

pushing the limits

From better bits to faster coil, companies leverage technology to ramp up onshore drilling performance
By Maurice Smith

CNX's first horizontal Marcellus Shale well, CNX #3



Onshore Records

T Two techniques

that have steadily gained ground in the drilling industry in recent years, horizontal drilling and drilling with coiled tubing, dominated many of the records set onshore in the past year.

While many of the rapidly improving technologies that have pushed the techniques into the foreground have evolved in Western Canada and Alaska, they are now seeing some of their most spectacular successes south of the border.

Speed zone

Calgary-based Xtreme Coil Drilling Corp. is a prime example, leveraging its unique coil over top drive (COTD) rigs to score more speed records over the past year, setting new marks in both the U.S. Rockies and Mexico.

Drilling in Mexico's Chicontepec field in the state of Veracruz, Xtreme's depth was as extraordinary as its speed when it reached a world record-setting depth of 3,034 metres (9,954 feet) in April with 3 ½-inch coil, setting a blazing rate of penetration in the coil section of more than double the historic conventional drilling rate.

The well's S-curve (37 degrees) was established with conventional drill pipe before Xtreme seamlessly transitioned to coil to drill vertically at 2,737 metres (8,979 feet) in seven-inch hole. Drilled with one of its four XTC 300 COTD rigs (AC drawworks rated at 300,000 pounds), the well demonstrated the value of coil's constant circulation in over-pressured formations, the company notes. The well was left ready for completion operations after coil was used to deploy logs and complete other downhole work.

Xtreme's dual-purpose rigs — designed to drill with conventional jointed drill pipe where necessary — drill with larger coil to reach deeper horizons. It is the only hybrid rig operator with drilling rigs rated to greater than 2,438 metres (8,000 feet), with 13. Using 3 ½- and four-inch coiled tubing, its rigs have increased the maximum depth obtainable with coil from 2,100 to 3,000 metres (about 10,000 feet), while with jointed pipe its five XTC 400 rigs can reach 4,267 metres (14,000 feet). In addition to drilling patents, the company has patented innovative transportation techniques that allow for faster rig-up and rig-out. Eight of its 16-rig fleet is currently under contract in Mexico, while three are under long-term contract in the U.S.

In the Rocky Mountain region of Colorado, an Xtreme XTC 400 rig drilled an S-curve well with 3 ½-inch coil and a rotary-steerable bottomhole assembly that it believes to be the deepest yet. The 2,280-metre (7,480-foot) well accomplished a maximum angle of 21 degrees

NEW MARK FOR COIL

Xtreme Coil's Rig #14, an XTC 300 coil over top drive rig, achieved world record depth with coil, at 3,034 metres, while drilling in Mexico's Chicontepec field in April.



Photo courtesy of Xtreme Coil Drilling

before returning to vertical. The field record well reached total depth in just 2.7 days, rig release to rig release. Also in Colorado, an XTC 300 successfully tested a third-party prototype rotary steerable tool using coiled tubing in the Denver-Julesburg Basin, reaching total depth of 2,277 metres (7,470 feet) in 44.25 hours.

Another first Xtreme marked was to penetrate the West Texas market, potentially opening up new opportunities until now considered beyond the scope of coil. In November, it drilled the first well ever undertaken with coiled tubing in the West Texas Waddell Ranch field, where an XTC 200 DT rig reached total depth in 10.5 days, about five days faster than Xtreme's customer had projected it would take.

The company has found it can complete wells in 50% fewer operating hours compared to the average offset well, even while penetrating hard carbonate formations to 2,225 metres (7,300 feet). Xtreme is presenting a case study detailing its increased drilling performance in the Permian Basin with Fort Worth, Texas-based XTO Energy Inc. to an International Association of Drilling Contractors conference in June.

Shale gas giant

Volume was the reward in one of the up-and-coming shale gas plays last year when an established coalbed methane producer tapped into a massive Marcellus Shale prospect located below its CBM producers in its very first horizontal shale gas well. At 6.5 million cubic feet (mmcf) per day, CNX Gas

Corporation established a record daily production rate for any well in the company's history. The well is also believed to be among the highest reported by any Marcellus Shale producer, the Pittsburgh-based company says.

Spud last June in Greene County, Pennsylvania, the well was drilled to 2,481 metres (8,140 feet) vertical depth in the Huntersville Chert, penetrating 83 vertical feet of Marcellus Shale. The well was logged then plugged back and a horizontal section of 1,035 metres (3,395 feet) was cut for a total measured depth of 3,273 metres (10,738 feet). The well was completed with a five-stage slickwater fracture treatment using three million pounds of proppant.

Crown Drilling, LLC started the well, drilling the vertical section before Les Wilson Inc., with a double telescoping derrick, completed the horizontal section. Scientific Drilling International provided directional drilling expertise while a BJ Services Company team was responsible for hydraulic fracturing.

When it went on production in October, CNX No. 3 flowed at a rate of 1.2 mmcf per day with 4,000 pounds of backpressure. In a press release announcing the well's record production, CNX explained that as backpressure was gradually reduced, daily production increased to about four mmcf per day until December, when the installation of new surface equipment enabled the well to flow at 6.5 mmcf per day, with pressure still being held at 2,640 pounds. Cumulative production from the well prior to that point was 106 mmcf.

The well can hardly be considered beginner's luck when the company's back-

ground is considered. It began extracting CBM in the early 1980s to reduce the gas content in the coal being mined by CONSOL Energy Inc., which retains an 81.5% ownership interest in CNX. In developing techniques to produce CBM from coal seams prior to mining to enhance the safety and productivity of mining operations, CNX has developed industry-leading expertise.

To achieve such success with its first horizontal Marcellus Shale well "speaks volumes about the breadth of our horizontal drilling expertise," stated Nick DeIuliis, CNX president and CEO, in announcing the well in December. DeIuliis was the recipient, in 2007, of the Ernst & Young Entrepreneur of the Year award. "Many investors may not be aware, but CNX Gas had drilled 160 horizontal coalbed methane wells before drilling its first horizontal Marcellus Shale well."

It wasn't the only recent record for the one-time mining company subsidiary, which has now become the U.S. energy industry's number one capturer of methane, a potent greenhouse gas. CNX had earlier set a new world record for cumulative distance with a single drill bit when a contractor accomplished 4,624 metres (15,172 feet). The bit went into the ground twice at the company's Mountaineer CBM and exploratory Marcellus Shale play for a total 238.9 on-bottom drilling hours. Smith Bits, a division of Smith International, Inc., provided the drill bit, while Crown Drilling was the contractor and Nevis Energy Services Inc. provided the directional drilling services. The company has since placed the prize bit on display at its Pittsburgh headquarters.

Paradigm shift

Meanwhile, Smith International also set records in another Pennsylvanian reservoir, where drilling horizontally is done within the extremely low permeable Ordovician layer prior to fracture stimulation. The challenge here, the company says, was to efficiently finish drilling the build section and land the well horizontally in the Bromide before extending the reach to its maximum extent. Wellbore placement was critical to ensure fracture stimulation would optimize production.

Smith's turbodrilling system could provide higher mechanical horsepower, excellent directional control and improved wellbore quality to the previously uneconomic wells, the company says. A paper authored by Smith Technologies and BP, titled *Beyond the Technical Limit: Turbodrilling a Paradigm Shift to World Class Horizontal Well Construction*, details running the new bottomhole assembly (BHA) with successively improving results.

After building to 90 degrees before landing horizontally with three bits on the initial well, the turbodrill was optimized for directional response on the next well by shortening the tool, and the diamond impregnated drill bit was downsized to 6 1/8-inch size to leverage available design options.

Optimization of a Middle Atoka horizontal drilling program with turbodrilling was then undertaken, the paper says. Though previous wells had required four polycrystalline diamond compact (PDC) inserts using high-speed positive displacement motors (PDM) per lateral, an analysis deemed it could be drilled with a single turbodrill BHA.

"Following this success, the new-style turbodrilling system used on the next well set a state record for slimhole total footage/ROP [rate of penetration]. On the subsequent well, the section was completed with one turbodrill run, this time establishing a world single-run footage record for 6 1/8-inch impreg," the paper concludes.

RAM tough

On Alaska's North Slope, a major technical challenge was overcome with the industry's first use of a new rotating, self-aligning multilateral (RAM) system that enables cost-efficient construction of extended-reach multilateral completions.

Baker Oil Tools' RAM system is the industry's first tool that can continuously rotate liners and screens into extended-reach lateral bores while simultaneously landing multilateral junctions, the company

announced in March 2008.

The RAM system is an evolutionary tool based on the company's HOOK Hanger and FORMation Junction technologies, says Alex Ortiz, wellbore construction manager. "On Alaska's North Slope, extended-reach multilateral wells are necessary to ensure maximum contact with trapped oil pools. The RAM System enables operators to efficiently construct long, horizontal multilaterals," he says.

A major operator determined that improving recovery from the sand horizon just below the permafrost at 900 metres (3,000 feet) depth required extended-reach multilaterals with horizontal departures of more than 5:1 ratios and liner lengths of more than 2,438 metres (8,000 feet).

Continuous rotation was necessary to get the drill pipe and liner to total lateral depth in these long horizontal sections. The RAM system was used to land two multilateral junctions and simultaneously rotate liners to bottom. Liner length of the upper lateral was 2,648 metres (8,689 feet) and total depth was 5,192 metres (17,035 feet), according to Baker Oil Tools, a division of Baker Hughes.

All project objectives were met, resulting in the world's first successful RAM multilateral system and providing an economical option for developing the large viscous oil reserves in Alaska, the company said.

In a paper co-authored by Baker Oil Tools and ConocoPhillips Alaska delivered at the SPE/IADC Drilling Conference and Exhibition in March, entitled *Development and Installation of an Extended-Reach Multilateral Junction*, development and testing of the new multilateral junction and several successful field installations are discussed.

A multitude of extended-reach technologies have been used in the West Sak field, the paper notes, with the use of multilateral horizontal wells — with a junction providing mechanical support and both through-tubing lateral isolation and re-entry capabilities — becoming significant to the shallow, heavy oil development. As ERD capabilities evolved to routinely reach departure to true vertical depth ratios in excess of 5:1, multilateral junction technology did not evolve at the same pace.

The new multilateral junction, it explains, allows lateral liners to overcome drag limitations by rotating the liner and junction to setting depth in one trip and includes positive indicators for successful installation. The paper includes operation highlights during the completion phase of a multilateral well with a lateral departure to true vertical depth ratio in excess of 6:1. •