Continuous Particle Monitoring and Removal for Molten Salt CSP Systems (37369)

Monitoring and Managing Insoluble Particles in Molten Salt Heat Transfer Fluids to Prevent Abrasion-Related Failure

1. Impact

High temperature heat transfer fluids based on molten chloride salts are a crucial part of the Gen3 CSP program's effort to reduce the cost of concentrating solar power by $0.02 per kWh. This projects helps to ensure the viability of these salts by detecting and removing insoluble particles that would otherwise lead to the destruction of the CSP equipment.

2. Project Goals

The main goals are to (1) provide capabilities for the in-situ measurement of insoluble particles over a range from 0.1wt% up to 10 wt%, and (2) provide capabilities for the on-line removal of 90% of the particles that would otherwise abrade structural metals, seals, and bearings

3. Methods

Electrical resistance tomography (ERT) can provide high-fidelity measurements of the distribution of the particles. This approach is commonly used to detect particles in aqueous systems, but major advances are required to get the approach to work in high-conductivity, high-temperature, corrosive, molten salt environments.

Cyclonic separation is commonly used for particle separations in aqueous systems. Transitioning this approach to CSP-relevant conditions requires new designs because the insoluble MgO particles are generally small (< 50 µm) and have a density close to that of the $MgCl_2$-KCl-NaCl fluid (3.6 g/cm^2 vs. ~2.0 g/cm^2).

4. Outcomes

Insoluble MgO particles can be detected and quantified in $MgCl_2$-KCl-NaCl salts at loadings as low as 0.1 wt%. Pending flow system tests will ensure that the particles can be efficiently removed from the molten salt.

5. Conclusion/Risks

The technologies under development show great promise for monitoring and separating particles from molten salts. Scale-up and cost optimizations are necessary to ensure the successful industrial deployment of these systems.

6. Team

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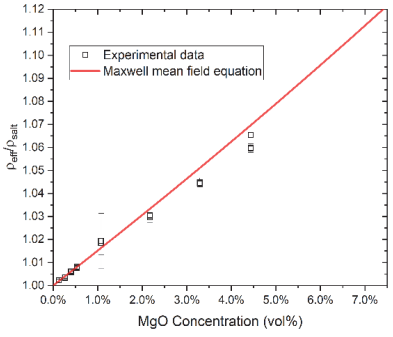


Figure 1. ERT sensor response as a function of MgO loading in $MgCl_2$-KCl-NaCl

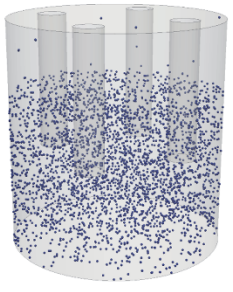
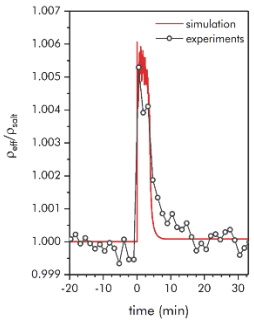


Figure 2. Comparison of experimental and simulation results for MgO particle settling experiment



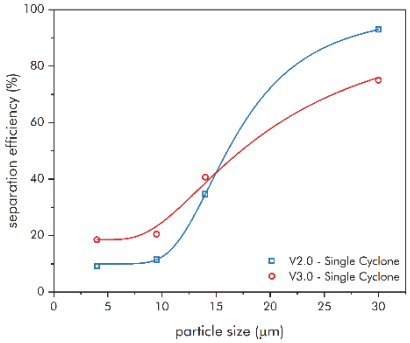


Figure 3. Separation efficiency of cyclone separator (aqueous test with surrogate particles)