Electrochemical Cell Mitigates Corrosion in Chloride Salts

1. Impact
This purification cell will substantially improve viability of molten chloride salt-based systems. It will decrease levelized cost of energy by enabling use of less-expensive containment alloys and will decrease maintenance costs. This will be a step toward reaching the goal of 5¢/kWh.

2. Project Goal
Molten chloride salts are stable at the higher temperatures desired for Gen3 CSP (500–750 °C) but are extremely corrosive. The species MgOHCl, which forms when MgCl₂ reacts with moisture, is responsible for much of this corrosion. We have developed an electrochemical method for removal of MgOHCl. In this project, we will build a lab-scale purification cell to demonstrate this concept under flowing conditions.

3. Method(s)
Corrosive MgOH⁺ is reduced at the cathode to solid MgO—which can be filtered out of the salt—and H₂ gas—which is swept out with the ullage gas. At the anode, Mg²⁺ dissolves into the salt, recombining with Cl⁻ from reduced MgOHCl so there is no net removal of MgCl₂.

4. Outcome(s)
The concept of electrochemical removal of MgOHCl has been demonstrated in a lab-scale batch reactor. We showed that MgOHCl content can be reduced from 1 wt.% to >0.1 wt.%. This purification took ~30 min, as the rate of purification was limited by mass transfer.

5. Conclusion/Risks
We have demonstrated that our method can be utilized to remove MgOHCl from molten chloride salts. However, because we have learned that purification rate is mass-transfer limited, we will evaluate kinetics of purification under flowing conditions. In the next phase of the project, we will consider methods for removal of purification byproducts (MgO and H₂) in more detail.

6. Team
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Figure 1. (Left) Illustration of the reactions occurring at anode and cathode of the electrochemical purification cell. (Right) Illustration of possible geometry of electrochemical purification flow cell.