High-Efficiency Low-Cost Solar Receiver for Use in a Supercritical CO_2 Recompression Cycle

Brayton Energy, LLC

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PROJECT OBJECTIVES

Goal:

- High performance supercritical carbon dioxide (S-CO_2) Brayton-cycle engines are currently under development and promise to significantly reduce LCOE via high cycle efficiency.
- The proposed receiver uses S-CO_2 as the heat transfer fluid, enabling these highly efficient engines to be used in concentrated solar power (CSP) applications.

Innovation:

- A solar receiver adapted to the S-CO_2 recompression cycle represents a major advancement in technology over the state-of-the-art in CSP systems, and will contribute directly to the SunShot goal of 6¢/kW-hr.

Quarterly Milestones (in progress):

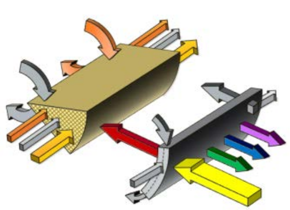
- Define an S-CO_2 Brayton Engine Cycle Model that can be used to specify receiver statepoints (initial specification received)

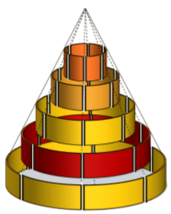
APPROACH

- Numerical Modeling is used to capture the highly nonlinear physical properties of S-CO_2 within the highly-effective enhanced heat transfer. region, where fluid temperature is changing rapidly
- Manufacturing Trials are used to demonstrate reliable methods for fabricating the enhanced heat transfer surfaces that will reside within the high-flux environment of the receiver
- Historical Data from a baseline installation location will be used to provide a year-long solar profile which feeds into the overall performance model to produce an annualized performance metric
- Subcomponents will undergo simulated operating conditions in test rigs to demonstrate their suitability and performance
- Ultimately a prototype receiver will be tested on sun in a power-tower application to demonstrate the full receiver system performance

KEY RESULTS AND OUTCOMES

- Preliminary SCO2 cycle statepoints received from one OEM, other forthcoming.
- Extended Heat Transfer Absorber Surface Numerical Model complete except for inclusion of thermal losses to ambient.
- Plate/Wire-mesh assemblies produced successfully, surface preparation defined
- Conservative wire-mesh coupons demonstrated exceptional burst strengths
- Cost model structure completed, with cost and rate information being applied and documented; currently awaiting receiver architecture
- Initial modifications of hot rig (unit performance and transient thermo-mechanical effects, long-term exposure and cyclic-pressure fatigue) completed





NEXT MILESTONES

- An S-CO2 Brayton Engine Cycle that will provide the baseline statepoints which will guide the design the receiver (28 Feb 2013)
  - RISK: Modeling assumptions used to produce statepoints are currently inconsistent between OEMs, introducing uncertainty
    - MITIGATION: Reconcile and align OEM assumptions
- EST cost model indicating ≤ $\$30/kW_{th}$ in high-volume production. (28 Feb 2013)
  - RISK: Final cavity configuration not defined
    - MITIGATION: Completed model readied and prepared for forthcoming inputs
  - RISK: Cost or Rate information not received, accurate, and/or updated
    - MITIGATION: Continue to track and document assumptions
- Cavity shape that maintains peak tube wall temperatures below 850°C and heat transfer fluid exit temperature ≥ 750°C. (30 June 2013)
  - RISK: Solar Field Input not fully defined
    - MITIGATION: Brayton to apply external and cavity receiver compatible fields in parallel until final down-select applied
    - MITIGATION: Apply simplified Brayton Partner and Google optical models as reference for down-select studies