Direct s-CO_2 Receiver Development

National Renewable Energy Laboratory

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PROJECT OBJECTIVES

Goal: Develop a high-temperature (650°C), high-efficiency (>90%) power tower receiver using supercritical CO_2 directly as the heat transfer fluid

- *Direct interface with turbine enhances system performance*
- *Fluid stability simplifies receiver design*

Innovation: Advances in supercritical CO_2 power cycles have caused demand for new, higher-temperature receiver designs.

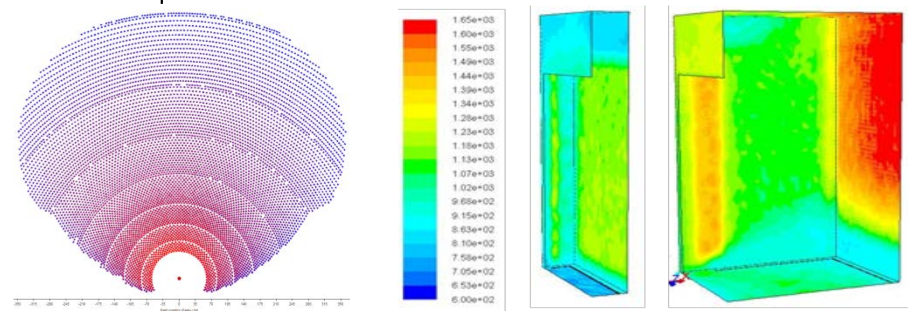
- *This project uses novel cycle configurations[1] and advances in heat exchanger technology[2] to meet the SunShot cost and performance targets*

Milestones: No milestones this quarter

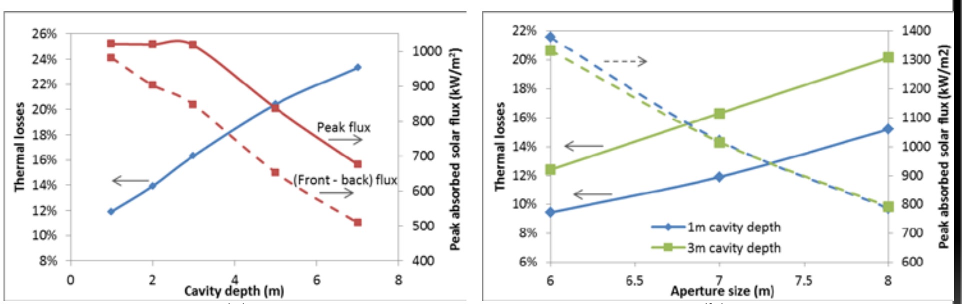
[1]Turchi, C. S., Ma, Z., Neises, T., & Wagner, M. J. (2012).
[2]Li, Q., Flamant, G., Yuan, X., Neveu, P., & Luo, L. (2011).

APPROACH

- Initial work focused on characterizing receiver thermal performance, solar field requirements
- Geometry optimization reduces thermal loss and material strain
- Key parameters for receiver optimization identified, including
    - Flux variability
    - Passive surface minimization
    - Aperture dimensions



KEY RESULTS AND OUTCOMES



(a) (b)

Thermal losses and peak absorbed solar flux as a function of (a) cavity depth with a 7m x 7m aperture and (b) aperture size with a cavity depth of 1m or 3m. Results show reduced cavity depth improves performance for fixed absorber area, and reduced aperture improves performance but also increases peak flux.

- Direct receiver shows promise for reaching efficiency target
- More work needed to address peak flux target of ~800 kW/m^2

NEXT MILESTONES

- *No milestones planned for completion in Q2*
- Continue to work towards demonstrating at least 85% thermal efficiency for receiver operating with 650°C outlet temperature (scheduled for July 2013)
- Work to date has demonstrated this efficiency as feasible. Additional analysis will work to:
    - Remove flux model simplifications
    - Improve geometry optimization
    - Use lessons learned to improve fundamental design
- Project risk is reduced through flexibility in design options