

IISc's Khivsara Studies s-CO₂ Receiver at Sandia as SERIUS Visiting Scholar

Sagar Khivsara, from the Indian Institute of Science (IISc), Bangalore, worked with the Sandia National Laboratories (SNL) SERIUS team to model and analyze a directly heated supercritical carbon dioxide (s-CO₂) receiver being developed as a part of the SERIUS CSP-1 project, "High-Temperature Receiver for CO₂ Cycle." His work, from October 2 through December 12, 2014, was carried out as part of the SERIUS Visiting Scholars Program.

Sagar and his team used SolTrace to model the receiver geometry and heliostat field at the National Solar Thermal Test Facility. The heat flux map from this optical modeling was modified using a Matlab code and then mapped as a boundary condition in ANSYS Fluent for thermal fluid analysis. An accurate and realistic simulation is the result of the direct mapping of the actual flux distribution from a heliostat field (unique to the current work) and real-time updating of the thermophysical properties by linking Fluent with the NIST database REFPROP. Further work on the proposed receiver includes parametric studies for s-CO₂ flow parameters, receiver geometries, and radiation absorption by s-CO₂.



The Sandia/IISc SERIUS team. From left to right: Jesus Ortega, Sagar Khivsara, Josh Christian, and Cliff Ho.

In addition to the above analysis, the team prepared a document to serve as a reference for design and testing requirements for future s-CO₂ receiver efforts. It identifies the key technical challenges and provides guidelines in six main categories: 1) operation and safety, 2) materials and manufacturing, 3) instrumentation, 4) maintenance, 5) environmental requirements, and 6) general requirements. This document also provides computational modeling recommendations and input parameters for computational fluid dynamics and structural analyses that use commercial tools such as ANSYS Fluent, ANSYS Mechanical, and nCode DesignLife.

Along with other Sandia scientists, Sagar is co-authoring two papers on the above work to be submitted to the 2015 ASME Power & Energy Conference. He also worked with SNL's Dr. Cliff Ho and with Prof. Pradip Dutta and Dr. Vinod Srinivasan, both from IISc, who visited SNL in November 2014. They developed a concept paper that outlines a proposal for the DOE CSP APOLLO funding opportunity. In this paper, Sagar and his colleagues described a novel s-CO₂ receiver design, as well as identifying the anticipated impact and the technical risks and challenges.

MIT's Mueller and Orosz Find Great Value in In-Person, Cross-Thrust Discussions

Matt Orosz and Amy Mueller, both post-doctoral researchers at the Massachusetts Institute of Technology (MIT), spent 10 weeks during the summer of 2014 at the Indian Institute of Science (IISc), Bangalore, working on the SERIUS CSP-4 project, "Small-Scale Positive-Displacement Organic Rankine Cycle Expander." They identified prospective research topics with researchers at IISc, the Center for Study of Science, Technology and Policy (CSTEP), Thermax, and the Indian Institute of Technology-Bombay (IIT-B). One of the important outcomes of the exchange included plans for the three SERIUS India-US joint publications over the next year between collaborators from IISc, CSTEP, and MIT.

Amy found that her fellowship tenure as part of the MAGEEP experience was of particular value. She shares that "it provided opportunities to interact very directly and consistently with researchers at all of the partner institutions in India. Frank discussions—which included identifying open questions and areas of shared interest—were enabled in a way that's simply not possible during monthly teleconferences."

One reason that such conversations were possible was because individuals from so many thrust areas were brought together to join the discussion—something that is notably lost under the current thrust-by-thrust telecon meetings. However, Amy thinks there was more, "There was an additional level of enthusiasm, motivation, and context provided by sharing across the integrated project vision that pushed everyone to think about their own projects in a new light."



Researchers from MIT, IISc, IIT-B, and CSTEP at the Thermax CSP plant in Shive near Pune (India).

Amy also stated that the three hours spent speaking with researchers at CSTEP expanded her understanding of the energy context in India almost exponentially. "CSTEP experts have an impressive breadth and depth of understanding of the market demands, regulatory structure, and existing infrastructure. And their ability and willingness to answer a long list of questions was incredibly helpful."

This meeting alone was a significant milestone toward contextualizing the work being done under CSP-4, and Amy is looking forward to following up on the work required to answer the open questions identified at this meeting.