High-Efficiency Thermal Energy Storage System for CSP

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PROJECT OBJECTIVES

Goal: The goal of this proof-of-concept project is to develop an efficient high temperature lab-scale thermal energy storage (TES) prototype by utilizing phase change materials (PCMs) in combination with new, high conductivity graphite foams.

Ultra-high thermal conductivity, low-density graphite foams will be impregnated with a PCM of a high specific latent heat of fusion, thereby, offering a combined system with thermal conductivities significantly greater than the PCM alone. This system will allow for quick, even distribution of thermal energy into the PCM, resulting in rapid charge/discharge cycles as well as full utilization of the PCM volume (i.e., no dead zones).

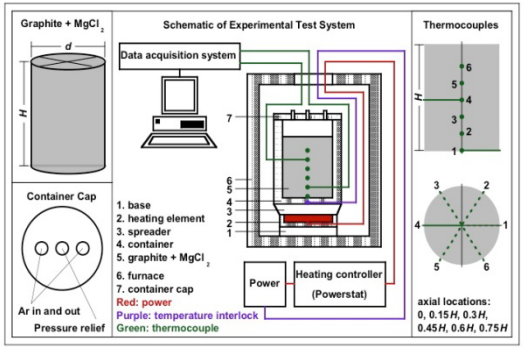
The laboratory scale prototype TES system will be built and tested with the purpose of gathering performance data.

Milestones: Laboratory scale prototype design and preliminary cost analysis of the proposed TES system completed.

APPROACH

- Thermal modeling will be conducted to establish the benefits of using a high thermal conducting graphite foams in conjunction with PCM and to develop a design for a laboratory scale prototype.
- Variety of characterizations will be carried out to qualify the materials (PCMs, alloys, coatings) for the prototype construction.
- Process to infiltrate selected PCM into the foam will be developed.
- Using the appropriate brazing/joining techniques, prototype will be assembled.
- Performance testing of the TES system prototype to ensure a full-scale system will meet the SunShot goals.

KEY RESULTS AND OUTCOMES



Schematic of the lab test system

- Preliminary cost analysis shows the storage system costs should meet the target of $15/kW$_{th}$

- Lab scale prototype test system design complete
- COMSOL 2-D modeling of melt front movement agrees well with the 1-D solution
- Silicon carbide coated graphite foam shows negligible oxidation for tests in static argon environment up to 900°C

High thermal conductive foam will lead to rapid charge/discharge cycles

NEXT MILESTONES

- Develop SiC coating using poly-carbosilanes for graphite foam and coat scaled-up samples
- Complete mechanical and thermal characterization tests comparing uncoated and coated foam specimens (e.g., strength, thermal diffusivity, oxidation)
- Complete 3-D modeling of the TES system