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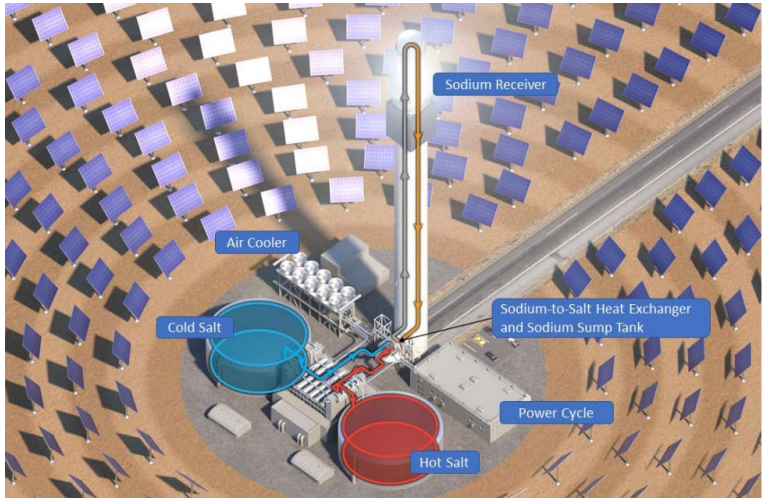
Molten Salt Pump Development for Solar and Nuclear Power Systems

MOTIVATION

The need to further develop alternative energy systems to reduce the carbon footprint has led to the Department of Energy's new initiatives which include exploring the next generation of CSP systems (CSP Gen3) which aim to achieve 50% efficiency from heat to electricity, and developing advanced nuclear molten salt reactors (MSR) concepts for improved safety and economics.



CSP Gen3 System Design

Sulzer VEY Pump design cross section

CHALLENGES

With higher temperatures and use of molten salts, there are several engineering challenges that need to be overcome. A few of the crucial areas are:

- Evaluation and selection of the molten salts of interest for both industries by evaluation of the thermophysical properties (e.g. $MgCl_2$-KCl-NaCl, FLiNaK, FLiBe).
- Characterization of the corrosion and integrity of suitable materials for the high temperature operating regime (up to 750 C). Some of these materials feature High-nickel alloys (e.g. Inconel 625) and ultra-high toughness cermet materials.
- Evaluation of the novel ultra-high toughness cermet materials as coatings and for use in molten salt pump impellers, seals, and bearings.
- Development of pumps concepts, salt purification, and filtering systems for plant operation.

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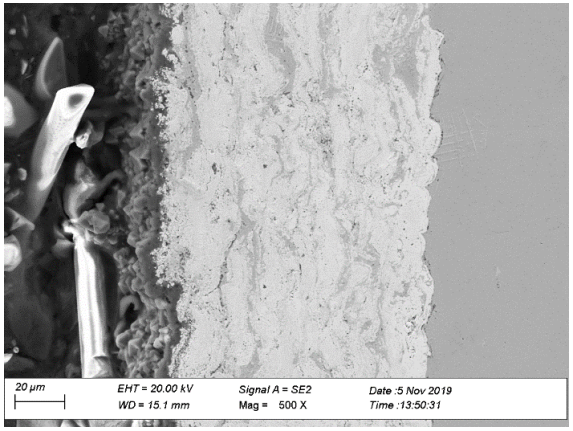
PROJECT OBJECTIVES

- Tribology testing to evaluate the friction, lubrication, and wear of the different materials of interest in molten salt over a range of temperatures, speeds and loads of interest.
- Evaluate materials compatibility of cermets, SmCo magnets and ceramic coated wire in molten salts.
- Test down-selected wetted bearing materials in a prototypic pump configuration for durations of up to 500 hours.
- Develop advanced pump design concepts with high wetted cermet bearings, high temperature magnets and advanced ceramic coated wire. Construct and test on existing molten salt loop.
- 5. Develop in-situ pump inspection techniques and pump health monitoring strategies to minimize O&M outages due to pump failures.

Stage sleeve and bushing with evidence of galling & rubbing post molten salt testing.



SEM imaging on cross section of coated HVOF NiWC3 cermet alloy.