The Beginning of a New Digital Era in the Middle East

Integrated Well Construction deep-gas project proves the value of digital technology in directional drilling operations.

Through automation, one directional well reached a TVD of 12,524 ft in 46.6 operating days, with spud-to-total-depth drilled at a rate of 370 ft/d and spud-to-release at 277 ft/d. These impressive results were delivered by integrating five distinct technologies.

The DrillOps solution was a key part of the drilling efforts, helping to execute and optimize every task, and saving 24 hrs in the process.

Deep gas wells brought major challenges

Drilling deep gas wells in the Middle East involves many challenges, including stuck pipe, high-pressure zones, intercalated formations, instability, and fluid loss. A recent and more frequent drilling requirement involves high-inclination 3D wells in shallow TVD environments. Tortuosity control is a key aspect of directional control, requiring smooth casing and liner runs.

Under such conditions, drilling success has always depended on the skill and training of individual crews. Adverse events, such as stuck pipe, are often blamed on human error. In recent years, however, the SLB Integrated Well Construction (IWC) team has been refining automated drilling technologies that mitigate human error and improve drilling outcomes as part of a long-term project with a major Middle Eastern oil company.

Human errors addressed through automated digital technology

Previous attempts by the operator to deal with drilling challenges were focused on the human element, using standard controls across all of its rigs to ensure consistency and accuracy. But the results, as always, were highly dependent on human competency, decisions, and actions. The emergence of new digital technology helped SLB introduce a control paradigm where errors were anticipated and prevented, guiding the operator's drilling efforts to newfound success.

For this project, IWC deployed a variety of digital tools, all integrated and working together for optimal results.

- **DrillOps*** on-target well delivery solution used the DrillOps Automate artificial intelligence engine to execute and optimize every task—from ROP optimization, pre/post connection optimization, survey and downlink automation, and drilling dysfunction mitigation, to drilling a stand to achieve the targeted goal, saving a total of 23.49 hr.
- **TruLink*** definitive dynamic survey-while-drilling service, implemented at more than 18 wells, delivered continuous confirmation of BHA location and lithology from tophole to TD, while averting washouts and maintaining consistent wellbore trajectories. The service limited stuck-pipe risk by eliminating the need to stop for surveys. It provided consistent readings in the vertical, curve, and lateral directions, and increased trajectory control with continuous and reliable real-time directional information.
- **Autonomous downhole control system** with auto-curve features was used along with the PowerDrive Orbit G2* rotary steerable system to drill curve sections to a specific dogleg severity (DLS) while maximizing the ROP. The intervals where it was tested were gradually increased from the initial 400 to 600 ft length to a complete landing section drilled at 85°. The main benefits were the minimization of downlinks required and the reduction in tortuosity.
- **PRESSPRO RT*** real-time downhole performance measurement software helped manage equivalent circulating density (ECD) and equivalent static density (ESD) measurements at each point in the drilling cycle. In the first stage of implementation, it was used to validate hole cleaning through the cuttings recovery percentage in the

horizontal section (94%). In the second stage, it was used to follow up on hydraulic behavior, preventing deviations and minimizing stuck pipe incidents.
- **RheoProfiler*** automated rheometer provided a straightforward way to test the density and rheology of all drilling fluid types—water-based, oil-based, and synthetic—which are important when drilling deviated and lateral sections. The rheometer is also used to minimize the hydraulic effect of ECD across the different layers and formations, and to avoid possible fluid loss or wellbore instability events.

Through close integration, all five of these technologies worked together to optimize drilling performance:

- The DrillOps Automate solution, coupled with the TruLink service, delivered consistent performance improvements by eliminating survey time and stuck pipe events. Use of the TruLink service in the 12-in section obtained the best connection times across intermediate sections in the rig involved.
- Auto-curve technology was focused on controlling the tortuosity generated across the directional section of the well, while building and turning the directional trajectory to obtain homogenous DLS.
- The PRESSPRO RT software and the RheoProfiler rheometer were run in tandem, using data extracted from the drilling fluid properties to adjust the hydraulic model in real time, providing better control of rheology, and preventing instability events
- In addition, swab and surge parameters were simulated and followed in real time to prevent fluid loss or well-control incidents.
- Real-time monitoring of hydraulics, ECD, and hole cleaning using PRESSPRO RT and RheoProfiler enabled verification of fluid models and resulted in stuck pipe prevention, lost circulation prevention, and constant control over hole cleaning.

Fastest well drilled to 12,912 -ft MD in 46.6 days

Digitalization for the deep-gas project evolved over time to a point where all the systems were connected and integrated online. To ensure success, local operating procedures and workflows were developed to familiarize drilling engineers with the process and the interfaces between the different tools being used. All digital automation technologies were tested in parallel across different rigs in the project and the main advantages and individual results were used to set benchmarks and objectives for full package integration.

The results of the technology deployments were impressive, with the fastest well delivered for the deep-gas project in a total of 46.6 operating days (versus 64.2 target days), after drilling to 12,912 ft MD (12,524 ft TVD). Key performance indicators for the well included spud-to-TD at a rate of 370 ft/d and spud-to-release of 277 ft/d, with 6.4% NPT.

These drilling successes can be replicated worldwide through the applied expertise of the SLB IWC team, which uses market-leading technologies and domain expertise to accelerate projects and optimize drilling performance in any environment.

With a 25-year track record and global footprint, IWC offers a single point of contact that can achieve drilling and financial objectives faster, while managing operational risks more effectively.

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