

Earthquakes the inspiration for increased production

by Lee Toop, Associate Editor

When an oil reservoir is shut down, it's done with the knowledge that there is still a substantial amount of oil left behind – oil that cannot be extracted because of the geological makeup of the reservoir that holds it tight no matter how much water is pumped into the ground.

The steady depletion of reserves means that producers are looking for the best way to increase productivity and draw more of that trapped oil to the ground in the later stages of production. One technique that is seeing greater use has taken a hint from natural geology, incorporating concepts developed from studying earthquakes into a tool that has boosted recovery in numerous wells.

In oil producing areas, it has often been noted that when an earthquake occurs nearby, the recovery rate of oil in a fluid flood jumps afterwards. The work of a former physics professor in studying the increased oil movement formed the basis of the Powerwave technology from Wavefront Energy and Environmental Services.

"It's well documented that when an earthquake occurs and you have an oilfield nearby, you see increases in oil productivity for several weeks after the earthquake occurred," explained Wavefront president Brett Davidson. "Many research institutes had looked at what kind of waveform can be generated to replicate an earthquake and induce the flow of fluids... we looked at it from the standpoint of knowing that an earthquake can create a fluid flow – what is it in the earthquake that does it?"

Wavefront started out with three people – Davidson, retired physics professor Dr. Tim Spanos and Maurice Dusseault, a professor of geological engineering at the University of Waterloo – and a theory Spanos was working on regarding improving fluid flow. They designed some laboratory experiments based on his derivations and in 1997 found a mechanism that would trigger that desired increase in flow underground. Field trials in the late 1990s near Lloydminster, Alberta, showed an increase in oil recovery in a flood situation by 34 percent.

"In 1999, we had historically low oil prices, but we trudged forward developing a technology that we felt was significantly valuable for the industry going forward. At the end of the day companies are interested in maximizing profitability regardless of economic conditions," Davidson noted.

Since then, the focus has been on improving efficiency of the tool even more, as well as creating a downhole product that is easy to use on-site. The first versions of the Powerwave tool used in field trials were trucked to the site on two large transport trucks. Today, as Wavefront increases commercialization, the tool can be carried over a shoulder and is easily threaded onto the downhole end of the tubing used to inject water into a reservoir.

"The tool is what we call a rapid open-

ing valve. It's about four and a half feet long, and 3.75 inches in diameter, with a circumferential valve – a 360-degree valve that opens and closes," he described. "You tell it to open and close from a computer at the surface."

While that may sound simple, it's actually challenging to get things just right – especially considering the valve opens some 20 times a minute, at speeds as fast as one-twentieth of a second, to initiate the pulse needed to move more oil.

"Envision a garden hose – if I turn on the hose, I get a constant flow of fluid from the end of the hose. Now when you think of that in the oil industry, my (down-hole) tubing is the conduit, like my garden hose; a pump at the surface is supplying water just like the tap on my garden hose," Davidson explained. "The open-ended tubing goes into the reservoir and finds nature's path of least resistance and moving wherever it wishes. When you put a kink in your garden hose, you shut off that flow momentarily, and when you open it back up you see a sudden increased flow of water – you're building up energy behind that kink, and when it's released the water is highly accelerated. That's what the Powerwave tool does."

The rapid opening valve on the Powerwave tool acts just like a kink in the hose – it flicks closed, and water builds up behind it, storing energy that is suddenly released into the flooded reservoir and essentially forces the pore spaces that hold on to oil to release the oil.

"Without Powerwave, water exits the well bore, finds its path of least resistance, and displaces the oil in front of it. But, I don't have good sweep efficiency, and the overall distribution is poor," he said. "With Powerwave, there's a tendency to push greater volumes of water out of the reservoir, producing more oil in its place."

In most reservoirs, even after secondary and tertiary recovery techniques have been used only around 40 percent of the oil is ever extracted. With Powerwave, the fluid injection techniques are improved to the



Wavefront CEO and president Brett Davidson with the Powerwave tool.

point where the operation can draw up to 50 percent – an increase that could mean billions of barrels of oil that would otherwise have been left in the ground.

"We know that companies will institute, where feasible, a secondary or tertiary recovery method. Powerwave is an optimization of that process. We're not asking oil companies to take a giant leap of faith to something new outside of water flooding – we're saying that Powerwave will complement that process," Davidson said.

Much of the work being done with Powerwave at present is in mature reservoirs, but the technology isn't necessarily specific to those types of projects, Davidson noted.

"We believe that the earlier Powerwave is used in the flooding operation, the more dramatic the results will be. Most of the reservoirs we go into today are mature water floods that have been around for 10 to 15 years, where the percentage of water per barrel of fluid produced is in the 98 percent range," he said. "What you'll see with greater sweep efficiency is a higher

per-barrel percentage of oil."

A number of operators are approaching Wavefront to look at using the Powerwave system; the company screens potential reservoirs before implementation to ensure that they're right for the tool, Davidson said.

"We want to know how old the water flood is, any complications they've had to date, what the best injection pattern is – perhaps their current injection pattern isn't conducive to maximum recovery, and we can help them out with that. We want to give the operator the best opportunity to maximize their recovery."

With approximately 100 Powerwave tools expected to be operational as of early 2009, Wavefront is expecting to hear from a lot of other potential users.

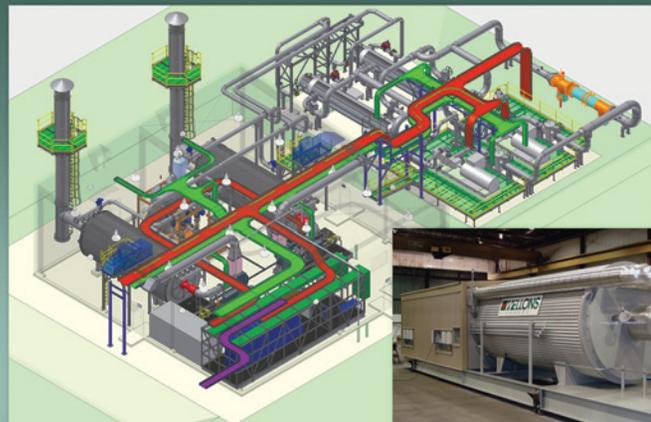
"There are approximately 200,000 wells used to inject fluid – that's our target market," Davidson said.

Wavefront Energy and Environmental Services, Inc.

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