Analysis of the impurity MgOHCl in molten chloride salts toward its electrochemical removal from CSP plants during operation

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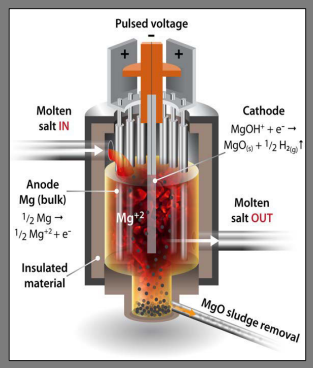
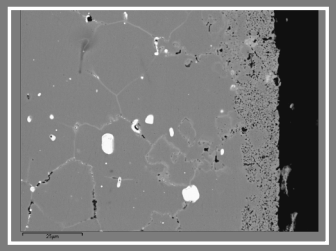
Project Summary

Formed when molten chloride salts are exposed to air and moisture, MgOHCl causes significant corrosion of containment alloys. Therefore, we have evaluated the physical and electrochemical properties of MgOHCl in molten chloride salts. These properties include kinetics of MgOHCl formation, diffusion of $MgOH^+$, and electrochemical behavior of $MgOH^+$. An understanding of these properties will inform future efforts to design an electrochemical purification cell capable of removing the species from chloride salts.

Project Impacts

- We will be able to predict how much MgOHCl will form in molten chloride salt-based 3rd Generation Concentrated Solar Power (Gen3 CSP) plants under operating conditions
- We will be able to design electrochemical solutions for removal of MgOHCl from Gen3 CSP plants during operation using a small amount of electricity generated *in-situ*
- Removing this corrosive impurity will prevent containment alloy corrosion, making molten chloride salt use more feasible
- Removing corrosive MgOHCl may facilitate use of less expensive containment alloys, contributing to cost-reduction goals

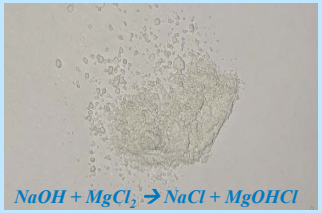




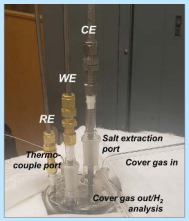
Above: Scanning electron microscope image of molten chloride salt corrosion on Haynes 230 coupons

Right: Schematic of a possible design for an electrochemical purification cell for removal of corrosive MgOHCl from molten chloride salt

Progress



Developed a method for introducing a known amount of MgOHCl (shown above) to molten chloride salts via addition of NaOH

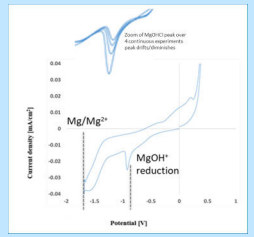


CE = *Magnesium counter electrode*

WE = *Tungsten working electrode*

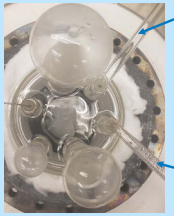
RE = *Tungsten quasi-reference electrode*

Designed an electrochemical cell capable of assessing physical and electrochemical properties of MgOHCl in molten salt

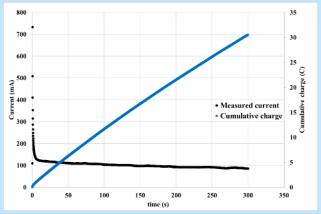


Conducted Cyclic Voltammetry (CV) studies to determine concentration of $MgOH^+$ and study its diffusion

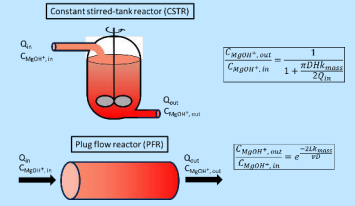
Current Work



Performing kinetic studies to find rate of formation of MgOHCl in molten salt when exposed to H_2O



Performing bulk electrolysis of MgOHCl and assessing kinetics of removal by CV, titration of salt, and evolution of H_2



Using kinetic data to inform engineering design for electrochemical purification cell to remove MgOHCl from Gen3 CSP plants

Planned Outcomes

- Develop an understanding of the kinetics of MgOHCl formation in molten salts to understand the corrosion risk posed by air and moisture ingress in CSP plants
- Evaluate physical properties of MgOHCl in molten chloride salts, especially mass-transport properties
- Determine kinetics of electrochemical removal of MgOHCl from molten chloride salts
- Design a purification cell capable of removing the MgOHCl that can be expected to form in Gen3 CSP plants during operation based on kinetics of MgOHCl formation.

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