

Cementing

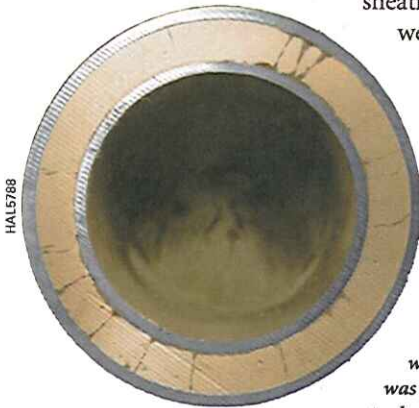
Foam Cement Delivers Long-Term Zonal Isolation and Decreases Remedial Costs

Foam cementing offers a truckload of benefits. But you may never realize them unless you do the job right. That's what Halliburton's ZoneSeal® Isolation Process is all about. Because Halliburton is the world's largest nitrogen fracturing company, the world's largest cementing company, and the world's premium supplier of foam cement, we've been able to put all the pieces together to make sure that you capitalize on all the advantages intrinsic to foam cement.

Advantages: Ductility and Tensile Strength

Ductility and tensile strength are the most crucial properties for long-term zonal isolation. The foam cement system exhibits improved ductility over conventional cements. This ductility allows the cement sheath to withstand higher hoop stresses from casing pressure and temperature cycling.

This feature allows the cement sheath to "give" as the well's casing expands, helping prevent long-term cement-sheath cracking.

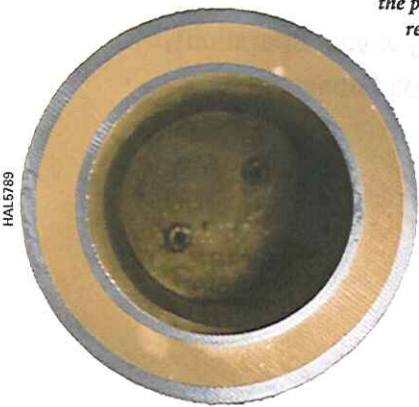


Conventional

The illustrations, left, show sectioned samples from cyclic stress tests. In each test, the cement was allowed to cure, after which the internal casing was pressurized simulating actual well conditions.

The conventional high strength neat cement (top left) failed when the pressure in the inner pipe reached 4,500 psi.

When foam cement (bottom left) was tested in the same way, it maintained integrity when cycled to more than 9,000 psi.



Foam

The useful life of a foam cement sheath to provide zonal isolation is measured in hundreds of stress-relaxation cycles compared to conventional cement, which will crack in two to ten stress-relaxation cycles. **Result:** Lasting zonal isolation that means no sustained casing pressure; less produced water for treatment and disposal; fewer workovers; and more efficient production.

Advantages: Helps improve mud displacement, prevent gas migration and protect the formation

- Foam cement under compression is a high-energy, high-viscosity system that is more efficient than conventional slurries in displacing mud. **Result:** Cement-formation bonds that really hold up because all the mud has been removed.
- The compressed gas bubbles in foam cement shrink or expand, but they don't move around or coalesce. Instead, they maintain pressure while the cement hydrates. **Result:** Virtually no gas migration into the cement, ever – while cement is being placed or while it sets.
- Foam cement has lower thermal conductivity. **Result:** Retention of heat as fluid is injected into the well – and fewer problems with paraffin, asphaltene and gas hydrate precipitation when the crude is produced.
- The bubbles actually "plate out" against the formation and form a barrier. **Result:** Lower water loss to the formation, which helps prevent formation swelling, washouts and other damage.
- The tensile strength and mechanical properties of foam cement makes it ideal in many hydraulic-fracturing operations.

Foam cement does not increase the risk for fracture initiation and propagation during hydraulic-fracturing treatments. **Result:** Improved zonal isolation in productive sections.

- The density of foam cement can be varied using the same base slurry. **Result:** Hydrostatic pressure that can be tailored to protect fragile formations and help prevent high-pressure zones from coming in – all within the same job.



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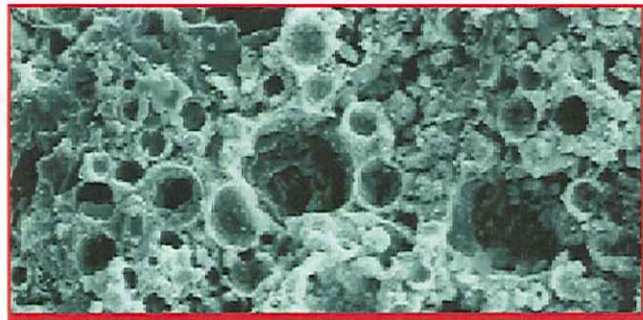
The Advantages are Clear

Foam cement is simply the right way to complete a well. It can be the best insurance of trouble-free operation and long productive life that you'll ever have. But unless it is applied the right way, its potential benefits may never be realized. Get the benefits you expect from foam cement now, by taking advantage of the ZoneSeal Isolation Process from Halliburton.

Success Story

Data from six deep gas wells in Wyoming indicate that foam cement outperforms conventional cement for zonal isolation. Two of the six wells were cemented across the production zones with conventional cements. In the four other wells, the foam cement sheath provided zonal isolation even after the sheath was perforated and stimulation treatments were performed.

The first well was cemented with the hollow-sphere and conventional cement systems. Radioactive tracer logs indicated communication on most of the zones. The second well that was cemented experienced casing damage during the completion phase, causing a lower zone to be abandoned.



This microscopic photo shows how foam bubbles prevent fracture initiation in stable foam.

At this point, the cementing program was thoroughly evaluated. Foam cement was reviewed and determined to be the best alternative for achieving effective zonal isolation on this program.

The cement evaluation logs from the four foam cemented wells showed zonal isolation between the low- and higher-pressure zones. In general, the initial production rates from the four foam cemented wells were 2.5 to 5 times higher than the two wells cemented with conventional cements.

These four wells hold the distinction of being the deepest foam cemented liners in the region.

**For more information on the benefits this technology can bring to your operations,
contact your local Halliburton representative – your Solution ConnectionSM.**

Visit our website at www.halliburton.com

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