

Case study: Argentina

First DELTA-DRILL application in Argentina optimizes drilling, saves 20 hours in unconventional reservoir

An operator undertook a drilling campaign for a series of development wells in its unconventional field in Argentina. The plan called for drilling each well in three distinct sections using different drilling fluids. The final section posed significant drilling challenges, including:

- An extended and narrow lateral section with a diameter of 6 3/4 in. and a length of 2600–2800 m (8,530–9,186 ft)
- High bottomhole temperatures (BHTs) and pressures at total depth (TD)
- High mud weight requirements of >15.0 ppg
- A narrow mud weight window, requiring managed pressure drilling (MPD)
- Directional drilling complexities

Information from offset wells suggested a high risk of mud losses, a risk of gas influx when the drilling fluid sagged, and a lower fluid flow rate to protect downhole tools from high temperatures. Reducing the flow rate as part of a cooling protocol would result in lower rates of penetration (ROPs) and reduced drilling efficiency.

Optimizing well construction through collaboration

To enhance drilling performance and efficiency in the challenging lateral section, Baker Hughes proposed a comprehensive 3D service model encompassing solutions from its Drilling and Completion Fluids (DCF), Drill Bits, and Drilling Services product

lines. Detailed discussions with Baker Hughes experts convinced the operator of the synergies a 3D model would deliver by facilitating seamless coordination and optimized performance.

The operator agreed to introduce DCF as part of the 3D model, which marked DCF's first job in the operator's unconventional field and in Argentina as a whole.

Boosting drilling efficiency with a customized fluid solution

The operator required a low equivalent circulating density (ECD) fluid solution to help increase average ROP by 10% in the challenging lateral compared to previous wells. The fluid would also have to mitigate downhole tool failures caused by high drilling solids content in the mud and excessive downhole temperatures.

DCF proposed DELTA-DRILL™ low-pressure-impact drilling fluid, a non-aqueous, low-ECD mud system engineered to extend drilling in narrow-pressure windows. DELTA-DRILL's unique rheological properties minimize plastic viscosity to keep pumping pressure and friction factors low. The fluid's viscosity increases at low shear rates to ensure effective hole cleaning with no sagging issues.

DCF also introduced a unique bridging strategy incorporating NANOSHIELD™ wellbore sealing polymer and CHEK-LOSS™ lost circulation material to help prevent downhole losses by sealing microfractures. This

Challenges

- High downhole temperatures necessitated a delicate balance between mud weight and flow rate
- Narrow drilling window and risk of mud losses and gas influx called for managed pressure drilling (MPD) techniques
- High rates of penetration (ROPs) were required while managing temperature and mud properties
- Effective hole cleaning was required to prevent sagging and maintain drilling efficiency

Results

- Achieved an 18% higher ROP than the best-performing offset wells
- Effectively managed downhole temperatures through a meticulous cooling protocol, ensuring uninterrupted drilling operations
- Saved 20 hrs in operational time once total depth (TD) was reached
- Recorded zero Health, Safety, and Environment (HSE) incidents
- Optimized performance with seamless integration of drilling fluids, drill bits, and drilling services within the 3D model

groundbreaking approach used 80% less material than traditional fiber-based bridging packages. The low concentration, small particle size, and spherical shape helped reduce drag and friction for lower dynamic downhole temperatures. Lower temperatures allowed for higher flow rates and increased ROPs.

Drilling Services established a cooling protocol to protect downhole tools, including a Management of Change (MOC) to effectively modify the flow rate once the BHT reached 140°C. This MOC helped keep fluid and tool temperatures within desired limits to increase drilling efficiency.

Delivering a new drilling standard

The integrated 3D service model optimized downhole conditions during drilling, thanks to the synergistic performance benefits of the drilling fluid, downhole directional tools, and drill bits.

DELTA-DRILL maintained high viscosity values at low shear rates ($\gamma S > 9 \text{ lbf}/100 \text{ ft}^2$) and low plastic

viscosity values of approximately 30–34 cP with a mud weight of 15.0 ppg. These viscosity values improved hole cleaning efficiency, maintained reasonable pump pressures at surface, and avoided fluid sagging.

The NANOSHIELD and CHEK-LOSS products effectively sealed microfractures to avoid the possibility of mud losses or instability. As expected, a thin and lubricious filter cake produced by the products also helped reduce drag and friction while drilling, keeping dynamic downhole temperatures low and downhole tools running longer.

The unique combination of DELTA-DRILL and the bridging agents helped drill through the 6 $\frac{3}{4}$ -in. hole section with an 18% faster ROP than the best ROP from the group of 18 offset well sections drilled with another mud supplier. In the horizontal lateral section, the ROP was 46% faster than laterals in offset wells drilled through the same objective and under similar conditions.

The 3D service model further improved drilling by increasing the data

acquisition rate from downhole tools to the surface by 22%. The model's geonavigation and rotary steerable services kept the wellbore 100% within the reservoir's target layer all the way through the lateral.

With the three product lines working synergistically, the 3D model helped drill a total of 2,646 m (8,681 ft) in just 32 hours. After reaching TD, the operator discovered that the 3D service model saved 20 hours in operational time.

The success of the 3D service model in this unconventional drilling operation is a testament to the power of synergy and innovation in conquering complex challenges. The collaborative approach to adopting cutting-edge technologies set a new standard for efficiency, safety, and performance in unconventional drilling operations in Argentina. Baker Hughes plans to replicate this standard through other strategic partnerships in future unconventional oil and gas plays.

6.75-in. section days vs depth (m)

