Case study: Azerbaijan, Caspian Sea

SealBond LT, LiteSet systems, CemMaster software provided isolation across permeable zones

The drilling and cementing of shallow sections for an offshore operator in the Caspian Sea consistently exposes several risks. The permeable (flow) zones, together with discrete permeable zones within the upper formations, are located between the 24-in. liner shoe and the 20-in. casing shoe. Because the shallow water zones contained varying formation properties—such as narrow pore and frac pressures—there was a high risk of losses to the formation. Designing cement jobs requires special attention to detail with respect to equivalent circulating density (ECD) modeling. The impact of different fluid densities, the location of lead and tail slurries, and flow rates must be considered when the fracture gradient is challenged.

The Baker Hughes cementing team proposed a fit-for-purpose solution for zonal isolation under challenging well conditions—a first for the company on a Caspian Sea offshore rig. The **SealBond™ LT cement spacer system** helps prepare downhole surfaces for cementing in low and medium temperature environments. The system forms a permeable seal over the formation, mitigating lost circulation issues during cementing and reducing cement loss and formation damage. It helps reduce filtrate invasion, prevent cement fallback, and increase ECD at casing depth in wells where the fracture gradient limits the design of the cement density.

Baker Hughes successfully implemented the **LiteSet™ lightweight cementing system** in combination with the expandable additive for the first time in the Azeri offshore field. The system optimized the volumetric proportion of liquid to solids, despite lowering the slurry density, and also maintained zonal isolation under high induced wellbore stress conditions of existing well. EC-1 (expanding material) was used to prevent the natural shrinkage of cement in wellbore to provide long term isolation.

The entire operation was designed and implemented using new Baker Hughes **CemMaster™ zonal isolation cementing software** which reduces risk, improves efficiency, and ensures quality performance during cementing operations to deliver a reliable and cost-effective cement job—from initial design through final evaluation.

Working in close collaboration with the operator, Baker Hughes cementing engineers proposed several solutions to mitigate these risks. The main operator concern was to design expandable lightweight blend which would help to compensate the percentage of cement shrinkage after set, and eliminate the micro-channeling and gas migration.

To mitigate the shallow water flow problem, the engineers recommended the lead and tail slurries contain different (controlled) transition times.

Challenges

- Provide a successful cement job without any losses and shallow water flow
- Ensure quality cement behind the 24-in. liner to allow structural support of the well
- Overcome wellbore stability issues
- Save the slot for further drilling operations
- Avoid isolation of shallow water flow formations
- Mitigate risks of losses and bring top of cement to top of liner depth as planned

Results

- Pumped expandable LiteSet cementing system in Caspian Sea field for the first time
- Achieved zonal isolation across permeable zones and shallow water formations
- Brought top of cement to top of liner as planned
- Eliminated expensive workovers and saved $300,000 USD daily rig time
- Avoided downhole losses at planned pump rates without any deviation from the actual plan
- Predicted 100% cementing coverage and zonal isolation across the high flow potential zone

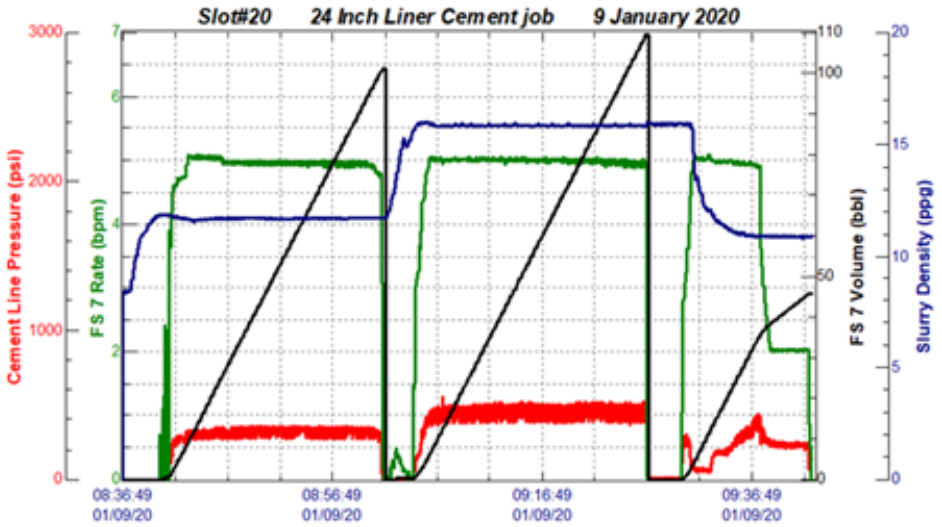
As such, the cementing job consisted of a 1.4 specific gravity (SG) (11.68 ppg) expandable LiteSet blend lead slurry and a 1.9 SG (15.85 ppg) neat class-G tail slurry. This combination—a first in this offshore field—optimized the volumetric proportion of liquid-to-solids despite lowering the slurry density. But it also maintained zonal isolation under high-induced wellbore stress conditions of the existing well.

The Azerbaijan team conducted extensive laboratory research, performing more than 100 lab tests for the cement and spacer to achieve a stable, working design.

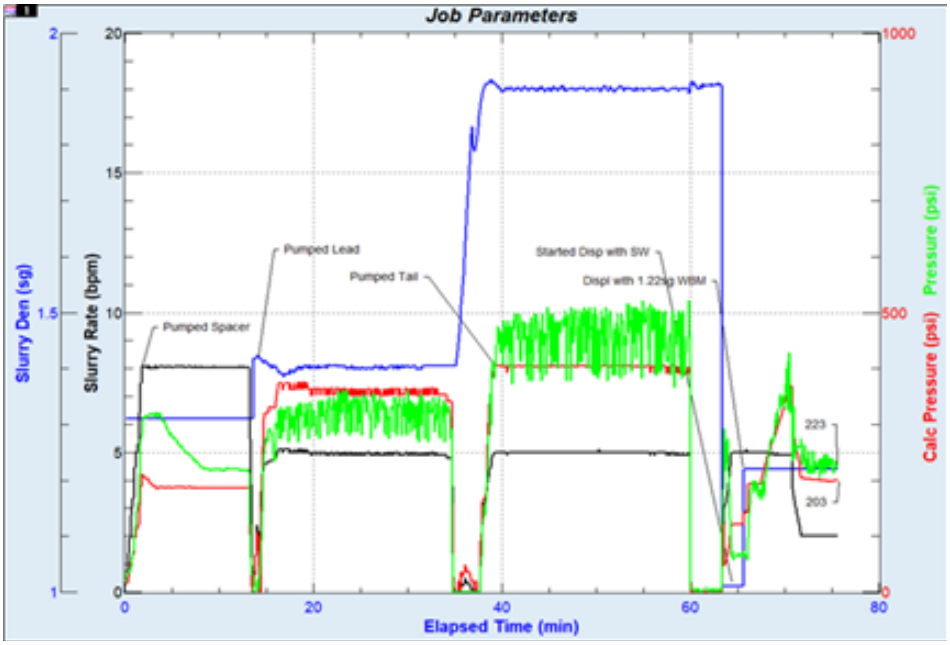
The EC-1 expanding additives prevented the natural shrinkage of cement in the wellbore to provide long-term isolation. Because of the high risk of flow from the Absheron formation and the open hole drilled across the discrete permeable zone, both slurries were designed to control of formation fluid migration. Engineers selected a 1.31-SG Sealbond LT spacer system to mitigate the risk of losses. This spacer had ultralow invasion fluid technology with sealing capability, which created a film barrier across formation and strengthened the wellbore.

The application of the expandable LiteSet slurry design in combination with Sealbond LT spacer enabled effective mud removal and mitigated the risk of losses during the cement job. Despite the significant ECD impact on the fracture gradient, the 24-in. job was performed without losses. The CemMaster software predicted, with 100% accuracy, the cementing coverage and zonal isolation across the high flow potential zone.

The operator commended Baker Hughes for its efforts, dedication, and deep involvement in every phase of the flawless well construction. The entire job experienced no health, safety and environmental (HSE) issues or nonproductive time (NPT).



Cement unit pumping job chart of the 24-in. liner cement job.



CemMaster post job pressure matching chart – comparing planned vs actual pressures.

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