Reduced Portland, High-Performance Cement Systems

NEOCEM™ CEMENT, NEOCEM™ E+ CEMENT, AND ENVIRACEM™ CEMENT

OVERVIEW

As we transition to a lower-carbon future, it is critical to design dependable cement barriers with reduced Portland content. To meet this challenge, Halliburton has developed a portfolio of reduced Portland cement systems that includes NeoCem™ cement, NeoCem™ E+ cement, and EnviraCem™ cement. These cement systems contain less mass of Portland content compared to conventional designs. The reduction in Portland content helps customers lower their carbon emissions baseline and provides engineered cement systems with enhanced cement sheath performance.

NeoCem Cement System: average 40% reduction in mass Portland cement of blend
NeoCem E+ Cement System: 50%-70% reduction in mass Portland cement of blend
EnviraCem Cement System: greater than a 70% reduction in mass Portland cement of blend

FEATURES

- Lower Portland content compared to conventional cement systems
- Leverages more mined and recycled materials
- Enables higher compressive strength at a lower density
- Increased ductility
- Reduced permeability
- Enhanced sheath performance
- Delivered using same equipment and processes as conventional designs

BENEFITS

- Contributes to a lower carbon footprint per cement job
- Reduces supply chain constraints
- Reduces ECDs to achieve planned top of cement
- Improved resistance to cyclic loading and wellbore stresses
- Improved corrosion resistance
- Improved wellbore isolation to reduce fugitive emissions
- Operationally efficient

Enhanced tailoring capabilities provide improved mechanical properties

NeoCem, NeoCem E+, and EnviraCem systems leverage the synergies between the chemical and physical properties of specialized materials combined with Portland cement. Halliburton's innovative tailoring process engineers these reduced Portland systems to deliver high-performance, compressive strength and ductility, at a lower density than conventional systems for improved barrier dependability

Lower density, higher compressive strength

The synergies these specialized materials impart allow for enhanced tailoring capabilities over conventional designs. Traditionally, higher density cement systems exhibit higher performance, such as higher compressive strengths, while lower density cement systems present reduced performance. However, laboratory data indicates that our reduced Portland cement systems can deliver a compressive strength-to-Young's-modulus ratio (CS/YM) greater than a higher density conventional cement system. Additionally, because NeoCem cement, NeoCem E+ cement, and EnviraCem cement are lower density systems, equivalent circulating densities (ECDs) are more manageable. Managing ECDs mitigates the risk of contamination, channeling, and lost circulation, which results in poor zonal isolation.

Table 1: EnviraCem Cement System Mechanical Properties and Permeability

	11.5ppg	12.5ppg	13.2ppg	14.5ppg
Ultimate Crush Compressive Strength [psi]	693	1,477	1,977	3,595
Young's Modulus [Mpsi]	0.370	0.621	0.857	1.360
Poisson's Ratio [-]	0.316	0.313	0.301	0.257
Permeability (µD)	0.029	0.023	0.420	0.010

Mechanical Property and Permeability Testing performed at Houston Technology Center. Samples cured for 7 days at 170°F and 3500 psi.

Increased Ductility

Cements with improved ductility allow the cement sheath to better withstand the cyclic pressures during operations and reduce the potential for stress-induced damage, which can lead to fugitive emissions. NeoCem cement, NeoCem E+ cement, and EnviraCem cement systems provide an increase in ductility and toughness compared to conventional systems. This improved flexibility enables our reduced Portland cement systems to better withstand the downhole demands from continual pressure and temperature changes throughout the life of the well to provide improved long-term zonal isolation compared to conventional cement systems.

Reduced Permeability

Reduced Portland designs engineered from the innovative Halliburton tailoring process provide reduced permeability of the set sheath compared to conventional cement designs. A cement sheath with low permeability provides more resistance to corrosive fluids and gases downhole to deliver a dependable barrier for the life of the well. Permeability testing of the four different density EnviraCem cement systems, as shown in Table 1, resulted in ranges from 0.01 to 0.42 µD. This range is exponentially lower than 0.1mD, or gas tight permeability.

Tailoring methodology provides flexibility for utilization of locally sourced materials

Halliburton's innovative approach to design reduced Portland systems incorporates more locally sourced, natural, and recycled materials. The reduced dependence on Portland cement to provide a dependable barrier enables flexibility with industry supply chain challenges and delivers a more sustainable barrier solution.

NeoCem cement, NeoCem E+ cement, and EnviraCem cement systems are compatible with the extensive Halliburton portfolio of materials and additives. These reduced Portland systems require no specialized equipment to deploy, to provide an operational efficient and sustainable cement system.