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Scientists Weigh Use of Bacteria for Cleaner Fossil Fuel Production

By GAYATHRI VAIDYANATHAN of ClimateWire

Much of the world's oil reserves lies in giant tar sand stretches in places like Alberta and Venezuela. While the oil industry uses an energy-intensive and fairly dirty process to make steam to cook the oil out of the tar sands, underground bacteria simply eat the crude oil and break it down into methane, or natural gas.

In nature, that process takes millions of years. A small group of cross-disciplinary microbiologists with their feet both in the oil industry and academic geochemistry wants to speed up the work. They are trying to get these bugs to break down carbon much faster to produce a steady supply of commercial natural gas, and to enhance the recovery of crude.

Interest in using microbes that grow naturally in oil fields, coal beds and shale deposits is growing, according to a group of industry insiders at the Biotechnology Industry Organization (BIO) 2010 convention last week in Chicago.

"We've garnered the attention of large oil and gas producers around the world," said Mark Finkelstein, vice-president of science at Colorado-based Luca Technologies. "The recent emphasis on climate change and natural gas bodes well for our technology."

And with the oil spill from the Deepwater Horizon rig in the Gulf of Mexico, and subsidies for carbon capture and storage, or CCS, in the recently released "American Power Act," the focus has turned to increasing production from traditional oil wells, according to John Steelman, program manager at the Natural Resources Defense Council's Climate Center.

In a typical oil extracting operation, only about 20 to 50 percent of the petroleum is removed from the ground. When the pressure of oil falls, the oil companies pump in some water to increase pressure. Then, with more than half the oil left underground, the wells get plugged and the company moves off to newer opportunities. Recently, that has meant offshore drilling.

Abandoned onshore oil fields could outproduce offshore wells

There are nearly 300,000 marginal oil wells in the country from which enhanced oil recovery techniques could extract some of the remaining 50 to 80 percent from the ground, according to BIO. Existing fields could supply more than 10 times the amount of oil present in the outer continental shelf, according to NRDC.

That comes to about 3 million barrels of oil a day by 2030, said Steelman. This dwarfs the offshore oil potential, as predicted by the American Petroleum Institute, of 286,000 barrels of oil per day.

Traditionally, enhanced oil recovery has focused on pumping in carbon dioxide into mature oil wells to

increase pressure and get the fuel gushing out by decreasing its viscosity, according to Tracy Evans, president of Texas-based Denbury Resources, which specializes in the technology.

"One of the added benefits of carbon capture and storage is that it'll produce enough carbon dioxide to do all the oil recovery in the lower 48," said Steelman, referring to subsidies in the recently released climate bill for separating the CO2 from emissions of power plants and refineries.

But growth of the technique has been limited by small supplies of carbon dioxide and the new infrastructure that needs to be built to transport the gas and inject it underground, said Evans.

While CCS technology attempts to becomes a commercial reality, geochemists are working on an alternative: using naturally occurring microorganisms living underground to increase oil production.

More futuristic thinkers, such as Steve Larter, the Canada research chair in petroleum geology at the University of Calgary, are trying to convert underground reservoirs directly into producers of cleaner-burning natural gas.

"Most of the oil in the oil sands is already microbially degraded," said Larter, explaining that bacteria have already turned it into methane and CO2. "There's 1 trillion barrels of oil in the oil sands, but this is only 50 percent of what was ever present."

Using an underground ecosystem to produce gas

It is not generally well recognized, even within the industry, that underground fossil fuel reservoirs are an ecosystem to themselves. They are host to a variety of anaerobic bacteria that live at the interface between oil and water. The bacteria react hydrocarbons with water to produce large amounts of methane in a process akin to fermentation. They can wreak havoc in traditional oil recovery.

Larter wrote in the journal *Nature* that the sands of the Athabasca Basin in northern Canada contain nearly 1,700 billion barrels of biodegraded oil. Most of the oil is extracted by surface mining or by steaming it out of the oil sands using chemicals.

If, instead, the reaction is sped up and the methane extracted, this would be a cleaner source of fuel.

"We could halve emissions at the source," said Larter, referring to the lower emissions of natural gas. He is trying to optimize the process to work on a larger scale, which would require reservoir engineering to get access to microbes spread out over thousands of acres of oil fields.

In the meantime, in a microbial version of the human genome project, the government of Canada is pumping in $12 million to map the genes of the organisms that live in the oil sands in Alberta. Among the myriad uses of this "metagenomics" project is to use the critters to produce lighter oil that does not need to be steamed and chemically extracted from the tar sands.

Microbe 'farming' in abandoned coal beds

The largest North American test for the technology is done by Luca Technologies, which is working on nearly 10,000 acres of nearly abandoned coal beds in the Powder River Basin in Wyoming. The company has tested

260 coal wells and not only shown proof of concept, but also produced enough gas to heat 20,000 homes in a year, according to Finkelstein, vice president of science.

Finkelstein compared the process of harvesting the microbes to farming. Add a little fertilizer and water, allow the microbes to grow and use the oil as feedstock to produce natural gas, he said.

"Our business strategy is to take over depleted wells before the operators decide to plug and abandon them," he said. "We restore them back to life."

The idea of incorporating biotechnology into oil recovery has been around for a while, but the oil industry didn't have a reason to sit up and take notice, said Finkelstein. There was minimal funding, and no one had demonstrably shown that these microorganisms could be used for making natural gas.

"It took several years of kissing a lot of frogs to get a prince," said Finkelstein, talking of his days of selling his idea to the industry. That prince was the chemical giant BASF, which has invested significantly in the company.

The technology can have minimal environmental impact, since the company uses existing infrastructure, including pre-drilled holes, for its operations, according to Finkelstein. He said that costs would decrease as yields go up, and the company would be profitable at moderate to high gas prices. Luca Technologies is currently working with the bacteria in the lab to engineer them to produce more methane.

Other companies harvest the microbes in more traditional oil recovery. Texas-based GloriOil feeds the underground bacteria and uses the gas produced by them as a pulse to shake up leftover oil and get it out.

"The carbon dioxide generated by the microbes is less that the carbon dioxide emitted while transporting fuel from Saudi Arabia," said Bhupendra Soni, vice president of technology of GloriOil.