CASE STUDY

Middle East / North Africa

HALLIBURTON

CHALLENGES

- Unconventional field with heterogeneous formations characterized by shale, carbonate, and anhydrite
- Interbedded formations that lead to premature bit damages and multiple trips
- Manage drilling parameters to maximize ROP in interbedded formations
- Improve efficiency and reduce rig time

SOLUTION

- Use automation solutions in real time to maximize bit depth of cut (DoC) and optimize drilling parameters in real time and improve ROP with the LOGIX® drilling performance optimizer

RESULTS

- Maximized drilling efficiency with the calculation of the expected DoC based on the bit-rock signature and delivery of optimum parameter set-points
- Early identification of bit-wear/damage while drilling
- Alerted operator of bit damage condition, and enabled a data-driven decision to trip out of the hole saving the customer rig time

Automation solutions enable data-driven decisions to reduce well delivery time

LOGIX® drilling performance optimizer identifies bit wear in real time and optimizes well delivery

Overview

Drilling unconventional development wells demands efficient solutions to meet timelines across multiple well pads. Achieve consistency and efficiency in well delivery requires the adoption of automated, data-driven strategies. With the integration of physics-based algorithms with real-time data, drilling operations can be optimized to improve efficiency and maintain consistency.
These advanced algorithms not only enhance downhole insights but also enable more precise predictions, that support informed, data-driven decisions. The LOGIX® drilling performance optimizer manages optimal drilling parameters to navigate difficult formations, and maintain optimal bit-rock engagement to achieve more consistent penetration rates toward the final well depth.

Challenges

Deep gas unconventional reservoirs require the operator to drill a monobore vertical-curve-lateral (VCL) profile. The vertical interval is known for crossing multiple layers of heterogeneous formations characterized by shale, carbonate, and anhydrite. The aggressive transitions in formation hardness can cause unexpected downhole vibration, reduced bit life, and drill string damage. This can lead to unplanned bit trips to the surface.

The combination of parameters, such as weight on bit (WOB), surface RPM, and flow rate are crucial to prevent trips for failure and maintain reliable and consistent performance. These parameters often rely on human-generated generic roadmaps or the expertise of drillers. This makes it unfeasible to consistently sustain large-scale drilling operations. Relying solely on such traditional methods makes it difficult to identify the cause of reduced performance, This often results in incorrect decisions that can cause non-productive time—either continuing to drill when it is crucial to trip out or tripping unnecessarily when drilling could continue.

Solution

The operator employed the LOGIX® drilling performance optimizer that uses advanced machine learning algorithms to auto-calibrate bit-rock interaction signature and calculate optimal drilling efficiency zones while drilling. This provides automated drilling parameters to increase drilling efficiency and maximize ROP, and automatically provide drilling dysfunction alerts to remote operations engineers.

Results

The LOGIX® drilling performance optimizer calculated the bit depth of cut (DoC) and operational efficiency in real-time and indicated a degradation in drilling efficiency. To restore the ROP performance, the driller increased the WOB by more than twice in magnitude without success. The algorithm determined that the drastic reduction in drilling performance indicators is due to bit wear/damage. The bit-rock interaction signature, shown in a real-time chart of WOB vs. DoC in Figure 1, uncovered a sudden loss in DoC from an average of 6 mm to 1 mm over 40 m drilled.

The real-time data alerts notified the operator of abrupt bit integrity damage. A data-driven decision was made to trip out of the hole and reduce the impact on the well delivery time. Additional time spent on manual data analysis to diagnose and identify the drill-bit dysfunction was avoided. Figure 2 shows a clear change in the bit-rock signature (blue shows bit rock interaction of a sharp bit cutter structure; orange shows the bit rock signature of a damaged bit cutter structure) and confirmed the degradation of drilling performance is due to bit damage.

Once the BHA was on surface, the operator confirmed the bit to be damaged, as predicted by the algorithm. This solution provided the operator with a confident and reliable data-driven decision and, as a result, reduced rig time.

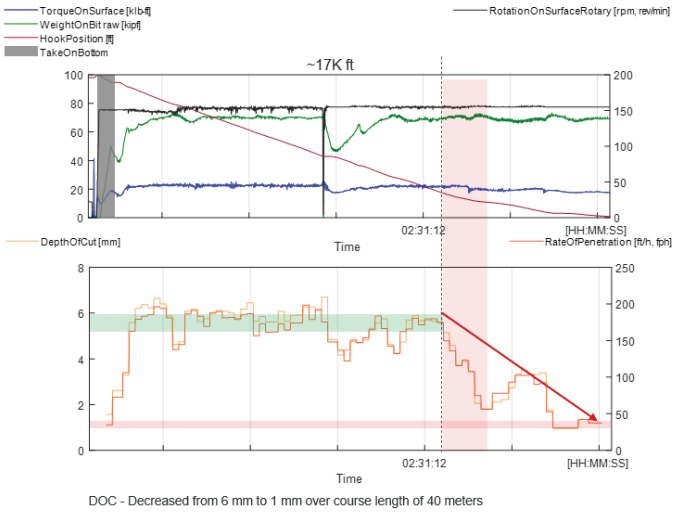

Figure 1: Real-time calculated DoC vs. WOB

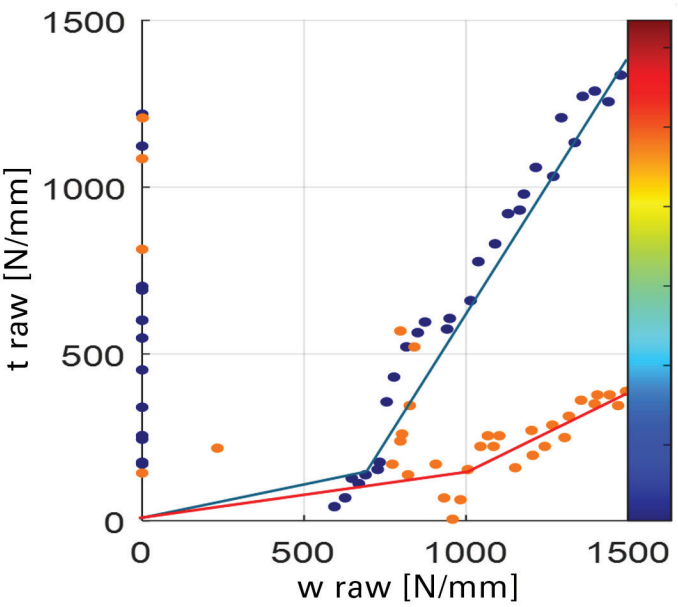

Figure 2: Chart output from the LOGIX Drilling Performance Optimization Service showing abrupt change in bit signature