Update on the Colorado Tract C–b Oil Shale Demonstration Facility

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ABSTRACT

In January 1991, Occidental Oil Shale Inc. (OOSI) withdrew from the Western Oil Shale Demonstration Project because of internal reorganizations within OOSI's parent company, Occidental Petroleum Corporation. Prior to withdrawing from this project, which was jointly funded by OOSI, U.S. Department of Energy (DOE), State of Colorado, and Rio Blanco County, OOSI prepared a plan for an oil shale demonstration facility on the Colorado C-b oil shale lease tract located in northwestern Colorado. OOSI has now terminated activities at the C-b lease tract and has proposed to flood the existing mine. All other activities relative to the project have been put on hold, although OOSI is maintaining the lease tract for possible future development efforts.

The plan developed by OOSI is for a 10-year commercial-scale project that would demonstrate both modified in situ (MIS) retorting and combustion of mined oil shale in a circulating fluidized-bed combustor (CFBC). A cluster of 13 MIS retorts would be developed under a commercial regime that involves simultaneous mining, retort construction, retort operation, and retort cleanup. Two MIS retorts would be operating simultaneously to produce about 1,200 bbl/day of raw shale oil.

During construction of an in situ retort, about 20% of the retort volume is mined to provide expansion room during retort rubbling. This excavated oil shale, together with the gas produced during retorting, would be burned in two CFBC units to raise plant steam and to produce electricity. About 25 MW of electrical power would be available for export sale after allowance for in-plant consumption. Design data for the CFBCs were obtained during pilot-plant tests conducted by two CFBC manufacturers.

An evaluation of potential environmental impacts of the proposed facility was completed. This study concluded that the primary negative impact would be on groundwater aquifers located in the oil shale horizons but that this impact would be acceptable if proposed post-burn retort cleanup procedures were used.

INTRODUCTION

The U.S. Congress appropriated $740,000 in the U.S. Department of Energy's (DOE) fiscal 1990 budget to support development of a comprehensive plan and justification for an in situ oil shale facility using western oil shale. In December 1989 Occidental Oil Shale Inc. (OOSI) submitted a proposal to DOE for a cost-shared project to prepare a plan and justification as requested by Congress. Upon satisfactory completion of the planning and design phase of the proposed project, OOSI proposed to proceed with construction and operation of the facility if DOE would commit to cost-sharing one-half of the project costs. Subsequently, DOE and OOSI negotiated a $2,687,000 cost-shared cooperative agreement to develop plans for a western oil shale demonstration facility based on OOSI's modified in situ (MIS) retorting technology. Under this agreement OOSI provided $1,547,000 as its share of project costs, DOE provided $740,000, and the State of Colorado and Rio Blanco County jointly provided $400,000.

The facility proposed by OOSI would be located on the Colorado Oil Shale Lease Tract C–b, which OOSI is leasing from the U.S. Bureau of Land Management (Zahradnik and Vawter, 1990). This 5,100-acre tract of federal land is located in Rio Blanco County, about midway between the towns of Meeker, Rangely, and Rifle. The C-b lease tract was first leased in 1974 under the Department of Interior's Prototype Oil Shale Leasing Program. OOSI bought into the lease in 1976 and acquired all lease rights to the tract in 1988. As a result of earlier developmental efforts, the tract contains much of the infrastructure, utilities, and mine facilities required for the proposed demonstration project. OOSI has estimated that over 4.5 billion bbl of shale oil can be recovered from the tract using a combination of MIS and above-ground processing.

PROJECT OBJECTIVE

The objective of the cooperative agreement was to prepare a plan (the Plan) for the development of an oil shale facility

(the Project) to demonstrate technical and economic viability, and environmental acceptability of the MIS retorting technology. The Plan was to address a 10-year project to recover approximately 1,200 bbl/day of shale oil using MIS retorting technology and incorporating a fluidized-bed combustion power plant to utilize the oil shale mined during mine preparation and the retort off-gas produced during retorting, supplemented as necessary with coal. The Plan was to include provisions for potential inclusion of a surface retorting facility.

PROJECT ACCOMPLISHMENTS

To achieve the objective outlined above, the Cooperative Agreement calls for completion of the following tasks:

- Preparation of preliminary engineering designs and cost estimate
- Confirmation of fluidized-bed combustor design parameters
- Review of permit requirements and status
- Inspection and review of existing facilities
- Review of C–b lease requirements to implement the Project
- Development of a financial plan for the Project
- Development of a marketing plan for the Project
- Performing an environmental analysis of the Project

As of this writing, essentially all of the tasks listed above had been completed, and the required reports or documents had been prepared either in final or draft form. Some of the more significant accomplishments are detailed below.

CFBC Tests

Two combustion test series using various mixtures of oil shale from the C-b tract, coal from sources near the C–b tract, and a simulated retort off-gas were run in two pilot-plant circulating fluidized-bed combustors (CFBC). The first test series was run in a 10-million-Btu/hour unit owned and operated by Tampella-Keeler in Williamsport, Pennsylvania, and the second series was run in a 2-million-Btu/hour unit owned and operated by PyroPower in San Diego, California. A total of over 150 tons of oil shale and 25 tons of Colorado coal was used in these tests, which provided emissions and operational data needed to design the commercial-scale CFBC electrical power plant to be included in proposed Project.

The results from these tests, which have been published (Vawter and Dockter, 1990; Moore and others, 1990), were very encouraging. The oil shale feed rate ranged from 30% to 100% of heat load, while the coal feed rate ranged from 0 to 50%, and the simulated retort off-gas feed rate ranged from 0 to 30% of heat load. No operational problems were encountered other than those expected with a very high ash loading. The combusted oil shale had excellent sulfur-capturing properties. Both CFBC manufacturers feel that they can design the required commercial-scale unit based on results of the tests performed.

Environmental Analysis

As part of the Plan development, OOSI worked with federal, state, and local agencies to prepare a list of all required permits for the Project. Many of these permits already were in place as part of earlier C-b tract developmental work, although some must be renewed or updated. In addition to these permit-related actions, OOSI also commissioned the National Research Center for Coal and Energy, West Virginia University, to assemble a task force to perform an independent environmental analysis of the proposed Project. The results of this comprehensive analysis have been compiled into a report (National Research Center, 1990) which concluded that no environmental reasons are appear that would preclude the Project from proceeding. The study flagged several issues, such as the effects on air and water resources, mine safety in the MIS environment, geotechnical, and solid waste areas, which are concerns for a large commercial facility, but it indicated that the Project should help quantify these impacts and develop remedial technologies as required.

Product Enhancement

The most common product scenario considered for a commercial oil shale facility is to perform a minimal degree of raw shale-oil upgrading and then using the upgraded shale oil as refinery feedstock. In this scenario upgraded shale oil would compete directly with petroleum feedstock. An alternative scenario is to extract higher valued fractions from the raw shale oil, thus increasing the value of the raw shale oil. This approach was investigated by Sinor (1989) in his shale oil niche market study, in which he concluded that for a small shale oil plant (3,000 bbl/day), it would make economic sense to separate the raw shale oil into two or more broad mixtures and then transform them into saleable products, such as waxes, creosote, tar acids, and bases.

With this niche market scenario in mind, OOSI contracted with James W. Bunger and Associates Inc. (JWBA) to investigate methods of separating raw shale oil into higher valued product streams. Using primarily distillation, extraction, and adsorption processing, JWBA was able to separate raw shale oil into a suite of specialty products worth about $90/bbl of raw shale oil in today's market (Bunger and Associates, in press). The additional cost of processing the raw shale oil into this product slate is estimated to be low enough to make it economically attractive.

Cost Analysis

Although cost estimates for the Project have not been finalized by OOSI at this writing, the current estimate for Project capital costs is $195 million. Throughout the 10-year life of the Project, operating costs are estimated to be $138 million, with offsetting product sales credits estimated at $104 million. After credit for electricity sales and other by-products, the Project is expected to incur an operating cost of about $30/bbl at steady-state production. It is important to remember that this project is not designed to be a commercial venture but rather a demonstration effort and therefore will have low production rates to offset high overhead and other indirect costs—it was not expected to be a money maker.

SUMMARY AND CURRENT STATUS

Occidental Oil Shale Inc. and its team of about 25 consultants and contractors have developed a plan for a 10-year commercial-scale project that would demonstrate both modified in situ retorting and combustion of mined oil shale in a circulating fluidized-bed combustor. A cluster of 13 MIS retorts would be developed under a commercial regime that involves simultaneous mining, retort construction, retort operation, and retort cleanup. Two MIS retorts would be retorted simultaneously, producing about 1,200 bbl/day of raw shale oil. Mined oil shale and gas produced during retorting are to be burned in two CFBC units to raise plant steam and to produce about 25 MW of electrical power for export sale after allowance for in-plant consumption.

A review of existing facilities at the proposed site indicates that the equipment, mine, and other facilities remaining from prior efforts are in good condition and can be brought into use at minimum cost and effort. An evaluation of the potential environmental impacts of the proposed facility concluded that the primary negative impact would be on ground-water aquifers located in the oil shale horizons but that this impact would be acceptable if proposed post-burn retort cleanup procedures are used. In addition to this evaluation, an Environmental Impact Statement must be prepared since federal land and funds will be used for the Project.

Circulating fluidized-bed combustion tests in two vendor pilot plants provide evidence that oil shale and coal-oil shale mixtures can readily be burned in CFBC units. These vendors are prepared to submit bids on the proposed facility. Negotiations were initiated to sell 25 MW of available electrical power, which would be produced by the Project.

Although the planning effort has gone well and the proposed Project seems viable, not all news is good news. In January 1991 OOSI notified DOE that it was withdrawing from the Project because of internal reorganization within OOSI's parent company, Occidental Petroleum Corporation. Since that notification, OOSI has terminated activities at the C–b lease tract and has informed the BLM of its intention to allow the mine to flood. OOSI has terminated all activities relative to the Project except preparation of the required final technical report but is maintaining the lease on the C-b lease tract. Because DOE funding for the Project is contingent on 50% cost-sharing by private industry, the Project will now most likely never go beyond the planning stage.

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