SOME OIL SHALE PROBLEMS — 1964

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"Oil Shale" has many problems to solve before it can become an industry. Some optimists have spoken and written that the industry can start now — that all it needs is someone with enough courage to start building a 20,000-barrel plant and the rush will follow like the gold rushes of yesterday. I do not believe this is true. I will try to point out some of the problems in providing raw material as feed for the retorts — a basic need — before we can look for a real industry. The problems of retorting and refining are left for those more qualified than I.

The problem of providing raw material for the retorts must be known to those who would develop the industry, but I sometimes feel they are forgotten or ignored. So the problems that I point out today can more nearly be called admonitions of things to look for while the mine planning is still on paper. The expensive experience of the Bureau of Mines can save oil-shale developers hundreds of thousands of dollars.

No large-scale mining of oil shale had been attempted until the Bureau started the Rifle mine in 1945. We pioneered the field. No one had been there before. Our successes and our mistakes are public record and bear close examination by industry before they proceed.

The technical problems of mining are the same now as when the Bureau mine was closed in 1956. A new element in the picture is the political angle which apparently cannot be discounted. In my mind the political thing has created an unfriendly atmosphere which has not helped, nor will it help, this State or the fledgling oil-shale industry.

Before proceeding with this paper I wish it understood that I do not own oil-shale land; I do not work for an oil company; I have nothing to sell and I do not have a personal axe to grind. I am a mining engineer and have been associated with oil shale at Rifle, Colorado, since 1945. I helped select the site for the Rifle plant. I am interested in seeing the oil-shale industry started for I have great faith in its future.

Retorting oil shale and refining shale oil are the two topics discussed in most technical meetings of this kind. It is seldom that mention is made of ways to provide raw shale for the retorts.

In my opinion, as of now, no one knows for sure how to mine oil shale. We have information on using the room-and-pillar method, but it

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is sketchy and all cost and production data are obsolete. This is a controversial statement, but it is my considered opinion.

The oil-shale industry in the United States — Colorado in particular — reminds me of an orphan without friends of any kind. In the 1920's a boom in oil shale took place in the DeBeque area of Colorado — the discovery of rich East Texas oil fields stopped the interest in oil shale and threw the orphan into the discard. Came the War years and oil shale flourished at Rifle, Colorado, for nearly ten years and then was virtually abandoned again. It is only now, years later, that any real interest is shown in oil shale.

A great deal was learned about oil shale while the Government operated the Rifle plant. The retorting work was considered successful but incomplete. The Union Oil Company conducted their work on retorting near Grand Valley, Colorado, and company officials have stated publicly their work was successful. Oil men now say that refining shale oil will not be more difficult than refining many western crudes.

The only mining method tested by the Bureau of Mines was the room-and-pillar which gave a 75-percent recovery. Equipment was designed and built to handle the special problems that were encountered in mining the 73-foot Mahogany Ledge. Some of this equipment is standard today.

I will not discuss the advantages and disadvantages of the methods used in mining by both the Bureau of Mines and Union Oil Company. However, I am critical that the Bureau work was stopped after testing only one mining method. It was recognized after a serious roof fall in the Bureau mine that alternate mining methods should be investigated. Work was started, but all work was stopped when funds were not appropriated by the Congress. This took place in 1956. Since that time about $120,000 has been spent annually for protective maintenance of the Rifle plant.

The Rifle plant and mine are situated on the Naval Oil Reserve. In 1962 a project designed to make use of the Rifle facility for additional research was sponsored by the Navy. The bill as introduced provided for the Rifle facility to be turned over to a non-profit organization to administer, and the organization would be authorized to negotiate with private firms to use the facilities for research paying a fee, with the expectation that the fees collected would eventually pay all Government costs. A second use of the facility was to provide a place where various universities could conduct work whereby graduate students could obtain advanced degrees. The bill provided that any patentable ideas developed at the Rifle facility would be the property of the developer except the Government would have free use of the patent in a national emergency.

The bill as passed by Congress authorized the Interior Department to negotiate with interested parties for the use of the facility for research purposes. The Interior Department set up a committee to evaluate any proposals that might be received. Various oil companies and university

organizations submitted proposals to the committee and eventually the Colorado School of Mines Research Foundation was awarded the responsibility of arranging a contract that would be mutually satisfactory to both the Interior Department and the contractor.

Several proposals were submitted including one from Socony Mobil Oil Company. This proposal has been well publicized and, according to published statements, the company agreed to expend $10,000,000 in the next five years on oil-shale research. The negotiations broke down when the Interior Department insisted that the contractor turn over to the public all patents the company had received prior to the date of the contract. No negotiations are in progress at this time. Once again the orphan is out in the cold world.

In my opinion this is a political problem and outside the sphere of an engineer. It sounds to me like an unfriendly Government atmosphere.

If the negotiations had been approved, retorting and refining would have been the principal fields of research. No mention has been made of mining research in any of the published plans. Probably 40 percent of the total cost of producing shale oil will be mining, and it is here where major savings can be made. I do not have a pet mining method that will solve all mining problems. I do point out that all oil-shale mining cost data today have been based on the two 30-day tests of the room-and-pillar method in 1950-1951 at Rifle — 14 years ago. Since that time many improvements in equipment have been made, such as rotary drilling, but no cost data using modern equipment have been developed from actual tests.

In selecting a mining method to develop a new project, the engineer usually has access to the unit costs of similar operations. A reasonably close estimate of expected mining costs can be made. But in the case of oil shale no actual cost data are available — they are mostly assumptions. It requires approximately 1½ tons of 25-gallon shale to produce one barrel of shale oil. Virtually all plant estimates I have seen recently have been for daily production of 10,000, 25,000 or 100,000 barrels of shale oil. This means the 10,000-barrel plant would require 15,000 tons of raw oil shale daily; the 25,000-barrel plant would require 37,500 tons — the daily production of Climax or the San Manuel Copper Company. Accurate unit cost and production data are required for planning an operation of this size. I cannot conceive of a reputable engineer estimating the cost of mining 35,000 tons of oil shale daily using a bunch of assumptions of cost and performance data 10 to 14 years old.

Lots is heard of in situ retorting as applied to oil shale. Little is known about this method, and, so far as I know, only limited field work has been attempted. Virtually nothing is known about recoveries and costs based on actual extended operations.

I personally know very little about the actual application of in-situ retorting. Oil shale is very dense and presents problems not found in oil

sands. If it can be made to work economically and efficiently it will solve many problems now facing the future industry. I am sure a great deal more experimental work must be done before anyone will spend millions of dollars on a plant with in-situ retorting as the source of raw material. I will listen to the discussion of in-situ retorting later in this program with a great deal of interest.

As of now there are three possible ways to secure the raw material feed for the plant: (1) in-situ retorting, (2) open-pit mining, and (3) underground mining. In-situ retorting has not progressed far enough to be adopted as the primary method, and because of the very high stripping ratio the open-pit method is not given serious consideration. This leaves underground mining as the most probable method for at least the first few years of operation.

Since room-and-pillar is the only mining method that has been given actual field tests. it is logical to assume this method will be the first to be used.

The cost and performance data for room-and-pillar mining published by the Bureau of Mines in 1950-51 was based on percussion drilling. This is important to keep in mind since drilling and blasting is a large part of the cost of mining. The rotary experimental test drill of the Bureau completely changed the former estimates. An unpublished Bureau of Mines report gave a cost-estimate comparison of percussion and rotary drilling that is interesting. The percussion-drilling data were based on mining 19,200 tons daily, and the rotary drilling estimate used 28,000 tons a day.

Using rotary drilling the tons-per-man-day total was 128 and for percussion drilling 65. It required 218 men to produce 28,000 tons using rotary drilling versus 298 men to produce 19,200 tons with percus- was equipped with a hydraulic motor and was used for drilling vertical sion drilling. It is obvious that the published cost reports of the Bureau should be re-examined before using. The rotary-test drill of the Bureau holes. The test drill for drilling horizontal holes was not fully developed. The contractor for Union Oil Company mine used rotary drilling but no results have been published.

Accurate data regarding cost and performance must be obtained before an engineer can recommend a method to extract raw material for an oil-shale plant with any degree of assurance that his many assumptions are correct and that the investor is reasonably safe in making the required tremendous preparatory investment.

The selection of the roof stone in planning to mine oil shale using the room-and-pillar method requires very careful consideration. It must be of competent rock of adequate thickness and strength to meet the require- ments of the proposed width of the room. It must be at or near the upper limit of the section of the bed to be mined, and it must require very little scaling after blasting. The Bureau of Mines selected a roof stone averag- ing 8 feet thick that gave a safety factor of 4 when using a 60-foot room span.

Core drilling has indicated that other roof stones are present in the Mahogany zone but very little is known about the continuity of any of them. Great changes frequently occur in sedimentary formations over a relatively short distance.

The Mahogany zone at the Bureau of Mines Rifle mine has several types of oil shale insofar as their behavior in retorting is concerned. These include coking, semicoking and noncoking shales. It is important that raw shale as mined for delivery to the retort stockpile be virtually uniform from each bench if the expense of blending is to be avoided. To achieve this at the Bureau mine, the top bench was 39 feet high and the lower bench was planned for 34 feet. The resultant stockpile material would be virtually uniform. It is doubtful if the characteristics of the oil-shale beds are the same elsewhere. The characteristics of the shale beds to be mined should be investigated while making plans for the mine. Some authorities state that no trouble should be experienced in retorting any type of shale, that it is a matter of handling the retorts. Other authorities disagree.

All present plans of mining oil shale underground that I have seen include the use of diesel equipment. It is well known that adequate ventilation is required to maintain the proper purity of the mine air. Colorado has strict mining laws covering the use of diesel equipment underground so this phase of mining must be considered. I have seen several mining plans where the mine air was coursed through the mine much as in ordinary coal-mine operation. That is easier on paper than in a mine such as the Rifle operation. To conduct ventilating air through the mine workings using brattices as in a coal mine would require covering the openings which are 73 feet high and 60 feet wide. It is obvious that these would be blown down by blasting. The Bureau of Mines used a makeshift method consisting of an incline rise to the surface and an exhausting fan. When the mine was in operation the air was pretty bad, and in a production mine I am of the opinion the mine inspector would have stopped operations.

Some people believe that limestone mining and oil-shale mining will be identical or nearly so, and that unit costs of mining limestone in such mines as the St. Genevieve mine in Missouri can be used in making estimates for oil shale. I do not believe this to be true. The cost of drilling and blasting will not be comparable although many other units of cost such as loading and transportation can be used.

You will note that I have not provided solutions for the technical and political difficulties to be expected in securing raw material for making shale oil. I have merely pointed out some of the things that should be considered when making plans for a new oil-shale mine. It will be much cheaper to find the answer to these and other problems on a small scale than after a final master plan of mining has been adopted and it is necessary to produce large daily tonnages.

I have purposely avoided a solution for the political problem mentioned earlier. I am leaving that for people who are more adept at "wheeling and dealing" than I am.

I have great faith in the future of oil shale. I want the very first attempt at commercial production to succeed, and to do so I firmly believe the experience gained by the Bureau of Mines will be very helpful even if the Bureau work was incomplete.