HEL™ MWD System and MPD Control System

Stand Up to Ultra-High LCM Concentrations in a North Sea HPHT Well

Objectives

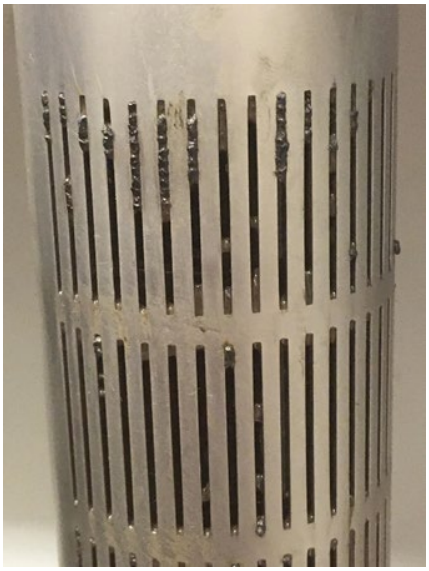
- Deliver full-performance drilling data and pressure control while pumping high concentrations of lost-circulation material (LCM) to safely reach total depth (TD) in a high-pressure, high-temperature (HPHT) well in the North Sea.

Our Approach

- Weatherford worked in conjunction with a major operator to test the proof of concept for measurement-while-drilling (MWD) systems operating in ultra-high LCM concentrations. The operator had concerns regarding potential lost-circulation zones in an upcoming HPHT offshore well.
- Weatherford MWD experts tested system performance in an onshore flow loop, where LCM pills were mixed at up to 147 lb/bbl (420 kg/m^3), or three times greater than industry standards. These LCM pills were successfully pumped through the hostile-environment-logging (HEL) measurement-while-drilling (MWD) system. The HEL tools maintained full communication before, during, and after the LCM pills were pumped through the toolstring. This capability gave the customer the confidence to pump LCM through the MWD tools, if required.
- After drilling began, the MPD control system provided early kick and loss detection and managed wellbore pressure changes. The HEL system relayed critical drilling measurements under HPHT conditions. The MPD drilling optimization software platform enabled automated or manual control of the closed-loop drilling equipment for quicker response to changing pressures.
- As anticipated, the operator experienced severe fluid losses while drilling through the fractured formation. In an attempt to seal the fractures, the operator pumped an LCM pill at 112 lb/bbl (320 kg/m^3). Despite the volume of LCM pumped through the HEL tool, it provided full data transmission to surface.
- As drilling progressed, the operator encountered more highly-fractured zones and was forced to perform multiple cement squeezes on the fly. Cement slurries of 17.5 lb/gal (2.10 sg) were pumped through the HEL and MPD systems, which enabled the operator to drill ahead.
- The Weatherford team carried out the job without any quality, health, safety, or environmental issues.

Value to Customer

- The Weatherford MWD system identified the pressure at which losses were seen. Working with the MPD system, the MWD system maintained bottomhole pressure to enable further operations to address the losses.
- The mud pulser and MPD system withstood the LCM and cement slurries. The LCM and cement aligned to the MPD choke manifold. Pumping through the HEL tool presented no problems for this equipment, which provided full functionality as expected with no plugging through the valve, chokes, piping, or downhole tools.
- The capability to handle high-viscosity fluids through the pulser and MPD system provided the operator with flexibility to pump LCM and cement to treat the losses. Once losses were cured, the customer was able to drill ahead to TD.



The above image shows the control-valve screen slot of the pulser used in the HPHT well. The screen is in excellent condition and successfully captured harmful, large components of the LCM to avoid blocking the control valve.

LOCATION
UK North Sea

WELL TYPE
Vertical, HPHT, production

TOTAL DEPTH
17,113 ft (5,216 m)

HOLE SIZE
12-1/2 and 8-1/2 in.

BOTTOMHOLE TEMPERATURE
325°F (163°C)

BOTTOMHOLE PRESSURE
12,397 psi (85.47 MPa)

PRODUCTS/SERVICES
- MPD control system
- MPD drilling optimization platform
- HEL MWD system

Weatherford®

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Value to Customer (continued)

- Pumping LCM through the MWD tools provided operational flexibility to reinforce the formation and expand the mud weight window from <0.01 to 0.03 sg.
- Because the mud pulser is able to transmit through LCM, this material no longer needs to be bypassed through a circulation sub, which might otherwise open a single barrier pathway from the reservoir to the drillstring.
- The MPD system identified losses in the early stages. During LCM and cement pumping, the MPD system maintained a constant bottomhole pressure to optimize results.

