

Case study: Gulf of Mexico

Self-sealing cement system maintained zonal isolation under harsh frac conditions

An operator drilled a deep production well in the Gulf of Mexico that required demanding fracture treatments during the completion phase. The stimulation design called for ten individual frac stages to be pumped at high pressures and rates. This treatment would create multiple large changes/cycles (pressure increases and temperature decreases) on the set cement sheath which could result in a failure if not properly anticipated.

Complicating the operation was the long zone of interest, with more than 2,000 ft (610 m) of pay/target sands to be completed and produced. The temperature reduction of the bottomhole temperature was expected to be approximately 83°F (23°C) during the fracture jobs. The maximum surface pressure during the frac operation was 12,000 psi (82.7 MPa), an approximately 7,000 psi (48.2 MPa) increase in wellbore pressure change on the set cement.

After modelling the predicted stresses on the cement using the **CemMaster™ zonal isolation cementing software**, Baker Hughes offered a fit-for-purpose design to the customer that could withstand the harsh conditions expected during well operations. The cement design consisted of using a cost-effective lead slurry with **DuraSet™ cement system** and a technically advanced tail slurry featuring the **EnsurSet™ self-sealing cement system** placed across the pay zone. Both slurries include a flexible, durable design with improved/enhanced mechanical properties that also had an expansion additive to negate

chemical shrinkage. The EnsurSet system, however, also possesses the ability to seal itself upon contact with hydrocarbons if a crack develops— up to 0.009 in.—during the initial ten frac stages or during the life of the well.

These customized, **Set for Life™ family of cementing systems** provided exceptional mechanical properties verified in the laboratory along with a durable, flexible, expansive, and self-sealing solution required for this unique well.

Careful planning and flawless execution by multiple product lines and onsite personnel contributed to the successful first application of the EnsurSet system in the Gulf of Mexico. No remediation work was required after the cement bond log showed superb zonal isolation. During the fracture treatments, no casing pressure or fluid flow was observed in the isolated casing strings. While producing the well, no loss of production or cross flow of produced fluids has been seen.

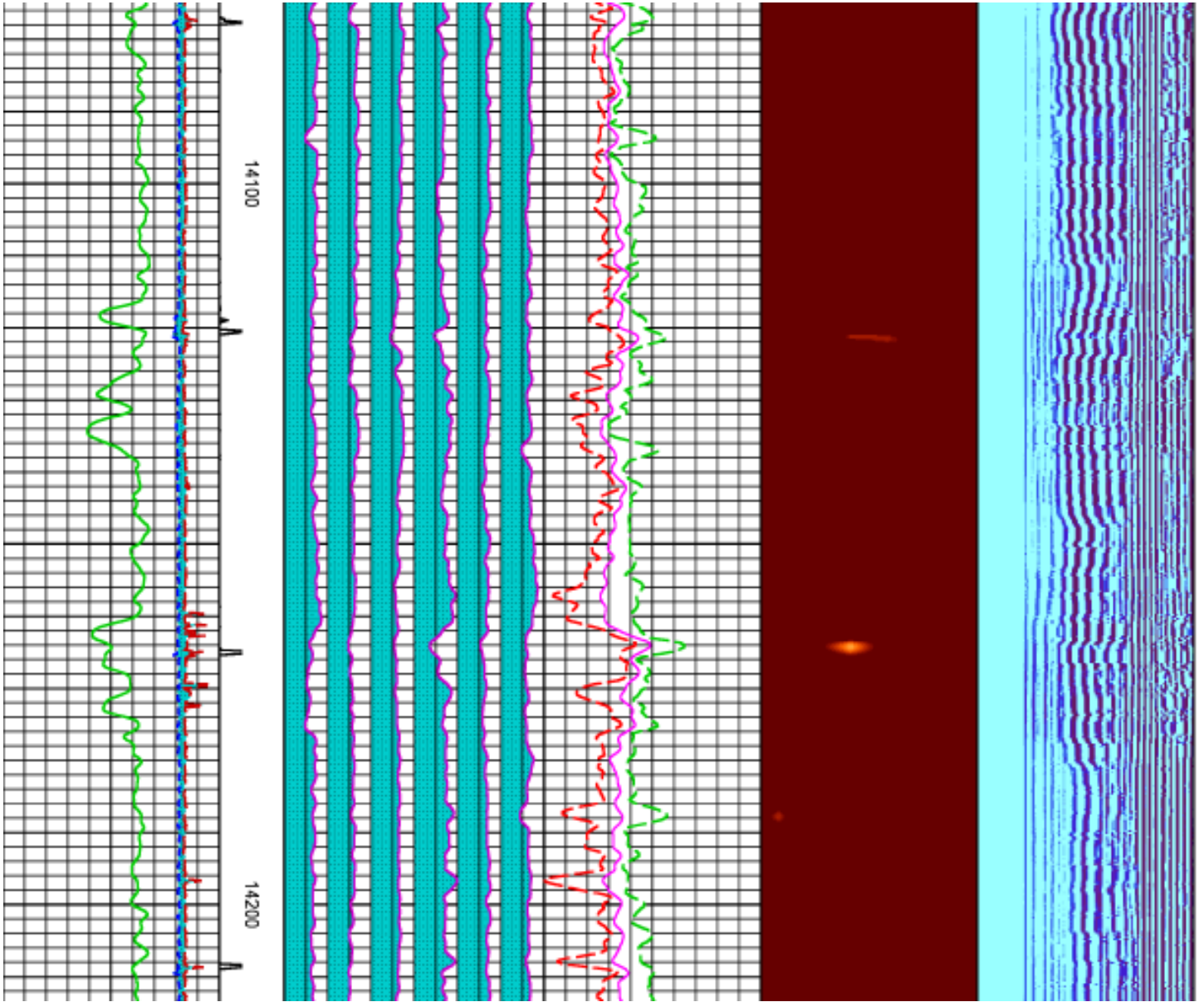
The combined technologies from Baker Hughes received great praise from the customer regarding the exceptional technical advantage in this challenging environment that not only met the engineering requirements but remained cost-effective without compromising zonal isolation. The project incurred no nonproductive time (NPT) or health, safety and environmental (HSE) issues.

Challenges

- Manage the numerous pressure/temperature cycles on the cement sheath planned during the completion phase of the well
- Navigate the long zone of interest to be completed and produced

Results

- Prevented remediation work after achieving a near-perfect cement bond log and maintaining zonal isolation
- Observed no casing pressure or fluid flow in isolated casing strings during the frac jobs or sustained casing pressure while producing the well
- No loss of production or cross flow of produced fluids due to lost zonal isolation from a cement sheath failure
- Experienced no HSE issues or NPT



Near perfect cement bond log results were highly praised by the customer and gave confidence that the set cement sheath would withstand the completion and production phases of the well for life.