Dish Stirling High Performance Thermal Storage

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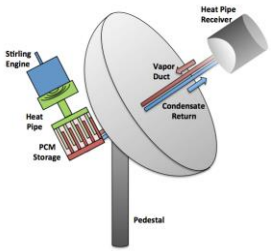
PROJECT OBJECTIVES

Goal:

- Demonstrate the feasibility of significant thermal storage for dish Stirling systems to leverage their existing high performance to greater capacity
- Demonstrate key components of a latent storage and transport system enabling on-dish storage with low exergy losses
- Provide a technology path to a 25kW$_e$ system with 6 hours of storage

Innovation:

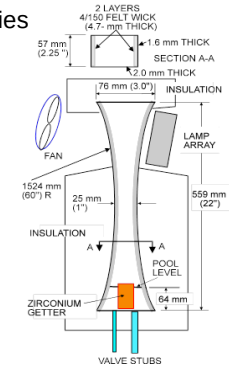
- Leverage high performance heat pipes to support feasible system layout
- Develop and test high temperature, high performance PCM storage
- Optimize storage configuration for cost and exergy performance
- Latent storage *and* transport matches Stirling cycle isothermal input[1]



[1]Andraka, C.E., Rawlinson, K.S., Siegel, N.P., "Technical Feasibility of Storage on Large Dish Stirling Systems," Sandia report SAND2012-8352 (2012).

APPROACH

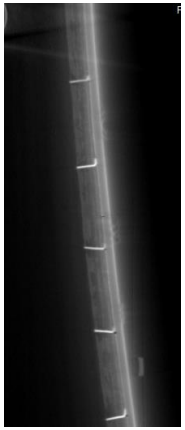
- PCM development and selection
  - Literature searches and modeling to develop candidate eutectics
  - Sample fabrication and characterization to develop properties
  - Modeling of compatibility with potential containment
  - Long-term testing of compatibility
- PCM Compatibility enhancement
  - Identify and develop or optimize coating chemistries to protect containment materials
  - Short-term and long-term compatibility exposure testing
  - Compatibility coating development and testing
- Heat Pipe
  - Felt wick enhancements for robust high performance[2]
  - Long-term performance and durability testing
- Proof-of-concept hardware subscale demonstration



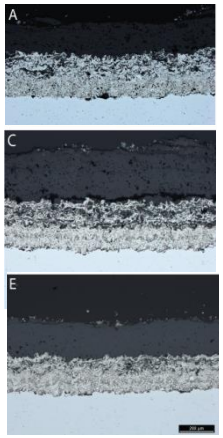
[2]Baturkin, V., Vladilen Zaripov, Charles E. Andraka "Development of Advanced Capillary Porous Structures of High Temperature Heat Pipes for Solar Receivers for Dish/Stirling Systems," Proc. 14th international heat Pipe Conference (14th IHPC).

Q4 KEY RESULTS AND OUTCOMES

- Heat pipe advanced wick
  - Over 1800 hours of operation on a robust high performance wick
  - X-ray analysis at 1000 hours indicates no loss of wick thickness
- Compatibility studies
  - Seven new ceramic coatings were exposed to PCM for 150 hour acute compatibility testing
  - Optical microscopy indicates high likelihood of success with3 ceramic coatings
  - 500-hour exposure test initiated to downselect coating for integrated system



Heat pipe wick X-ray shows support pins and no loss of thickness



Micrographs of 3 successful ceramic coatings

NEXT QUARTER

Heat pipe advanced wick development

- Complete 3500 hours of wick operation at representative operating conditions
- Confirm lack of wick compression with x-ray analysis at 2500 hours

Coating development and PCM compatibility

- Complete 500 hour coating exposure to melted PCM and analyze for interactions
- Downselect 1-3 coatings for long-term testing
- Downselect 1 coating for integrated storage test unit
- Begin long term (20k hour) PCM exposure testing with selected coatings and methods
- Complete design of integrated thermal storage test unit

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