NATIONAL RENEWABLE ENERGY LABORATORY

Castable Cement Can Prevent Molten-Salt Corrosion in CSP

Highlights in Research & Development

NREL's initial study identifies silica-based castable cements most capable of protecting internal metallic walls of tanks from molten chloride corrosion.

Concentrating solar power (CSP) technology often depends on molten salts to store and transport thermal energy from the sun during the day to generate electricity at night. Advanced high-temperature molten salts—chlorides and carbonates—are effective for next-generation CSP plants. But at these temperatures, they can corrode the internal metallic wall surfaces of tanks that contain them in the thermal energy storage subsystem. An NREL study indicates that certain castable cements can protect containment metallic alloys, increasing the performance of CSP and reducing costs.

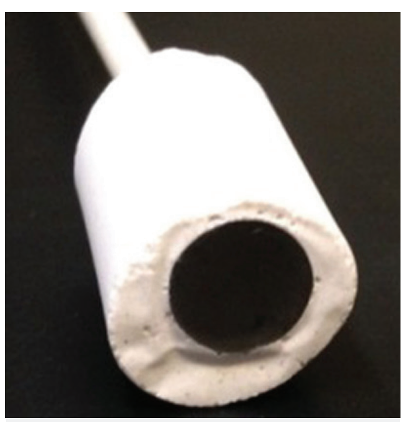
By using castable cements, exposed metal surfaces could potentially be repaired and CSP plant downtime minimized. This approach is similar to that used by the metal-production industry to protect metal containments and brick furnaces containing molten slag.

NREL researchers tested four different castable cements for chemical compatibility in several molten-salt mixtures. Some cement samples were painted or sprayed with a ceramic compound to block porosity in the cement. The most chemically stable configuration in the molten chloride was a silica-based cement with or without boron nitride (BN). The cements were not chemically stable in molten carbonates because the bonding components dissolved in the molten salt.

Cements that passed the chemical stability test were tested using electrochemical techniques with metallic samples (bare and encapsulated in cement) to determine the best configuration that prevented the salt from permeating the cement. The best-performing encapsulation configuration was BN spray on top of a silica-based cement.

Finally, NREL scientists used thermodynamic modeling of the degradation to identify possible reactions between the components of a silica-based castable cement, BN, sodium chloride, and lithium chloride. The cement and the BN film proved to be chemically stable in molten NaCl–LiCl.

The final study results show that silica-based castable cements can protect containment metallic alloys from the attack of molten chlorides at temperatures as high as 650 °C in short-term tests. In addition, BN is required to block the porosity of the cement (after curing) to prevent permeation of the molten chloride toward the metal surface.



Encapsulated stainless steel 347 cylinder.
Photo by Judith Gomez-Vidal.

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References: Gomez-Vidal, J.C.; E. Morton (2016). "Castable cements to prevent corrosion of metals in molten salts," *Solar Energy Materials and Solar Cells*, vol. 153, August 2016, pp 44–51.

Key Research Results

Achievement

NREL's study demonstrated that castable cements on metals are a protective barrier that can prevent permeation of molten salts toward metallic surfaces.

Key Result

The silica-based castable cement, when sprayed with boron nitride, can protect containment metallic alloys from attack by molten chlorides at high temperatures (650 °C) in short-term tests.

Potential Impact

Improved thermal energy storage technology could increase the performance of CSP and reduce costs, helping to reach the goal of the U.S. Department of Energy's SunShot Initiative to make solar cost-competitive with other non-renewable sources of electricity by 2020.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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