Tribology and Purification of Molten Chloride Salts

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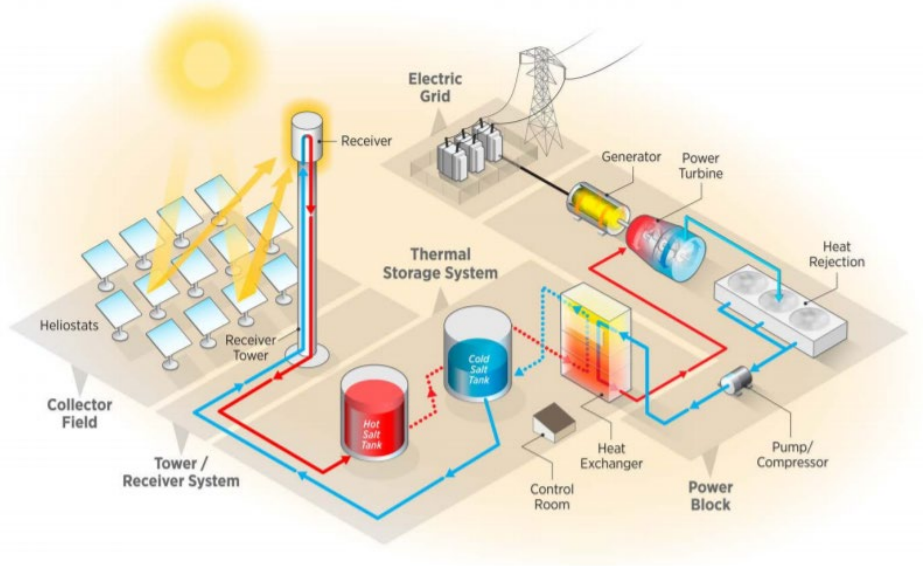
Background

Current Concentrated Solar Power (CSP)

The Thermal Energy Storage (TES) capability of CSP systems increase capacity, reliability and stability while also allowing power arbitrage attributes to the electrical grid. Current nitrate salt CSP systems use towers integrated with 2-tank, molten-salt TES, delivering thermal energy at 565 °C for integration with conventional steam-Rankine power cycles.



source: energy.gov/solar-office

- The Department of Energy (DOE) seeks to increase the efficiency of CSP plants to >50% cycle efficiency requiring operating temperatures >700°C.
- The nitrate salts currently used become unstable at temperatures above 600°C.
- Ternary chloride salts, consisting of MgCl2-KCl-NaCl, were selected as the most promising high-temperature molten salts for Gen3 CSP systems due to their desirable thermophysical properties (higher thermal stability limit, relatively low melting point, high thermal conductivity, high heat capacity).
- The elevated temperatures needed and corrosion mechanisms of the chloride salts present challenges to material selection for system component design.

Salt Purification

Raw MgCl2-KCl salt

Particles caught by filter (left) purified and filtered salt (right)

	Salt Components (wt. %)		
	$MgCl_2$	KCl	NaCl
Target Composition	45.98	38.91	15.11
Purification Results ICP-OES	43.44	38.41	18.15

- The proposed chloride salt for Gen3 CSP systems is mined from the Dead Sea and has many impurities present in it.
- Impurities in the salt, such as MgOHCl increase the corrosivity of the chloride salts.
- Thermochemical purification of the salt can help remove these impurities from the salt prior to introducing the salt to a system.
- Continued electrochemical purification of the salt has been proposed as a method of keeping impurity levels low while flowing through a system.
- Filtration of the salt removes small particles that could damage system components.

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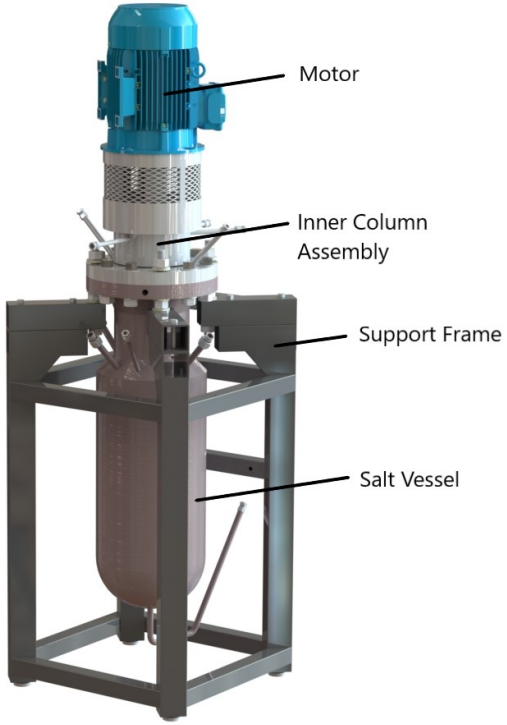
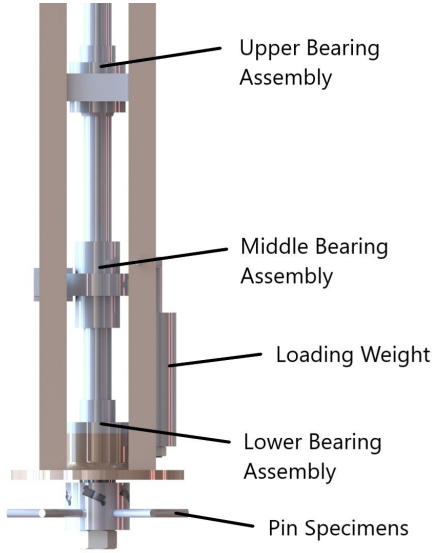
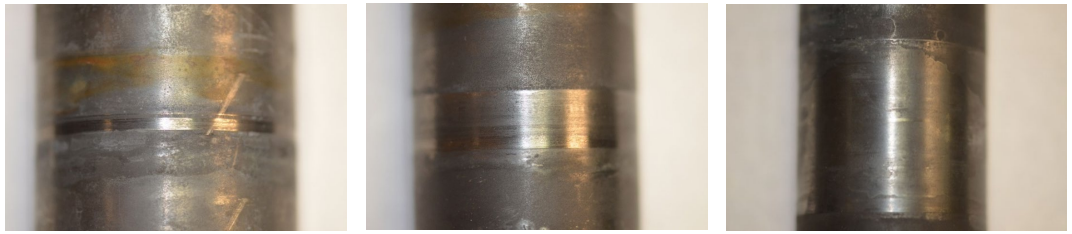
Tribology Testing





Inner column assembly



NiWC-coated Shaft Sleeves

NiWC alloys, developed by Powdermet, have been found to display high corrosion and wear resistance in ternary salts during baseline material testing.

To evaluate wear and erosion rates of NiWC pump components (i.e., bearings and impellers) in ternary chloride salt, a tribology test bed was designed with the capabilities of testing three journal bearings, three shaft sleeves, and five pin specimens, submerged in molten salt.