

# Reduced Portland, High-Performance Systems

NEOCEM™ SYSTEM, NEOCEM™ E+ SYSTEM, AND ENVIRACEM™ SYSTEM

## 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 slurries that includes the NeoCem™ system, NeoCem™ E+ system, and EnviraCem™ system. These slurries contain less mass of Portland content compared to conventional designs. The reduction in Portland content helps customers lower carbon emission baselines and provides engineered systems with enhanced barrier performance.

**NeoCem System:** up to 50% reduction in mass Portland cement of blend
**NeoCem E+ System:** 50%-70% reduction in mass Portland cement of blend
**EnviraCem System:** 70% or greater 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

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## 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 systems can deliver a compressive strength-to-Young's-modulus ratio (CS/YM) greater than a higher density conventional cement system. Additionally, because the NeoCem system, NeoCem E+ system, and EnviraCem system are lower density slurries, 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 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. The NeoCem system, NeoCem E+ system, and EnviraCem system provide an increase in ductility and toughness compared to conventional systems. This improved flexibility enables our reduced Portland designs 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 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.

The NeoCem system, NeoCem E+ system, and EnviraCem system 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 barrier.