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Research Offers Hope for More Efficient Oil Sand Industry

By HENRY FOUNTAIN

Several years ago, Paul Painter, a professor of polymer science at Pennsylvania State University, saw a news report about the deaths of hundreds of ducks that landed on a tailings pond near an oil sands mine in the Canadian province of Alberta. The ducks had become coated with residual petroleum floating on the pond, which was filled with wastewater from the process used to extract oil from the strip-mined sands.

“It wasn’t that I’m a rabid environmentalist,” Dr. Painter said recently. “It just occurred to me that we were working with something that might prove useful.”

That something was an ionic liquid, a salt that, unlike ordinary table salt, is liquid at temperatures below the boiling point of water. Dr. Painter had been using ionic liquids to try to get nanoparticles to mix with polymers, but he realized that they could also be used to help separate different materials — in this case, oil from sand.

Dr. Painter has since demonstrated in the laboratory that ionic liquids have the potential for greatly reducing the amount of water used in the oil sands industry. If he can scale up the process, and if it is adopted, it could go a long way to making the oil sands industry more environmentally sound.

Canada’s oil sands are going through boom times, as the world’s need for petroleum, and the accompanying rise in prices, has made extraction of so-called unconventional oil economically viable. Last year, the oil sands — thick, heavy oil called bitumen that is mixed in with sand and clay — produced about 1.5 million barrels of oil a day, half from strip mining of relatively shallow deposits, the other from injecting steam into wells in deeper reserves. More than half of the oil is exported to the United States.

But that production has come at an environmental cost. In strip mining, about 3 to 4 gallons, or about 11.5 to 15 liters, of water are used for every gallon of oil produced, and as the deaths of Dr. Painter’s ducks show, the wastewater can be toxic. Steam injection, which heats the bitumen in place so it will flow out of a well like conventional oil, uses far less water. But so much natural gas is used to make the steam that a gallon of oil-sands oil produced in this way results in emissions of the heat-trapping gas carbon dioxide that are several times higher than those from producing a gallon of conventional oil.

The carbon-footprint problem has led several companies to develop alternative approaches to heating the bitumen in deeper reserves.

E-T Energy, a small production company based in Calgary, Alberta, uses electrodes placed in separate wells surrounding a production well. Water is pumped into the electrode wells, current is applied to the electrodes and as a result the water and the surrounding oil sands heat up. The bitumen eventually gets warm enough to be pumped out of the production well.

The technology was developed by Bruce C.W. McGee, chief executive of another Calgary company, McMillan-McGee, which first commercialized the process for cleanup of contaminated sites. In 2004, the company founded E-T Energy to bring the technology to the oil sands. E-T Energy has conducted field tests since 2006 and expects to begin commercial oil production in 2013.

Dr. McGee said the amount of water used in the process is minimal, and that much of the heating — and thus the use of electricity — can occur in off-peak hours, making more efficient use of generating capacity. When the production drops off, the wells can be plugged and the entire operation moved a short distance, where it can begin again. “This is like mining with electrodes,” he said.

But electrical heating is not the only alternative to steam. Another Calgary company, Petrobank Energy & Resources, burns some of the bitumen in place to heat the rest of it.

Combustion has been tried in one form or another in the oil industry for nearly a century. The Petrobank method, called toe-to-heel air injection, uses a vertical well drilled above the toe, or end, of a horizontal production well. Steam is injected in the vertical well first, but only for two to three months, to warm the bitumen. Then when air is injected, the bitumen begins to burn like a charcoal briquette. The combustion front travels very slowly above the production well, heating the bitumen so that it can be pumped out.

One advantage of the process is that only the heaviest hydrocarbons in the bitumen burn, leaving the higher-quality lighter fractions to drain into the production well, said David McLellan, Petrobank’s manager of intellectual property. The bitumen that is produced needs less dilution with other hydrocarbons to be able to flow in a pipeline.

“We’re the only production method that upgrades the oil in-situ,” Mr. McLellan said.

Petrobank, which has run demonstration projects since 2006, has now expanded one of its field test sites, which the company expects will start producing oil in commercial quantities next year.

But getting other companies to use any of these alternative technologies may be difficult.

“You’re dealing with an industry that I wouldn’t say is the most innovative industry,” said Dr. McGee, the McMillan-McGee chief executive. “When you’re trying to do a billion-dollar sale, if you have the term ‘new technology’ attached to it, it doesn’t go too far.”

But E-T Energy, Dr. McGee noted, now has an agreement with Total, the French oil company, that gives Total an option to license the technology.

Dr. Painter, the Penn State researcher, said he would face similar hurdles to getting his ionic-liquid separation process adopted.

“It’s a large industry and won’t move very quickly,” said Dr. Painter, who is developing a demonstration unit that will allow the economics of the process to be analyzed. “I don’t think a lot of people are going to invest in this unless they see something that gives them numbers.”