

# reservoir REJUVENATION

WAVEFRONT TECHNOLOGY PROMISES TO BOOST OUTPUT AT AGING RESERVOIRS BY ELSIE ROSS

## The Alberta oilsands

are today's stars of the energy world. Their massive reserves have attracted the attention of global petroleum players and the sheer scale of the development has caught the attention of the public.

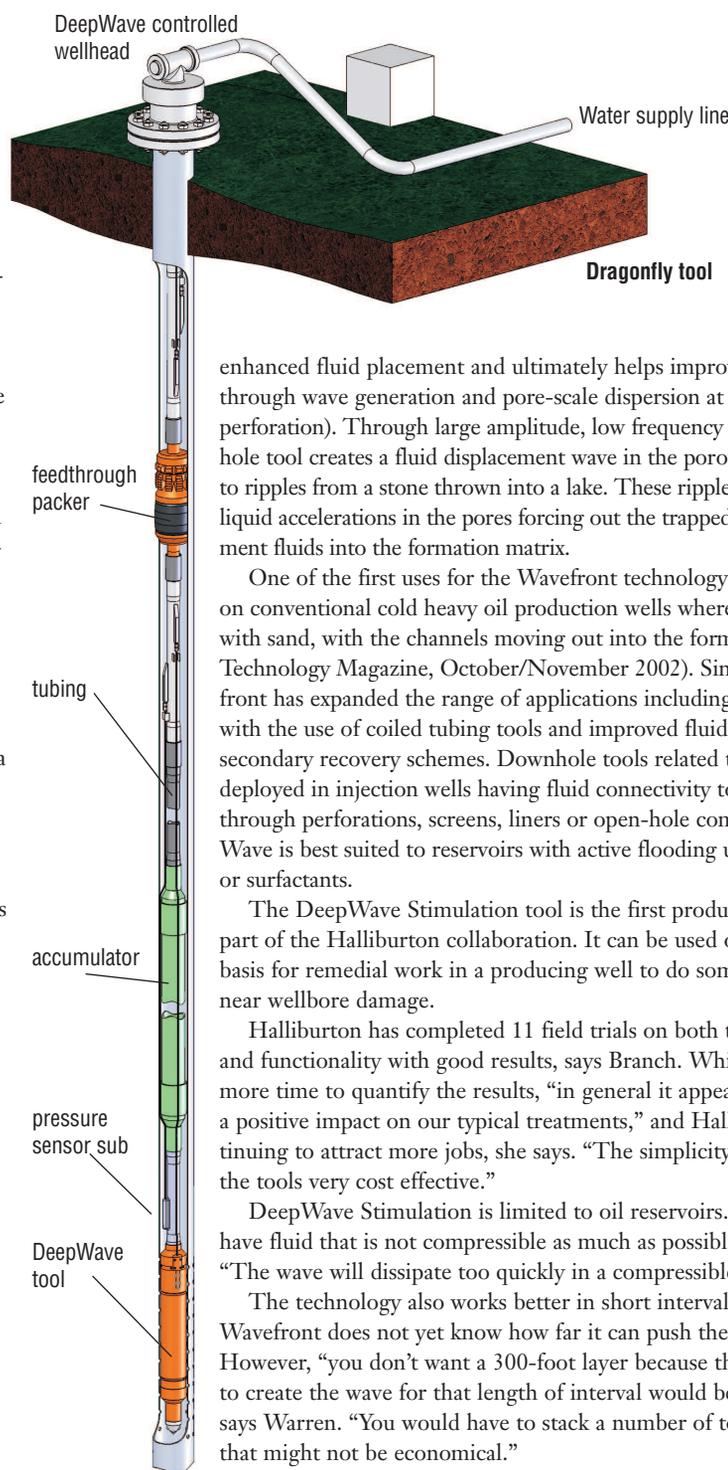
With the spotlight on the oilsands, however, there has been a tendency to ignore less glamorous aging conventional reserves. With an estimated average recovery of 40% of original oil-in-place, these reservoirs still offer considerable potential for secondary and enhanced oil recovery with significant economic benefits, given the right technology.

Wavefront Energy and Environmental Services Inc., an Edmonton technology development company, is targeting that market through its proprietary DeepWave stimulation technology for fluid flow optimization. "It can really work on both ends of the spectrum from an oil perspective," says John Warren, vice-president of operations and business development for Wavefront's United States subsidiary. While the technology has great potential for lighter crudes, which are easier to mobilize, it also has a significant impact on heavy crudes, he suggests.

Wavefront's proprietary knowledge of wave theories and the benefits of slow strain waves in traditional oilfield waterfloods caught the attention of oilfield giant Halliburton Energy Services Group, which has licensed the pressure pulsing technology process. It also is collaborating with the Canadian company to jointly develop new pressure pulsing technology products.

Halliburton has been developing, licensing and commercializing pressure pulsing and acoustic technologies as part of its overall portfolio for several years, says Zelma Branch, a company spokeswoman. "By collaborating Wavefront and Halliburton know-how, along with a global distribution network, we view the development areas as the next generation technologies for both stimulation services and permanent installations," she says. "Both of these areas can have beneficial impacts on the growing mature oilfield assets globally."

DeepWave Stimulation (previously known as Pressure Pulse Technology or PPT) provides



enhanced fluid placement and ultimately helps improve production through wave generation and pore-scale dispersion at the source (the perforation). Through large amplitude, low frequency pulsing, a down-hole tool creates a fluid displacement wave in the porous media, similar to ripples from a stone thrown into a lake. These ripples generate high liquid accelerations in the pores forcing out the trapped liquids, or treatment fluids into the formation matrix.

One of the first uses for the Wavefront technology was in workovers on conventional cold heavy oil production wells where oil is produced with sand, with the channels moving out into the formation (New Technology Magazine, October/November 2002). Since then, Wavefront has expanded the range of applications including fluid injections with the use of coiled tubing tools and improved fluid displacement in secondary recovery schemes. Downhole tools related to DeepWave are deployed in injection wells having fluid connectivity to the reservoir through perforations, screens, liners or open-hole completions. DeepWave is best suited to reservoirs with active flooding using water, CO<sub>2</sub> or surfactants.

The DeepWave Stimulation tool is the first product developed as part of the Halliburton collaboration. It can be used on a short-term basis for remedial work in a producing well to do some clean-up of near wellbore damage.

Halliburton has completed 11 field trials on both the tool design and functionality with good results, says Branch. While it will take more time to quantify the results, "in general it appears we are getting a positive impact on our typical treatments," and Halliburton is continuing to attract more jobs, she says. "The simplicity of design makes the tools very cost effective."

DeepWave Stimulation is limited to oil reservoirs. "You want to have fluid that is not compressible as much as possible," says Warren. "The wave will dissipate too quickly in a compressible fluid."

The technology also works better in short interval pay layers, but Wavefront does not yet know how far it can push the limits, he says. However, "you don't want a 300-foot layer because the energy needed to create the wave for that length of interval would be significant," says Warren. "You would have to stack a number of tools in that arena that might not be economical."

So far, DeepWave Stimulation has been working at about 30 feet of net height where the layers are fairly stratified, allowing it to dissipate the wave a greater distance radially away from the wellbore.

Earlier this year, a licensee completed a DeepWave acid stimulation to revitalize declining oil production in a horizontal well at Fort St. John, British Columbia, the first Canadian application of the technology. The process was used to achieve greater distribution and penetration of the injected liquid. Prior to stimulation, average production was about 14.5 barrels (bbls) of oil per day and that steadily increased following the stimulation. A production test on March 20 found the well was producing nearly 41 bbls of oil a day, nearly three times the initial production.

In May, Halliburton deployed a coiled tubing tool as a main component of DeepWave Stimulation for the placement of a treatment chemical at a California oil well operated by a major oil producer. The application was a combined research project/commercial application designed to validate the capabilities of the tool as well as to differentiate it from other coiled tubing applications for injecting fluids. The well was configured to allow for real-time downhole monitoring of the injection stream to confirm the ability

of the DeepWave tool to focus injectivity at the point of discharge from the tool. The results verified that the tool effectively focused injectivity across the entire production zone, including a 200-foot zone that had not previously seen treatment fluids as the result of other coiled tubing options.

In reporting on the results, Warren indicated that the tool can provide focused injectivity without the need for isolation assemblies or other diversion techniques. "This will enable many operators to treat longer intervals with less concern of not knowing where the treatment fluid leaks off," he says.

Further development work is in progress for a permanent installation that will be used in injector wells for secondary recovery, says Warren. The first DeepWave permanent tool, which is not part of the collaboration, will be installed in an oilfield in Oklahoma in early July, adds Branch.

Wavefront has also been working on other projects on its own. The newly commercialized Dragonfly waterflood injection tool, named for its speed of operation, was recently deployed in a water injector well on a Wavefront oil lease in Rogers County, Oklahoma. As part of its business model, Wavefront has acquired 1,360 acres of mineral leases in the area to showcase how horizontal producers and vertical DeepWave water

injectors can improve overall recovery rates.

The Dragonfly tool provides the ability to stimulate reservoirs that contain substantial amounts of oil but which have been difficult to produce because of the extremely low flow characteristics, according to the company.

In enabling Wavefront to use one tool design for a broader range of applications, "the Dragonfly tool significantly increases opportunities for the company and its licensed providers to implement the technology over the broadest spectrum of reservoir conditions," says Warren. With the tool in place, the operator can orient the desired type of wave, which may vary depending upon the formation and reservoir characteristics. The activity can be monitored and oriented from a laptop computer.

Wavefront technology is not limited to oil production. On the environmental side, it accelerates contaminant recovery and improves in-ground treatment of groundwater contaminants, thereby reducing environmental liabilities and speeding up site restoration. 

#### CONTACT FOR MORE INFORMATION

John Warren, Wavefront, Tel: (713) 826.5627,  
E-mail: johnw@onthewavefront.com