The operator was using managed pressure drilling (MPD) technology to drill the first ultra-slim deviated well in the Kingdom of Saudi Arabia (KSA). The challenges included potential for differential sticking due to a 5900 psi overbalance, potential H₂S, oil and salt water influxes, and lost circulation. Offset wells in this field had exhibited issues with shale inhibition, well control, and differential sticking. The ultra-slim design of this well, and its specific casing design, increased its complexity.

The MPD method required managing two different mud systems: drilling fluid and kill fluid. Optimal lost-circulation remediation strategies were also necessary to prevent non-productive time (NPT) related to drilling fluid services. The Baroid team worked closely with the operator to identify the parameters required to control well kicks and different types of flows, minimize the high hydraulic effects on the formation, cure losses, provide proper shale inhibition, and avoid differential sticking through the depleted formation while tolerating overbalance pressures up to 5900 psi.

**Lost Circulation Materials**

### Customized STEELSEAL® and BAROFIBRE® Lost Circulation Solution Helped Stabilize Ultra-Slim Overbalanced Well and Save 48% on Fluid Costs

**Location:** Ain Dar - Eastern Province, Kingdom of Saudi Arabia

**Overview**

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### Challenges

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<td>Drill ultra-slim overbalanced well with minimal NPT.</td>
<td>Treat active mud system with STEELSEAL® and BAROFIBRE® lost circulation materials (LCM) products to plug and bridge fractures.</td>
<td>The operators drilled the well with zero fluids-related NPT for nearly half the estimated fluids cost.</td>
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Baroid Team Recommendations

To help ensure success on this critical first well, the Baroid technical team recommended treating the active mud system with 5 ppb each of the following lost circulation materials:

- STEELSEAL® 50 resilient carbon-based material
- STEELSEAL® 100 resilient carbon-based material
- STEELSEAL® 400 resilient carbon-based material
- BAROFIBRE® Superfine natural cellulose fiber
- BARACARB® 25 sized ground marble
- BARACARB® 50 sized ground marble

The Baroid team also bullheaded conventional pills containing 60 ppb of the previously stated LCM products.

The STEELSEAL® resilient carbon-based material was selected for its ability to lodge tightly packed particles under compression in fractures and pores, which can expand and contract without being dislodged or collapsing. The optimal particle size distribution was determined using the Baroid DFG™ software wellbore-strengthening module (see plot on front).

The BAROFIBRE® Superfine natural cellulose fiber can also be used effectively in pills, sweeps, and maintenance treatments with minimal effect on rheology and filtration control. The cellulosic material helps decrease the permeability of the wallcake.

The BARACARB® sized ground marble is an acid-soluble bridging agent that works well in combination with plugging and fibrous materials to help seal the wellbore.

This LCM package has a minimal effect on rheology and equivalent circulating density, a strong advantage in the ultra-slim, deviated well drilled with high density drilling fluid, and they provide good bridging to help minimize the risk of lost circulation and/or differentially stuck pipe.

The potentially difficult ultra-slim MPD well was drilled successfully with zero incidents and zero NPT related to drilling fluids services. Mud volume lost to contamination by influxes or lost circulation was minimal, and 85% of the initial mud volume was recovered from the well. To reduce costs, some of the mud used during the operation was recycled from other rigs or the mud plant.

The planned cost was $198,716. The actual cost was 48% less at $104,247.