



# Methane farming

Profero Energy feeds heavy oil-eating microbes to make natural gas

By R.P. Stastny

Steve Larter lived with the classic theory of how heavy oil is formed—that oxygen somehow works its way in the subsurface where microbes use it to convert oil into heavier oil and methane—for much of his career. That notion accompanied him through his early years with Unocal Corporation in California in the 1980s, through his return to academia in the mid-1990s and through the heavy oil work he did in northeast China.

“Then in 1999, a brilliant paper was published by the Max Planck Institute for Microbiology in Bremen,” says the University of Calgary professor. “They isolated a group of micro-organisms that just react hydrocarbons with water to make methane and CO<sub>2</sub>. At that point, it seemed to us, this had to be the explanation for these subsurface processes.”

A number of research projects over the next five years then proved that these anaerobic, not aerobic, processes were the cause of natural gas formation. In the last six years, scientists identified which organisms are involved, what controls the rates they operate at, and—recognizing the commercial potential of turning heavy oil into cleaner-burning natural gas—how to accelerate those conversion rates.

In 2008, Profero Energy Inc. was formed under the University Technologies International’s IGNITE program (UTI’s company creation and incubation service) with the focus of microbial conversion of stranded heavy oil into natural gas.

## WHAT’S FOR LUNCH?

Over the course of geological history, colossal quantities of natural gas have been released from microbes eating oil, turning it into heavy oil and bitumen. Scientists estimate as much as

seven times the volume of oil in the oilsands, for example, has been converted to natural gas. The gas over bitumen is just the remnant of this ongoing process.

“The microbes are already in the reservoir, so essentially we’re just fertilizing them to stimulate the process,” Larter says.

The water injected into the reservoir is laced with key nutrients such as phosphorus, special metals, cobalt, nickel, etc.—think of it as a vitamin pill.

But there are bugs you don’t want to stimulate. You don’t want sulfate in there, for example, to spur poisonous hydrogen sulphide gas formation. You also don’t want to create too much biomass, which could plug the reservoir.

“It’s not beer you’re making, where you end up with a sludge of yeast at the bottom,” Larter says. “Ideally, you want a load of sprinters and once one sprinter dies, the next one eats it and carries on eating oil.”

Since these microbes tend to recycle themselves, the process is somewhat self-sustaining once it’s underway.

The microbes get all the glory, but at the end of day, microbial methane production comes down to good reservoir engineering. A host of reservoir management issues come into play around moving gas through the liquid, relative permeability and saturation issues, and gauging how well the process is working.

## HAVE PLANE, NEED PILOT

So far methane production from heavy oil has only seen laboratory tests. But these experiments have yielded promising results, converting as much as 20 per cent of the crude oil to methane in one year.

“That’s published and we’ve got papers on this,” Larter says, stressing, however, that these are controlled lab tests in sealed bombs and test tubes. What is needed now are field tests.

Even though the cost of a microbial pilot is expected to be a fraction of a thermal recovery pilot, finding partners or investors for the fieldwork has been a challenge. One reason is low gas prices. The other is high oil prices.

“You’d think that with high oil prices companies would have plenty of money to invest in R&D, but what happens is marginal resources become profitable and that’s where the money goes,” Larter says.

So Profero continues to beat the bushes for partners and is trying to raise money.

#### MORE THAN A PET PEEVE

Talk of R&D gets Larter onto a topic close to his heart: the oil and gas industry’s lack of appetite for new technologies.

“This industry is a slow-moving beast,” he says. “Its heavy oil recovery processes are 30-50 years old. We need a different model that’s more focused on technology development. In general, I think Canada has an innovation crisis. We don’t stack

#### THE FUTURE IS TODAY

A form of microbial methane farming is already a commercial reality in the United States, where Colorado-based Luca Technologies Inc. uses anaerobic bacteria to harvest natural gas from coal. Founded in 2003, Luca Technologies has raised \$100 million to date and currently produces modest quantities of natural gas.

“Luca Technologies is to coal what Profero is to oil,” Larter says. The folks at both companies know each other well. “They’re probably the nearest thing to a success story in microbial methane production and have about 2,000 wells in the Powder River Basin in Wyoming.”

Larter acknowledges that coal is the bigger prize for microbial conversion. But it’s also a harder target because it’s solid and is pretty horrible stuff to eat, even if you’re a microbe. Oil is easier to eat, but in terms of reservoir engineering, it’s more challenging to manage.

Larter says Luca wells produce only about 20 thousand to 40 thousand cubic feet a day. Based on lab results, Profero expects it could easily get to several hundred thousand cubic feet or

Photo: Profero Energy



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up with the other OECD countries in terms of what we spend on R&D. And energy companies are only spending about half a per cent of revenue versus say a chemical or pharmaceutical company that spends 10 or 15 per cent of its revenue on R&D.”

But the fact that Alberta has a lot of depleted reservoirs may be a strong incentive. Further, only 17 per cent of the heavy oil in place has been produced, leaving a massive target for methane conversion.

“This idea has been picked up by others,” Larter says. “BP published a paper last year, claiming that most of the gas in Siberia is actually related to this anaerobic process from the heavy oil underlying the gas reservoirs.”

In the greater scheme of things, Larter believes the 21st century is going to be the century of biology. As the scientific revolutions in nanotechnology, robotics, Internet and biology cross-pollinate and inspire other industries, microbiologists will begin cropping up in even the most conservative oil and gas companies.

perhaps even to a million cubic feet a day. But again, those are just projections based on scaled-up lab results.

If and when Profero gets to field tests, and they go well, coal may become its next target. Beyond that, there is even a more environmental dimension to this technology. The intermediary step in the conversion of crude oil to methane is the production of hydrogen, CO<sub>2</sub> and some acetate—vinegar.

“So even more exciting than methane is the possibility of producing hydrogen if you could stop the subsequent conversion to methane,” Larter says. “Then you could have a truly green process that produces a zero carbon energy—hydrogen.”

And that’s not even to mention the potential of co-producing a blend of oil and vinegar to be marketed as Larter’s Own Salad Dressing...okay, strike that.

But the oil-to-hydrogen conversion is an even more difficult process to manage and, in any case, to get to hydrogen, Profero has to first prove the methane process in the field. ■