HENRY TERRELL, NEWS EDITOR

Oil-loving bugs enhance recovery in old and new reservoirs

Life on Earth is ubiquitous and adaptable. From the top of a bone-dry mountain in Antarctica to the bottom of a 7-mile-deep trench in the ocean to the lip of an erupting volcano, you will find microbes, comfortably basking in unspeakably harsh environments, happy as unicellular clams.

Oil eaters. Most existing petroleum deposits are host to microbial life, except for those that have been subjected to temperatures above about 80°C, in which case they experience a sort of "pasteurization" that sterilizes the reservoir. Researchers have estimated that the great majority of heavy oil deposits were formed over millions of years by biodegradation of lighter oil. Anaerobic bacteria digest the light oil, producing acetic acid and hydrogen as a byproduct. Then other microorganisms called archea come into play. These are not bacteria, but occupy a different domain entirely, possessing genes and several metabolic pathways that are more closely related to those of eukaryotes. The archea in oil deposits are called methanogens, gobbling up hydrogen and CO_2 to produce methane.

Subsurface microbes grow and do their business on a geological time scale. Injection of nutrients dissolved in water can have the effect of shrinking the scale from millennia to months, leading to more rapid degradation and more gas production from heavy oil fields.

Go for the black gold. The big spread between gas and oil prices, however, has led companies away from methane production toward oil from mature fields. Tertiary production includes a variety of chemical and mechanical processes to try and loosen up trapped oil. Microbes can also be injected directly into a formation, or stimulated by the injection of nutrients. This can enhance oil production in a number of ways. Methane produced by the previously mentioned process can build up pressure in an oil reservoir. Oleophilic (oil-loving) microbes can attach themselves to microdroplets of oil to break them up and allow them to flow, or change the interfacial tension between oil and water. Also, the microbes can produce an emulsion that blocks microscopic thief zones and forces the water to find new pathways, pushing more oil to the wellbore.

Glori Energy, based in Houston, was formed at the end of 2005. Its initial technology was licensed from The Energy and Resources Institute (TERI) in India. TERI scientists spent 15 years on R&D in the field, studying the use of microbiology for EOR with the Indian national oil company ONGC, focusing on stimulation at the producing well. Glori acquired access to this and additional technology, and carried out extensive in-house research to develop a new approach to enhanced recovery. "Our company was founded to take that technology and commercialize it," Glori Energy CEO Stuart Page told *World Oil*. "We started with some field implementation, and had some great success. It taught us that you can really influence the microbiology of the subsurface. Recognizing that there is live bacteria in all reservoirs, it occurred to us it could be a very powerful technology if we started at the injector well, not just the wellbore of a producing well."

Glori scientists engaged with a few organizations around the world and saw that interesting research work had already been done—the best by Statoil in the North Sea—so the company partnered with Statoil to incorporate its research with what Glori Energy scientists were working on. A company in Argentina, called Biotopics, had also done some intriguing injection-based work, and this was incorporated into the mix.

The company created the AERO (Activated Environment for the Recovery of Oil) technology and did the first full implementation in a Kansas field in May 2010. Results were successful, and demonstrated the project's feasibility.

"Biotechnology has really changed in the past decade," Page said. "The basic understanding of DNA, the Human Genome Project and so forth, has really changed the way scientists look at microbiology and gave them insights they hadn't had before."

The process begins by taking samples from the producing well and from the injection system. "You have to look at it holistically," Page said. "You can't just put a product into a well and hope something happens. It's a living system, not a chemical system."

By understanding the microbiology of the reservoir, the components in the injection water, the produced water and the type of oil in the system, a formulation is customized that can be piggy-backed on the injection system.

"One interesting thing is the sheer number of species and types of microbiology there are in the subsurface," Page said. "Most of them have never been seen before. They may be part of a known family, but are not uniquely identified. We don't focus on the specific microorganism, but on its functionality. We're looking for phenotype, not genotype; we want to know what it can do."

Greenfield project. In order to have a live field for a test site, Glori Energy acquired a played-out oil field in Kansas. "We can investigate nuances of mechanisms, change performance characteristics and improve implementation procedures," Page said. "It lets us demonstrate in controlled conditions how we can change recovery."

The ultimate goal is to recover more oil, but in an environmentally responsible way. Because all the activity in the AERO process is done in the reservoir and not at the surface, it is a cleaner technology.

"Industry uses big, capital-intensive tools to try and recover oil," Page said. "It's about using a bigger hammer to crack the nut. Our philosophy is to move away from brute force toward biology. Nature can take care of production on its own, if you allow it the right circumstances." WO

HENRY.TERRELL@GULFPUB.COM