Work on U.S. Oil Sands Heating Up

U.S. oil sands are a modest resource, but they could help ease the transition to alternative energy sources

Oil sands in North America have a long history of exploitation. North American Indians used pitch from surface deposits to waterproof canoes long before Europeans set foot on this continent. Christopher Columbus is said to have used asphalt from Pitch Lake in Trinidad to patch up his ships on his third voyage to the West Indies in 1498. Sir Walter Raleigh reported the same bitumen deposit in 1595; his ships' crews broke the crusted surface of the lake with picks and carried the tar to the beach to caulk their ships. The deposit was used by buccaneers, merchants, and navy men alike for more than three centuries to repair their vessels.

This is one of a series of occasional articles about the prospects and problems of alternative energy sources.

Now it appears that other oil sands deposits in North America may be used to patch up holes in U.S. petroleum production. Admittedly, the United States has nowhere near the resources of oil sands that are present in, for example, Canada and Venezuela. Current estimates indicate that the United States has the equivalent of 30 billion barrels of petroleum in the form of oil sands, and some scientists think that estimate is low.

Even 30 billion barrels is roughly equal to the remaining U.S. petroleum reserves that can be pumped out of the ground by conventional means. Exploitation of oil sands could help the United States through a difficult period of transition while other sources of liquid fuels, including oil shale and coal, are being developed. In fact, plans for a number of research projects, both in this country and Canada, are under way, and the first commercial oil sands plant in this country could be onstream in as few as 5 years.

That plant will most likely be located near McKittrick, California, about 70 kilometers west of Bakersfield. There, as many as 1 billion barrels of heavy, viscous oil saturate the fossilized remnants of diatoms, tiny, one-celled plants that thrived in the bay that covered the San Joaquin Valley hundreds of thousands of years ago. A major portion of that deposit is owned by Getty Oil Company.

In the 1950's, Getty hoped to mine the deposit and extract the diatomaceous earth, with the oil as a waste byproduct. The Getty staff soon found, however, that the quality of the diatomaceous earth was not good enough for use as a filtering agent, and that other markets could not profitably handle the bulk of the material that the operation was capable of producing. Spurred by the recent price increases for petroleum, Getty now wants to mine the material primarily for its oil content, in which case the diatomaceous earth would be the byproduct.

Getty engineers have tested more than 15 different processes for producing usable oil from the deposit and have narrowed the choice down to the two most promising. One is a solvent extraction process developed by the Dravo Corporation of Pittsburgh. A volatile hydrocarbon solvent, "much like lighter fluid," would be used to "wash" oil and water from the ore. A multistep process including distillation separates the solvent, oil, and water. The solvent is recycled into the system, the oil is transported to refineries, and the water is used for dust control and to restore the diatomite to its naturally occurring liquid content before it is returned to the mine as backfill.

The second potential method is a retorting process developed by Lurgi Mineroltechnik of West Germany. The ore is first put through a rotary dryer to remove moisture, which is condensed and later used to dampen the spent diatomite. The dried ore is then heated to about 650°C to vaporize the hydrocarbons, which are subsequently condensed and treated to produce usable crude oil and gas. The heat content of the spent diatomite would then be used to help dehydrate the incoming ore.

Getty filed an environmental impact statement on their proposed project last year and, shortly after Christmas, received permission from regulatory agencies to begin construction of pilot plants to test the two processes. Once the engineers have decided which of the two processes is best, construction of a full-scale plant could begin.

The plant will be much smaller than the oil sands plants at Athabasca in northeastern Alberta (*Science*, 17 February 1978, p. 756), but it will also be much cheaper. Getty plans a capacity of 20,000 barrels per day (bpd), and the company says the cost will range from \$200 to \$260 million, depending on which process is selected; inflation could raise those figures substantially. If all goes well, it could be in operation as early as 1986.

Getty is not the only company interested in the diatomite deposits. Amoco Inc., Barber Oil Corporation, and Belridge Oil Company each have holdings at the California site. Barber has already sunk a shaft into the deposit to ascertain the feasibility of mining, and Amoco has commissioned a report from Golder Associates of Kirkland, Washington, for the same purpose. Shell Oil Company is in the process of purchasing Belridge, and one of the reasons for its interest is believed to be Belridge's McKittrick holdings.

A slightly different mining operation may be undertaken by American Exploration and Management, Inc., a small firm headquartered in Albuquerque. According to vice president John Dickman, the company plans to strip-mine oil sands on 2000 acres of what used to be known as the Jones Asphalt Mine Ranch in Guadalupe County, New Mexico, just north of Santa Rosa. The firm would then use a proprietary solvent extraction process to separate the heavy oil from the sand.

The ore at Jones Ranch is primarily sandstone containing between 5.5 and 9 percent heavy oil by weight, with the total resource believed to be in excess of 600 million barrels. Dickman says the company plans to build a 10,000-bpd plant at a cost of about \$18 million, which would make the cost of the crude about \$17 to \$18 per barrel. First, the company is constructing a 100-bpd pilot plant to refine the solvent extraction process. Construction of the full-scale plant could then begin sometime in 1981.

Another potential use for oil sands is in road surfacing. Around the turn of the

0036-8075/80/0314-1191\$00.50/0

Injection of steam is already being used to increase production of heavy oil, as in the San Ardo field in California. [*Source: Department of Energy*]

century, oil sands deposits in many areas of the country were mined and the ore was used to construct asphalt roads. When cheap oil became available, it became more profitable in most cases to produce asphalt at the construction site by mixing petroleum residues with locally obtained sand.

With the recent price increases in petroleum, it is again becoming cost-effective to use oil sands. Whites Mines, Inc. and Uvalde Rock Asphalt Company, for instance, both mine a limestone rock impregnated with 5 to 8 percent bitumen from a deposit near Uvalde, Texas. After being mined, the rock is crushed, mixed with a lighter petroleum fraction known as flux oil, and used as an asphalt surface for streets and highways. Whites Mines has used the material for this purpose for nearly 50 years, but their output has increased sharply in recent years. The two companies now mine more than 1.5 million tons of oil sands per year.

Most of the oil sands deposits in this country, however, are not susceptible to surface mining. Bitumen must be recovered by heating it in situ so that it becomes mobile enough to pump. The Department of Energy (DOE) is supporting half a dozen field projects and several laboratory projects developing technology that can be applied to oil sands; its budget for this purpose is about $3 million per year. The major American oil companies are also conducting research on in situ recovery of oil sands, much of it on the richer deposits in Canada.

At DOE's Laramie Energy Technology Center (LETC) in Wyoming two major projects have been conducted to test in situ combustion on oil sands near Vernal, Utah. The center is now in the midst of a third project in which the sands will be heated by steam injection. So far, LETC's greatest success has resulted from a technique known as reverse combustion followed by forward combustion. In the reverse combustion phase, a fire is ignited at one well drilled into the oil sands stratum, and air is injected into an adjacent well to draw the fire to it, thereby creating a channel between the two wells. Once the fire reaches the second well, continued air injection forces the fire backward along the channel (forward combustion). Heat from the fire thins the bitumen so that it flows through the channel ahead of the fire and can be pumped to the surface from the first well.

An actual installation would require a large number of wells in an as yet undetermined configuration. The Laramie investigators estimate that a full-scale facility might recover 50 percent of the bitumen in place while consuming perhaps 10 percent. An economic analysis is not yet complete, but the investigators contend that the preliminary results are encouraging and that in situ combustion in the Utah deposits should be feasible.

Several other small, DOE-sponsored in situ pilot projects are also under way. Most of them are refinements of techniques that have already been applied to lighter oils.

▶ Getty is flooding a small section of the Cat Canyon field in Santa Barbara County, California, with steam to stimulate oil flow. In steam flooding, steam is injected continuously into one set of wells and oil is pumped from a second set. Many investigators believe that steam flooding will be the most serviceable technique for recovery of oil sands.

▶ Ogle Petroleum Company has been attempting steam flooding in an oil sands deposit in Monterey County, California. In the first experiments, however, most of the steam found its way into the overlying shale rather than into the oil zone. Ogle is now testing a new configuration for the wells.

▶ Chanslor-Western Oil & Development Company is testing steam flooding in a deposit in Kern County, California.

▶ Husky Oil Company has been studying in situ combustion, accompanied by water injection to produce steam, at another site in Monterey County. General Crude Oil Company is in the preparatory stages of a similar project in the same area.

▶ Cities Service Company is experimenting with in situ combustion combined with water injection in a deposit in Bossier Parish, Louisiana. Production has been as high as 600 bpd.

Potentially more important are those projects by the major oil companies for which there is no public information. At least two companies, and perhaps more, are said to be conducting in situ operations in this country during the last year, and others are attempting quietly to obtain leases on oil sands properties. Technical information from the Canadian projects also seems certain to find application in this country.

One potential impediment to development of oil sands is the need for emission controls. Heat for thinning the bitumen must be obtained by burning some of it, either above ground to produce steam or in situ to produce heat. Nearly all of the oil sands deposits have a high sulfur content, and uncontrolled burning would produce unacceptable amounts of sulfur dioxides. The emissions can be controlled with scrubbers, but at a cost of $1 to $2 per barrel of oil; the scrubbers themselves produce a sludge that is classified as a hazardous waste, and it too would have to be disposed of. Even with scrubbers, difficulties in meeting federal and state air pollution standards have already been a source of concern for California companies that have used steam to produce heavy oil. Eliminating these problems will not be easy.

Nonetheless, the rapidly escalating price of conventional petroleum makes it almost certain that several oil sands projects will be undertaken during the next decade. None will compare to the Canadian surface mining endeavors, but the cumulative production of several projects could supply a modest energy resource to help ease the coming crunch. Much of the knowledge obtained in oil sands projects, furthermore, may also find use in recovering residual oil from fields that have been depleted by conventional techniques. That possibility will be the subject of a second article next week.—THOMAS H. MAUGH II