

Case study: Vietnam

Intelligent solution to wellbore strengthening in offshore wells saves \$800,000 USD with zero NPT

A customer with an offshore well in a depleted formation wanted to drill and case the wellbore to total depth with minimal-to-zero nonproductive time (NPT) but suffered major losses and stuck pipe. Competitors attempted to solve the issue by injecting water-based mud (WBM) into the formation, but faced continued losses and stuck pipe in addition to large mud build volumes with WBM and synthetic-based mud (SBM). Consequently, the customer racked up enormous costs for fluids.

Seeking an alternative, the customer reached out to Baker Hughes. Before suggesting any solution, Baker Hughes collected all the available data and downhole conditions. The engineers used the **IntelliBore™ drilling fluids engineering solutions** to accurately predict and manage circulating pressure windows (with **BOREWISE™ engineering software**) and provide product recommendations to strengthen the wellbore (with **BRIDGEWISE™ engineering software**). With this new information, Baker Hughes proposed an Intelligent Fluids Solution to reduce NPT when the operator encounters costly wellbore instability and lost circulation events while drilling.

Six sets of simulations were conducted with the BOREWISE and BRIDGEWISE software with variable minimum horizontal stress (S_{hmin}) and equivalent circulating density (ECD) factors that were analyzed and selected, based on worst-case

scenarios, to model the fracture width and select the bridging package for wellbore strengthening (WBS). With the BOREWISE software, the primary intent was to calculate a small fracture with a low height and very shallow penetration to create an increase in hoop stress, thus increasing near-wellbore strengthening. The idea was to create a small fracture while simultaneously plugging the fracture with appropriate wellbore strengthening material. The resulting elevated stress around the wellbore wall should strengthen the wellbore.

The modeling developed via the BRIDGEWISE software determined a suitable product mix to cover these two fracture sizes. The product selection was optimized for the larger fracture size while still providing a reasonable fit for the smaller size. Particle plugging test (PPT) performance confirmed the ability of the modeled product mix to form a seal across the fracture throat with a total of total 50 ppb of bridging material via a lost circulation and wellbore strengthening materials pill in the following:

- **LC-LUBE™ sized, synthetic graphite particulate**—10%
- **CHEK-LOSS™ complex cellulosic LCM**—10%
- Fine and medium calcium carbonates ($CaCO_3$)—80%

The LC-LUBE particulate is specially formulated to control circulation loss

Challenges

- Overcome major formation losses and stuck pipe
- Drill and case well to TD with minimal NPT

Results

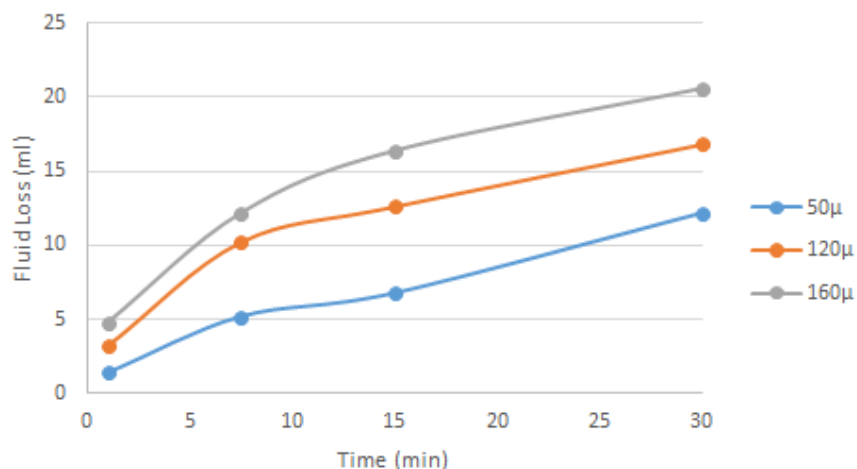
- Prevented major losses during drilling and cementing in 2 wells, an estimated savings of \$600,000 USD
- Saved an estimated \$100,000 USD per well by applying WBS pill rather than treating whole system
- Experienced no major downhole losses during drilling, cementing, casing, logging, and coring operations
- Eliminated wellbore stability issues including pack-offs and tight hole condition in the depleted section
- Experienced no HSE issues or NPT

and partial seepage losses of drilling fluids. The size, shape, and durable nature of the LC-LUBE particulate makes it ideal for pre-emptive use in highly depleted reservoirs and depleted, high-pressure/high-temperature (HP/HT) wells. It is also able to function as a solid lubricant in the majority of drilling fluids.

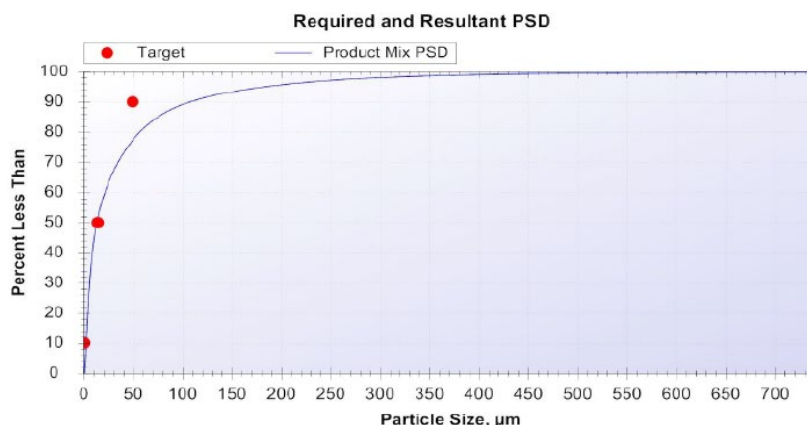
CHEK-LOSS LCM is a water-insoluble, ultrafine complexed cellulosic material used for controlling seepage and loss of circulation while drilling through depleted or underpressured zones. The ultrafine particles are ideal for seepage and losses when LCM particle size is a concern while drilling extended-reach wells.

After the application, the well experienced no major downhole losses. Rather than applying the wellbore strengthening materials to the whole system, engineers suggested a more cost-efficient option and pumped the materials as a pill for a minimum coverage of 328 ft (100 m) of open hole while drilling to solve the customer's issues.

The Baker Hughes solution enabled the customer to drill, log, core, and case the well successfully with zero fluids-related NPT or hole instability issues.



Permeability Plugging Tester (PPT) results on 11.5ppg After-Hot Roll Mud.



The BRIDGEWISE software determined the suitable wellbore strengthening product mix to seal the predicted fracture width based on the BOREWISE simulation.