Case study: Pre-salt drilling, Brazil

First ADVANCE SEAL AS deployment effectively controls fluid losses, saves $900,000 USD in fluid costs

The customer planned the first phase of an extensive drilling campaign in a deepwater reservoir located approximately 185 km (115 miles) off the coast of Brazil in water depths of approximately 2,050 m (6,725 ft).

Reservoirs in this offshore area are characterized by pre-salt, heterogeneous carbonate/lacustrine rocks at a total depth (TD) of approximately 6,000 m (19,685 ft) from sea level. The operator planned to drill a well with five sections using water-based drilling fluids. Due to high reservoir pressures, the reactivity of the formation, and lost circulation risks, the operation required a drilling fluids system that guaranteed well integrity and stability while minimizing fluid losses.

While drilling the last section using the Baker Hughes DYNAFLOW™ drill-in fluid (DIF) system, a circulation loss of 60 bbl/hr occurred at a measured depth (MD) of 6,260m (20,540 ft). After reviewing the fluid program, the Baker Hughes Drilling and Completions Fluid (DCF) team and the operator decided to pump a lost circulation material (LCM) pill comprising 20 ppb of SOLUFLAKE™ Fine and 20 ppb of MIL-CARB™ 50 in 100 bbl of DYNAFLOW. The DCF team designed this pill to control seepage to below less than 10bbl/hr, but a static evaluation after the first application showed a loss in the static condition of 20bbl/hr.

Designing the optimal bridging material

The high pressures and heterogeneous carbonate formation profile convinced the DCF team that the pill required a bridging material to control medium and severe circulation losses, guarantee well integrity, and improve stability. Based on these requirements, the DCF team proposed ADVANCE SEAL AS, which contains solids with an optimal size and shape distribution to deliver effective formation bridging and control circulation losses without damaging the reservoir.

This application marked the first deployment of ADVANCE SEAL AS in a Brazilian well. As a result, the operator needed additional assurance that the LCM additive would perform as required. Reservoir information provided by the operator proved crucial for designing and testing the optimal solids package in the lab before moving it to the rig.

In slotted disk tests conducted at an overbalance of 500 psi and a temperature of 100°C (212°F), 120 ppb of ADVANCE SEAL AS added to a DYNAFLOW/SOLUFLAKE formulation consistently formed a filter cake that plugged the slot and held pressure. The particular solids package in the LCM additive demonstrated high solubility in a 15% hydrochloric acid solution.

Challenges

- Effectively drill an ultra-deepwater well at 2,050 m (6,725 ft) water depth
- Deliver wellbore through a pre-salt, heterogeneous carbonate section while avoiding formation damage
- Maintain effective lost circulation control to minimize fluid losses at temperatures exceeding 100°C (212°F)

Results

- Maintained fluid stability at 500 psi and 100°C (212°F)
- Afforded easy, efficient DIF preparation at the rig site with no special mixing equipment
- Maintained well stability and reduced fluid losses by 85%
- Achieved high acid solubility for effective wellbore cleanup and reservoir access
- Saved $900,000 USD in fluid costs and up to $3 million USD in related rig and logistics costs

Satisfied that these test results would translate to effective lost circulation control and wellbore integrity in the field, the customer agreed to deploy ADVANCE SEAL AS as part of the DYNAFLOW DIF system for the well.

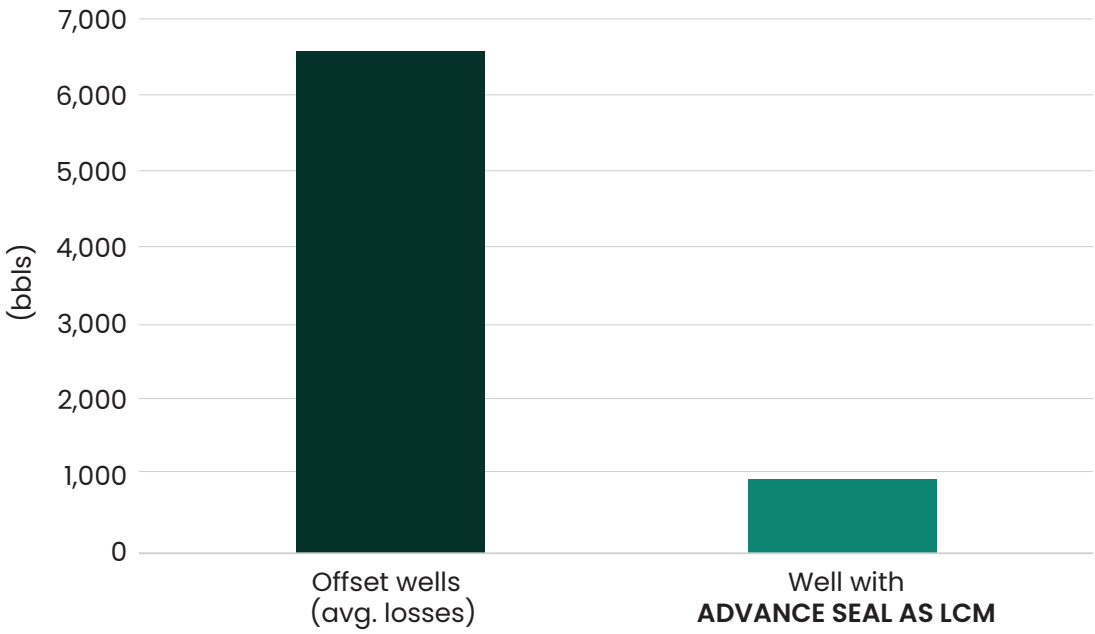
Efficiently controlling losses to maintain well integrity

The customized ADVANCE SEAL AS formulation arrived at the rig site in sacks. The DCF team added the solid formulation into 100 bbl of the premixed DYNAFLOW/SOLUFLAKE/MIL-CARB solution, without the need for any specialized mixing equipment or rig customization, to arrive at a dosage of 120 ppb of the ADVANCE SEAL AS solids in the pill. The drilling team pumped the pill in a section of the reservoir with a high risk of fluid losses exceeding 12,000 bbl based on offset well information.

A flow check performed after deploying the pill confirmed high stability in the well. The pill kept fluid losses below 1,000 bbl for the drilled section. Thanks to the high acid solubility of the solids in the ADVANCE SEAL AS bridging material, the pill dissolved quickly during the wellbore cleanup stage to ensure excellent reservoir access.

The ADVANCE SEAL AS application saved at least $900,000 USD in drilling fluid costs alone. Total cost savings potentially exceeded $3 million USD when accounting for reduced rig time and improved logistics.

The success of this first ADVANCE SEAL AS application in Brazil proved the bridging material's ability to deliver a stable wellbore in a challenging deepwater well—with minimal time, cost, and environmental impacts. Baker Hughes is taking the lessons learned from this well to further refine the formulation for other companies eager to apply it in their own wells.



The ADVANCE SEAL AS LCM kept the fluid losses below 1,000 bbls, an 85% reduction in losses when compared with averages in offset wells.

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