Chemically Reactive Working Fluids for the Capture and Transport of Concentrated Solar Thermal Energy for Power Generation

Argonne National Laboratory

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PROJECT OBJECTIVES

Goal: Demonstrate feasibility of employing chemically reacting fluids (CRFW) as heat transfer fluids (HTF) for CSP systems operating at 650°C–1200°C.

- *CRWFs will enable energy to be transmitted at higher temperature, to produce more power per unit solar energy absorbed – greater exergy*

Innovation: The capture and transfer of solar energy as chemical energy in-addition-to sensible and latent heat enables heat transfer between 650°C and 1200°C, at pressure below 160-bar, to produce more power/unit mass of working fluid per unit solar energy absorbed.

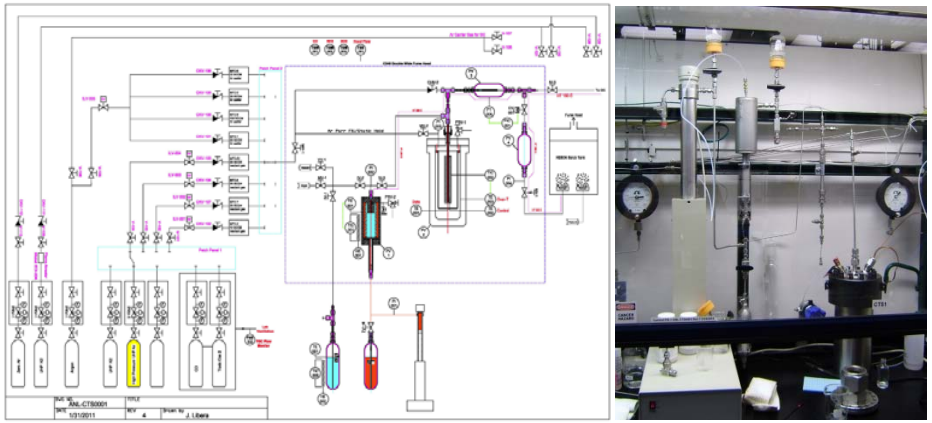
- *Conventional HTF either decompose above 400℃ (and can not be easily regenerated, or are salts that are solids below ~ 230℃ and can not be pumped. Superheated steam is limited to ~360℃ and 70 bars – a saturation T of 165℃ only allows heat to be available below 165℃.*

Milestones: Base-line 5 CRWF candidates

APPROACH

- Thermodynamic and process simulations conducted using Aspen Plus®, combined with published kinetic data, identified 5 CRWF candidates and process windows that enable reversible reactions, which efficiently recover CSP heat for power generation at temperatures in the range of 650°C-1200°C.
- Develop and construct CRWF reactor system.
- Conduct base-line CRWF testing for 5 candidate systems.

KEY RESULTS AND OUTCOMES



- *Reactor test system designed (PID on left) and built (on right)*

NEXT MILESTONES

- Evaluate the following for each CRWF candidate
  - composition of CRWF reactive products at steady-state conditions
  - chemical compatibility of reactor materials with CRWF reaction products and the need for a protective coating
  - need for a catalyst to decrease residence time in the regeneration reactor - rank-ordered list of useful catalysts prepared by evaluating the figure of merit for each catalyst
- Establish an industrial or commercial partnership/engagement to focus scale-up activity for commercial application.