DATA SHEET

HALLIBURTON

Cementing Solutions
Cement Systems and Additives

CorrosaLock™ Cement System

Resin modified cement solution for corrosive CO_2 environments.

FEATURES

- Significantly reduces permeability compared to conventional Portland cement slurry designs
- Delivers enhanced elasticity and shear bond strength

BENEFITS

- Resistant to chemical alteration caused by carbonation and other corrosion reactions
- Combats the effects of stress induced by downhole conditions and injection operations
- Provides enhanced bonding between the formation, cement, and casing

Overview

Cementing wells for carbon capture, utilization, and storage (CCUS) presents unique challenges to barrier integrity and long-term stored CO_2 containment. CCUS projects aim for permanent underground CO_2 storage, which requires long-term cement sheath chemical and mechanical stability. Factors like temperature and pressure cycles and chemical interactions can impact the cement integrity over time. CO_2 produces carbonic acid in the presence of water, which can degrade conventional Portland cement. Cement used with CCUS applications must be resistant to CO_2 exposure.

CCUS involves the injection of CO_2 deep into subsurface formations, typically at significant pressure. For this reason, cement slurry design and placement techniques must ensure proper bonding of cement to the wellbore and formation to provide a reliable and impermeable seal. Halliburton has decades of experience with the design of annular barriers for corrosive environments. We recognize the importance of proper material selection and best practices for long-term CO_2 storage. CorrosaLock™ cement system is part of the Halliburton CCUS solutions portfolio. The system is tailored to provide excellent chemical resistance to CO_2 and enhanced mechanical properties that minimize the impact of cyclic loading on the mechanical integrity of the cement barrier.

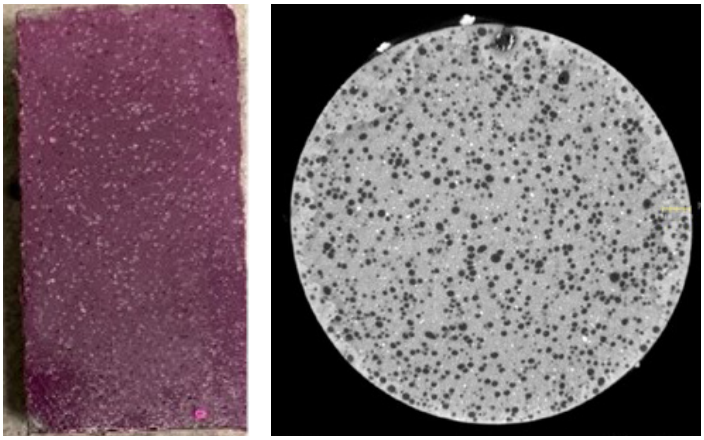
Reduced permeability provides superior corrosion resistance

The CorrosaLock cement system is a composite of Portland-based cement and the proprietary Halliburton WellLock® resin system. The cement component of the composite is tailored based on Halliburton's slurry design best practices. Portland cement is minimized, and the blend is supplemented with CO_2 resistant materials to meet performance requirements. A specified volume of WellLock resin and cement are blended to yield a system that provides a significant permeability reduction. The resin system helps in two ways. First, a portion of the resin creates a film on the composite system's surface, which creates a coating effect to help with bonding. Second, the resin creates small spheres that occupy the pore space within the composite system's matrix. This reduces the system's effective porosity and forms an adhesive layer to

protect the cement grains from CO_2 degradation. The combined coating effect and matrix enhancement benefits result in a greatly reduced permeability composite system, which can provide superior corrosion resistance in dry and aqueous supercritical CO_2 environments.

Enhanced mechanical properties deliver long-term barrier integrity

Incorporation of resin into the design enhances cement sheath elasticity and shear bond strength compared to conventional cement systems. Improved shear bond strength allows the CorrosaLock system to provide increased anchoring to the casing and the formation. This can significantly minimize the risk of debonding, which can cause gas migration and integrity loss. Additionally, the cement sheath is more crack-resistant to better withstand the downhole forces during cyclic injection.



Phenolphthalein, a pH stain, provides visual cues of carbonation. Purple represents unaltered cement. The results of CorrosaLock cement after one month of static supercritical CO_2 exposure at 100ºF exhibit no noticeable CO_2 chemical alteration compared to conventional Portland cement.

CCUS solutions portfolio

The Halliburton CCUS solutions portfolio includes non-Portland, modified Portland, and reduced Portland products. These solutions use tailored chemistries, pure resin, cement and resin composites, and additives to enhance mechanical properties. They also reduce the set cement permeability and deliver an improved CO_2-resistant barrier with long-term integrity. The CorrosaLock system is part of our modified Portland solutions portfolio.

Significant permeability reduction and enhanced mechanical properties provide superior corrosion resistance in CO_2 environments.

Post-exposure mechanical properties results

SAMPLE	1 WEEK	1 MONTH	5 MONTHS
Compressive strength (psi)	7,638	7,471	8,104
Young's modulus (psi)	1.83E+06	1.71E+06	2.02E+06
Poisson's ratio (-)	0.276	0.242	0.265

No noticeable deviation in the CorrosaLock™ cement system mechanical properties after five months of supercritical CO_2 exposure.

For more information, contact your local Halliburton representative or visit us on the web at www.halliburton.com