Supercritical Carbon Dioxide Turbo-Expander and Heat Exchangers

Southwest Research Institute, General Electric, Thar

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PROJECT OBJECTIVES

Goal:

- To develop a novel, high-efficiency sCO_2 hot gas turbo-expander optimized for the highly transient solar power plant duty cycle profile.
- To optimize novel printed circuit heat exchangers for sCO_2 applications to drastically reduce their manufacturing costs.

Innovation: This MW-scale sCO_2 turbo-expander is a leap-step in sCO_2 turbo machinery technology and advances the state-of-the-art of sCO_2 turbo-expanders from TRL3 to TRL6. The sCO_2 expander and heat exchanger close two critical technology gaps and provide a stepping stone to achieving CSP power at $0.06/kW-hr LCOE, increasing energy conversion efficiency to >50%, and reducing total power block cost to <$1,200/kW installed.

Milestones:

- Finalize heat exchanger requirements and fabricate test articles
- Evaluate concepts for turbo machinery
- Finalize requirements for test loop

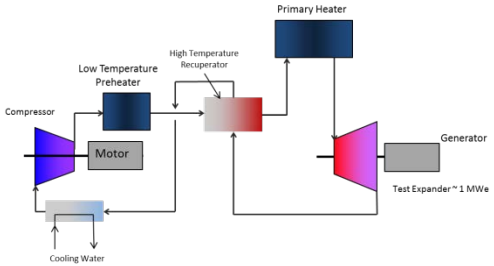
APPROACH

- To accomplish the stated objectives, the work will be divided into three phases that emulate the development process from TRL3 to TRL6.
- Phase I is expected to last 18 months during which the turbo-expander and heat exchangers will be designed, and all engineering analysis and modeling will be conducted
- Phase II will focus solely on fabrication and commissioning of the test loop and integration with the heat exchanger and turbo expander. This phase is expected to last 12 months.
- Phase III will be dedicated to testing and will also last 12 months. The performance and endurance of both main components will be documented to ensure they meet the operational requirements set during Phase I. Based on the test results, the final design will be optimized to meet all related goals, such as cost and efficiency.

KEY RESULTS AND OUTCOMES

- A first prototype of the heat exchanger was fabricated and is ready for bench-scale testing.

- Several high- and low-speed configurations were discussed. Some were discarded owing to their complexity. The rest will be further studied.
- Thermodynamic analysis of the test loop was completed and requirements were determined.



NEXT MILESTONES

- Material selection and manufacturing techniques will be finalized for the heat exchangers – TBC 1/31/2013
- A smaller proof-of-concept heat exchanger will be tested to verify its performance – Ongoing through 8/12/2013
- Steady and transient aerodynamic 1-D flow analysis – TBC 2/28/2013
- Turbomachinery component general layout – TBC 2/28/2013
- Design P&ID for turbo-expander test loop – TBC 1/31/2013
- Design test loop layout and identify integration into existing infrastructure – Ongoing through 8/9/2013