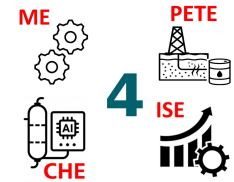


Co2 Resistant Geopolymer Cement for Oil & Gas Wells Applications

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Background

OPC cement has high CO₂ emissions and poor durability in CO₂-rich environments, limiting long-term well integrity. This project develops a CO₂-resistant geopolymer cement as a sustainable and durable alternative

Problem Statement

Oil and gas well cementing relies on OPC, which has high CO₂ emissions and poor durability in CO₂-rich environments. Under exposure, it degrades, causing strength loss, zonal isolation failure, and increased leakage risk.

Solution

A low-carbon, CO₂-resistant geopolymer cement from waste materials (Glass Fiber & Granite), designed for high strength, durability, and chemical stability in CO₂ environments with reduced emissions.

Optimal Sample	75% Glass Fiber	25% Granite Waste	NaOH Concentration 6 M
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Integrated CO2 Exposure & Geopolymer Cement Testing



Cement Samples: These samples are made from a geopolymer mix of Fly Ash, Glass Fiber, and Granite waste, and are tested under high-pressure CO₂ conditions.



CO₂ regulator : to control the gas pressure and ensure it does not exceed 1500 psi during the carbonation process



Pressure Vessel : used for CO₂ injection on cement samples under controlled pressure conditions.



Dashboard Monitor : OR model and SPC charts on the dashboard monitor process stability, variation, and sample feasibility.



Pressure Booster: CO₂ is supplied at ~800 psi. The booster increases pressure to 1500 psi while maintaining it in gas phase for carbonation.

Constraints

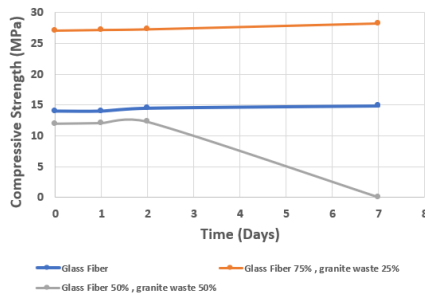
- API Standard compatible
- API RP 10B-2 testing (if applicable)
- Activator only if needed (NaOH 4–12 M; ratio 1–2)
- Cure at 27 ± 3 °C
- SPC monitoring

Specifications

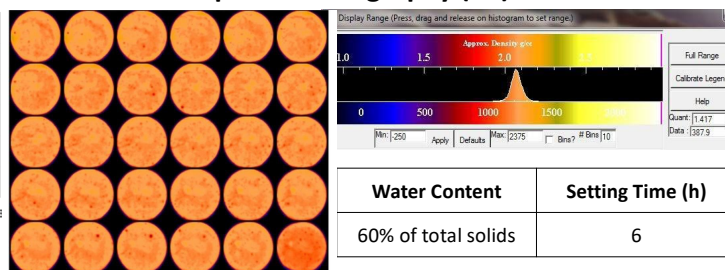
- Setting time: 4–6 h
- Density: 1.8 ± 1.0 g/cm³
- Mold: 4 inch - cylindrical steel
- SME ≈ 1 (mixing)
- Strength loss ≤ 15% after CO₂
- (water / solid) = 0.30–0.6
- Waste A ≥ 50% → 1-day strength ≥ 3.4 MPa
- Material waste ≤ 15% (initial mass)
- Inventory sufficiency ≥ 90%

Testing & Validation

Compressive Strength:



Computed Tomography (CT) Scan:



Conclusion

The CO₂-resistant geopolymer cement successfully met key performance requirements, including strength, density, and durability. It demonstrated stable and consistent performance, supported by effective process control and reduced variability through the application of SPC techniques.

Future Work

Future work will focus on evaluating long-term durability under real operating conditions, improving field-level optimization, and enabling industrial-scale implementation to further enhance sustainability and achieve greater reductions in CO₂ emissions.