shut down in 1966.

After the shut-down of the Tosco plant in 1966, Sohio and Cliffs made an extensive survey of the world-wide technology for retorting oil shale. Among 35 different technologies which were studied in detail, a series of new inventions by John B. Jones, Jr. were selected as the most promising. They were referred to as the Paraho technology.

Before a program could be organized to test the Paraho technology on oil shale, negotiations began with Atlantic Richfield Company (Arco) to form the second Colony Development program. These were completed by Sohio, Cliffs, Tosco, and Arco in 1969. Arco became the Operator of Colony for the four companies. By early 1971 the Parachute mine and plant had been reactivated and operations attempted. In September 1971, having completed their financial commitments, Sohio and Cliffs withdrew from funding the second Colony program retaining their land interests. Arco and Tosco continued plant operations into early 1972 before shutting down.

In 1971, Sohio began providing financial assistance to John Jones to help defray certain expenses of obtaining a lease on the Oil Shale Experiment Station at Anvil Points from the Bureau of Mines. With Parachute Creek occupied, the Anvil Points site was needed so the Paraho processes could be tried on oil shale. The Anvil Points lease was approved by the President of the United States in May 1972. In 1973, organization of the Paraho Oil Shale Demonstration began. By year-end, 17 participants had joined the project.

* The seventeen Paraho participants are Atlantic Richfield, Carter Oil (Exxon), Chevron Research (Standard of California), Cleveland-Cliffs Iron, Gulf Oil, Kerr-McKee, Marathon Oil, Arthur G. McKee, Mobil Research, Phillips Petroleum, Shell Development, Sohio Petroleum, Southern California Edison, Standard Oil Company (Indiana), Sun Oil, Texaco, and the Webb-Chambers-Gary-McLorraine Group.

PROGRAM

Two new Paraho retorts, a pilot plant and a semi-works size unit, were installed at Anvil Points. The oil shale mine on the adjacent Naval Oil Shale Reserve was reactivated. The mine and new retorts were put into operation during 1974. The pilot plant is used to explore operating parameters in order to define conditions for testing in the larger semi-works size retort. The experimental operations in 1974 set the stage for the successful runs in 1975 and early 1976. The results of the Paraho operations to date have been encouraging. They demonstrate that the process works, that the equipment is durable and that both are environmentally acceptable on a pilot and a semi-works plant scale.

During 1975, the operation being conducted at Anvil Points progressed from the experimental into the operability phase. A 56-day operability run in the direct fired mode was completed on the semi-works retort in March 1975. Following this run, 10,000 barrels of the shale oil produced were refined into seven different fuels for the U. S. Navy in the largest such conversion of shale oil into military products. A nationwide product testing program by industry and government of Paraho's synthetic fuels followed. This included an operational test of Paraho JP-4 in an Air Force T-39 jet aircraft flight from Wright Patterson Air Force Base near Dayton, Ohio to Carswell Air Force Base near Fort Worth, Texas; a 7-day Great Lakes cruise on Paraho heavy fuel oil by a Cleveland-Cliffs Iron ore carrier; and a full-scale boiler burning test by Southern California Edison of Paraho crude shale oil.

Success of the Paraho Project suggested that the next logical step should be the construction and operation of a full-size Paraho retort. This would reduce industry's and government's concerns about the ability to successfully scale up proven technology to commercial size. In May 1975, Paraho announced its proposal to construct and operate a full-size Paraho module at Anvil Points. The proposal included a full-size Paraho retort, an expanded mine and all the auxiliary equipment needed to operate this full-size module. A cost of \$76 million was estimated for construction and operation.

Considerable interest and support was evidenced by industry and government in Paraho's full-size module proposal. The chairmen of the Armed Services Committees of the U. S. House of Representatives and the U. S. Senate granted the right to mine the additional shale required from the Naval Reserve. The Navy authorized proceeding when ready. Paraho's subsidiary, Development Engineering, Inc., exercised its option to extend the lease on the Anvil Points Oil Shale Experiment Station. The Bureau of Mines completed a favorable environmental assessment of the module proposal. The Solicitor's office of the Department of Interior issued Guidelines for the Federal Prototype Oil Shale Leasing Program. These Guidelines provided, among other things, that expenditures by lessees for patented or demonstrated technology, such as Paraho's, would be creditable against the fourth and fifth lease bonus payments.

In July 1975, the \$6 billion Synthetic Fuels Amendment was added to the ERDA appropriation act and was approved by the U. S. Senate. With this federal assistance in the offering, it looked like everything needed to move ahead with joint government-industry financing would be available for the full-size Paraho module.

President Ford visited Paraho's Anvil Points operation in August 1975 with Frank Zarb, Congressman Tim Wirth (Colo.-D) and Senator Gary Hart (Colo.-D). They toured the mine and plant, witnessed Paraho's ability to produce oil from oil shale and were impressed. President Ford reported favorably to the media about the size, productivity and environmental acceptability of Paraho's operation and stated that oil shale must have a bigger part in this country's energy program. This was before the Energy Research and Development Administration reacted to a legal threat by an environmentalist.

In October 1975, ERDA decided that a new Environmental Impact Statement would have to be prepared before Paraho could build its full-size module at Anvil Points. This would require at least a year and was commenced immediately.

In November 1975, Paraho conducted a 26-day direct fired run on the semi-works retort. This run, designed to confirm the results of the earlier 56-day run and subsequent variable studies, was an outstanding success. A very stable operation at essentially 100% on-stream time with high thermal efficiency (87%) and excellent liquid yield (97% by volume of Fischer Assay C₅+ oil) confirmed that the Paraho direct fired process was ready for scale-up to the full-size module. This mode will produce more than enough low Btu gas to provide fuel for the process and to generate all the electricity required to power and light a commercial plant.

Two federal actions adverse to oil shale occurred in December 1975. One was the defeat of the \$6 billion Synthetic Fuels Amendment in the House of Representatives. The other was the passage of the compromise 1975 Energy Policy and Conservation Act which rolled-back the price of domestic crude oil. Unfortunately, these actions occurred at a time when incentives, rather than restraints were and still are needed to encourage energy production and conservation.

On February 10, 1976, Paraho completed a 32-day run in the indirect heated mode. Operation in this mode, which offered the potential of higher liquid yields and the production of a high Btu gas, was one of the original objectives of the Paraho Oil Shale Project. Selected conditions from the run indicated a high liquid yield of 98% and gas production of 850 standard cubic feet per ton containing 865 Btu per cubic foot (dry basis).

It was not anticipated when the objective of testing the indirect mode was set that the liquid yield on the direct mode would be as high as the 97% actually obtained. All of this oil is useful product because the large amount of low Btu gas produced in the direct mode can be used to fuel the process. In the indirect heated mode it would be necessary to burn as fuel either the high Btu gas or some of the oil produced. A potential benefit of the indirect heated mode is the production of a higher quality, lower pour point crude shale oil. This oil may be suitable for pipeline transmission without local upgrading or prerefining. If so, the savings in investment and operating cost of prerefining would more than off-set the higher costs of indirect mode retorting. Eliminating local prerefining also would eliminate a major water consumer.

A confirming indirect heated run was commenced in March 1976. During this run, a series of evolutionary changes in operating conditions were made which reduced the heat input required per ton of shale thereby increasing thermal efficiency.

OBSERVATIONS

Paraho's retort performance exemplifies simplicity in process and mechanical design:

1. It has few moving parts and low construction and operating costs.
2. It utilizes counter-current flow and gravity transport without requiring a separate circuit for solid, heat carrying bodies.
3. The Paraho retort consumes no water.
4. The lumps of retorted shale it produces do not create serious dust problems.
5. Retorted shale management experiments demonstrate the ability to easily compact this material to a condition which is impermeable to water. Very little water is required in retorted shale management. This is primarily

- for vegetating the surface of the retorted shale.
6. Emissions of sulfur and nitrogen oxide and particulates have been found acceptable under the strict Colorado standards.
 7. High thermal efficiencies are attained. Rather than discard the residual carbon on the retorted shale, the Paraho direct heated process consumes much of it to fuel and power the process. On the other hand, the indirect mode produces a high Btu gas and a better quality oil. A combination of the direct and indirect mode may be the ultimate solution. It should be possible to fuel the combination mode by burning carbon on the retorted shale. This would liberate both the oil and the high Btu gas as useful products.

In anticipation of the May 31, 1976 Paraho Project completion date, the Anvil Points mine was closed in December 1975 as sufficient rock was on hand to carry out the privately funded retorting program. The retorts are scheduled to shut down on March 31, 1976 unless additional funding is obtained. The equipment will be put in stand-by condition and the plant secured by April 30, 1976. All final reports will be issued by May 31, 1976 except for the Commercial Evaluation Study which will be ready for distribution by June 30, 1976. After analysis of the results of the retorting program, a mode or modes of operation will be selected for the Commercial Evaluation Study. The advantages of the Paraho process will be reflected in the economic results obtained in this study. However, construction of a full-size Paraho module at Anvil Points or at some other location would still be the next logical step toward commercialization.

WHAT NEEDS TO BE DONE NOW

It is almost inconceivable, during this time of critical need for synthetic fuel development, that the only operating, large scale, successful oil shale retorting project in the United States will be compelled to shut down upon completion of its privately funded program. Continued operation of the Anvil Points facilities would offer important benefits. Additional variable studies need to be performed to improve efficiency and optimize operating conditions. A second generation retort could result from additional work on the combination mode. Significant volumes of shaleoil could be produced. This crude shale oil would be extremely desirable for large scale refining and synthetic product testing programs over an extended period of time.

Paraho is a small privately owned company which appears to have the answer for oil shale commercialization. It is operating at Anvil Points under a lease from the federal government in the presence of ERDA observers. It has been successful in accomplishing its initial objectives. Paraho does not fit into ERDA's highly structured methodology for developing and demonstrating technologies by making requests for ERDA's conceived specific proposals. What is wrong with accepting progress already made? Paraho has established by its accomplishments what should be an acceptable basis for initiating government financial support for continued operation.

Our national alternative to supplementing our domestic crude oil supply with shale oil production is to purchase more and more imported crude oil. Such purchases would be made at higher and higher prices exporting both dollars and U. S. jobs. Under this alternate we will become more and more vulnerable to another oil embargo and less and less capable of maintaining a prosperous economy or of mustering an effective national defense.

This nation must recognize that we have an energy shortage and that all acceptable forms of domestic energy development will fall short of meeting our needs, particularly for transportation fuels. New legislation must be passed to correct the adverse federal actions of December 1975. Federal non-recourse, guaranteed loans should be made available to help fund the building of full-size modules for oil shale. They are the best way to eliminate uncertainties relating to the production and economic acceptability of shale oil. Technologies already demonstrated by industry on a semi-works scale should qualify for such funding.

After the module phase is completed, one or more retorting technologies may be successfully demonstrated and be ready for commercial plant construction. Ten to twenty full-size retorts might be required for such a commercial plant. To justify moving into commercial mining, retorting, and upgrading, involving very high capital investments, an exception to the administered oil prices under the "Energy Bill" will be required. Industry needs to know now that a free market will exist in which crude shale oil and refined synthetic products can compete price-wise with imports.

Conceding that our government needs to take a long look down the road to energy independence and help in developing technologies toward commercialization, it is still in this nation's best interest to encourage private industry to move through the profit system into the new technologies as they reach feasibility. The future conditions actually required to encourage commercialization by private competitive enterprise cannot be determined at this time. When such conditions do occur, if federal funding assistance is required, it should be available. Non-recourse guaranteed loans may be needed to encourage the construction of the first group of commercial plants by industry and for socio-economic projects by the communities to be impacted by such commercial plants for which actual private commitments to build are made.

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