On-Sun Testing of a Novel High-Temperature Bladed Gas Receiver and Validation Using CFD (CSP-1)

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Scientific Achievement:

A solar thermal receiver capable of heating sCO_2 was constructed and tested on-sun (Fig. 1). Preliminary tests using air show that the novel bladed receiver design absorbs more sunlight than conventional flat-panel receivers. The tests were validated using coupled modeling (optical/thermal/fluid).

Significance and Impact:

A solar receiver capable of delivering sCO_2 at high pressures (~20 MPa) and temperatures (~700°C) must be developed to enable a high-efficiency (~50%) sCO_2 Brayton cycle. This work will make CSP technologies more cost competitive.

Fig. 1. On-sun testing of the bladed receiver design at the National Solar Thermal Test Facility, Sandia National Laboratories, USA.

Research Details:

- A novel bladed receiver configuration intended to trap more incident sunlight was tested using banks of compressed bottles to prolong the test duration (Fig. 2, left)
- A unique flow pattern (Fig. 2, right) was employed to increase heat transfer to the fluid, reduce thermal emissivity, and avoid hotspots.
- The experiment and computation results showed satisfactory agreement for air, and the design can be used with sCO_2 to yield high receiver thermal efficiency.

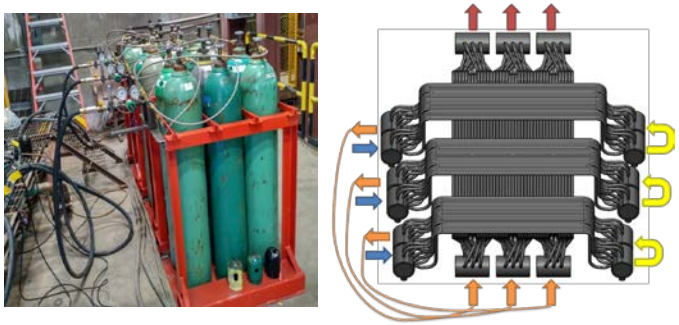

Fig 2. Left: Three sets of six bottles that supply flow through the sections of the receiver. **Right:** Bladed receiver flow path.

Publications:

- Ortega, J.D., Khivsara, S.D., Christian, J.M., Dutta, P., Ho, C.K., 2018, On-Sun Testing of a High Temperature Bladed Solar Receiver and Transient Efficiency Evaluation Using Air, Proceedings of the ASME 2018 Power & Energy Conference & Exhibition, PowerEnergy2018, Lake Buena Vista, FL, June 24–28, 2018.
- Khivsara, S.D., Ortega, J.D., Dutta, P., Christian, J.M., Ho, C.K., 2018, Computational Modeling of a High Temperature Bladed Solar Receiver With Air as the Heat Transfer Fluid, 5th International Conference on Computational Methods for Thermal Problems, Bangalore, India, July 9–11, 2018.

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