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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 $MgCl_2$ 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 H_2 gas—which is swept out with the ullage gas. At the anode, Mg^{2+} dissolves into the salt, recombining with Cl^- from reduced MgOHCl so there is no net removal of $MgCl_2$.

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 H_2) in more detail.

6. Team

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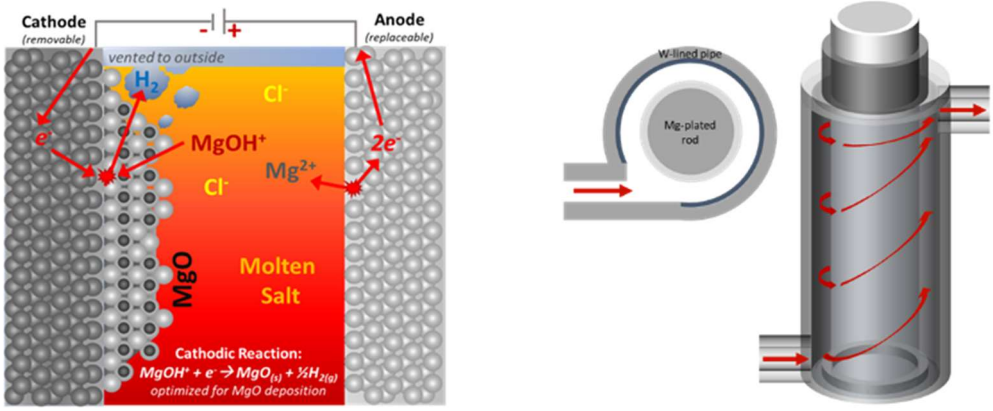

Figure 1. (Left) Illustration of the reactions occurring at anode and cathode of the electrochemical purification cell. (Right) Illustration of possible geometry of electrochemical purification flow cell.