Continuous improvements helped oil company double production from high-temperature wells

**OVERVIEW**

The Haynesville play stretches across northwest Louisiana and east Texas. Its tight shales have higher porosities – and gas content – than most, making it very attractive to developers. However, its geology also provides extreme technical challenges that demand state-of-the-art horizontal drilling capabilities, and high-temperature tools and technologies.

In 2008, a large oil company partnered with Halliburton to provide integrated drilling and completion services for its new horizontal drilling program in the Haynesville Shale. Through continual process improvements, the operator and Halliburton have brought drilling and completion days down 50 percent – saving millions of dollars per well. The operator recently drilled one of these challenging wells in just 26 days. The operator has also more than doubled the estimated ultimate recovery (EUR) of initial wells. Due to the program’s success, the oil company plans to drill more than 70 wells in 2011, and another 70 in 2012.

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<th>CHALLENGE</th>
<th>SOLUTION</th>
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<tr>
<td>Improving cost-efficiency</td>
<td>Integrated services 24/7</td>
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<td>Due to the Haynesville Shale’s challenging downhole conditions, initial wells took months to drill and complete. To make this play more economic, the operator needed to improve time and cost savings.</td>
<td>Integrated services, lessons learned and around-the-clock operations helped the operator cut drilling and completion time by 50 percent. This helped reduce the cost of each well by more than half.</td>
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<td>Boosting recovery</td>
<td>Continuous optimization</td>
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<td>Initial well EURs were around 3 billion cubic feet (BCF) of natural gas per well. To meet production targets, the operator needed to optimize drilling and completions operations and, ultimately, improve recovery.</td>
<td>Local experience and global best practices helped the operator and Halliburton improve drilling practices, well layout, fracturing designs, perforation spacing and more. Now the operator has EURs as high as 7 BCF.</td>
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<td>Hostile downhole conditions</td>
<td>Pushing limits of technology</td>
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<td>The temperatures and fracturing pressures in Haynesville are much greater than other unconventional shale plays. Wellbore circulating temperatures frequently exceed 340°F (171°C). Average fracturing pressures reach as high as 12,500 psi. These conditions require equipment running near or above the operational limits of conventional tools.</td>
<td>To meet these wells’ challenges, Halliburton deployed high-temperature tools and doubled hydraulic horsepower for stimulation treatments. Halliburton implemented condition-based maintenance (CBM) to ensure equipment reliability in difficult conditions.</td>
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A CASE STUDY: High-temperature drilling and completions in the Haynesville Shale

Reduced completion days
Reduced drilling days

50%

Initial wells in this challenging, horizontal program took months to drill and complete. New efficiencies helped cut drilling and completion days in half.

Bottomhole temperatures frequently exceeded 340°F and average wellhead treating pressures during stimulation reached as high as 12,500 psi.

Increased EUR from 3 billion to as high as 7 BILLION CUBIC FEET OF GAS PER WELL

Operator reduced cost per well by more than half

2008 >>> WELL COST >>> 2011

Continuous improvements in stimulation designs have helped the operator more than double production since the start of the program.

PRODUCTION INTERVALS DRILLED WITH ONE BHA UP 20% IN 2011

Since 2010, the operator has increased production intervals (curve and lateral sections) drilled with one bottom-hole assembly (BHA) by 20 percent.

Solving challenges.”
High-temperature gas play presented complex challenges
The Haynesville Shale is one of the largest onshore natural gas resources in the United States. Conservative estimates show 168 trillion cubic feet of natural gas, making it the fourth-largest gas field in the world. However, the area’s geophysical properties present operators with a host of unique challenges. The play is deeper and hotter than comparable North American unconventional gas plays. As a result, wells in the Haynesville Shale take longer to drill and require more advanced technology.

Integrated services helped reduce rig days, increase production
This oil company entered into the Haynesville play in 2008. Halliburton provided integrated drilling and completion services, including:
• Bits
• Cased hole logging
• Cement
• Coiled-tubing
• Directional drilling
• Drilling fluids
• Frac plugs
• Logging-while-drilling (LWD)
• Measurement-while-drilling (MWD)
• Open hole logging
• Project coordination
• Service tools
• Stimulation
• Tubing-conveyed perforating

As knowledge and experience increased, the integrated services helped the operator improve drilling and completion time, cost-efficiency and production. Today’s wells are drilled and completed 50 percent faster than initial wells. EUR from most wells has increased from approximately 3 billion cubic feet of gas to as high as 7 billion cubic feet. And, the cost per well has decreased by more than half.

Industry-leading MWD/LWD tools
Many wells in the program reached 18,000 feet total depth, including laterals up to 4,600 feet. Circulating temperatures frequently exceeded 340°F and have reached as high as 370°F.

To overcome this extreme environment, the operator deployed Halliburton’s industry-leading SOLAR 175™ suite of MWD and LWD services. The tools have directional, gamma, resistivity, density and porosity sensors rated to circulating temperatures of 347°F (175°C). To provide even more reliability, Halliburton upgraded electronics packages and made improvements to mud pulse telemetry. Halliburton’s ability to provide timely, accurate formation data despite hostile downhole conditions helped the operator stay in the pay zone.
Upgraded motors withstood fluctuating temperatures
The rubber in most mud motors can withstand temperature variations of +/-50 degrees from the optimal operating temperature. The rubber in these motors had to endure temperature ranges up to 100 degrees. The operator and Halliburton worked with vendors to optimize rubber products and improve motor reliability.

CBM increased reliability while minimizing risk
Because all of the tools were pushing their operating limits, Halliburton implemented condition-based maintenance. CBM increased reliability and availability by allowing Halliburton to service equipment based on recorded vibration, temperature and pressure data. This helped enhance drilling efficiency by preventing costly, time-consuming breakdowns.

For example, Halliburton helped the operator increase production intervals (curve and lateral section) drilled with one BHA by 20 percent since 2010. Each production interval drilled with one BHA in one run helps the operator save approximately three drilling days.

Doubled hydraulic horsepower for high-pressure fracturing
During completion operations, Haynesville’s deep, high-temperature wells created difficult pumping conditions. Wellhead treating pressures during stimulation commonly exceeded 12,500 psi. These wells required almost twice the amount of hydraulic horsepower than other shale plays – putting significant strain on equipment. The unique designs of Halliburton’s pumping equipment consistently met the challenge.

Local experience helped double production
Through extensive experience, Halliburton’s technology teams helped the operator optimize completion designs and double EUR. This involved tweaking proppant concentrations, fracturing fluids, perforation design and more.

24-hour completions improved collaboration and efficiency
Halliburton moved completions operations from a day schedule to a 24-hour schedule. This enabled Halliburton to improve transitions between services and minimize downtime. Previously, teams would complete one-and-a-half frac stages per day. Now the operator and Halliburton can complete more than four stages per day. Because of this, completion days have dropped from more than 10 days to five or less.

Pad operations helped drill a well in just 26 days
Due to the success of the program, the operator plans to drill more than 70 wells in 2011, and another 70 in 2012. To drill and complete wells even faster, the operator and Halliburton are transitioning to pad operations. Pad operations enable Halliburton to provide services for multiple wells at the same time. This approach enabled Halliburton to drill one of the first pad wells in just 26 days. It also enabled Halliburton to perform the best stimulation to date – six fracturing treatments in one day.