Advanced Characterization of Particulate Flows for CSP 08372

The first comprehensive characterization of CSP particulate heat transfer properties and flows at temperature

1. Impact

Significantly advancing the state-of-the-art in CSP coupled to particle-based solar thermal energy storage (TES) with fundamental characterization and heat and mass transfer modeling and experimentation to inform the next generation of solar receiver/reactor designs and enabling improvements to the LCOE of CSP.

2. Project Goal

To address a serious gap related to the fundamental understanding of flow behavior and heat and mass transfer for particle-based TES and to disseminate results to CSP researchers around the world.

3. Method(s)

Fundamental experimental measurements are conducted to determine flow and radiative heat transfer properties of different granular materials for TES. Physics-based models are then employed to characterize flow and heat transfer behavior of complex granular flows. Simplified flow experiments are performed across a range of temperatures to verify predicted granular flow behaviors from different models.

4. Outcomes

Temperature-dependent flow properties and volume-averaged radiative heat transfer properties have been measured and disseminated for the first time. These form the basis for characterizing granular flows and inform first of their kind heat transfer models which have been constructed, evaluated, and experimentally validated at temperatures up to 800 °C.

5. Conclusion/Risks

Fundamental flow and radiative heat transfer properties significantly impact granular flow and heat transfer characteristics. The flow properties are highly dependent on the particle temperature, which must be considered in all aspects of solar reactor/receiver designs to accurately capture the relevant physics at scale.

6. Team

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Visuals

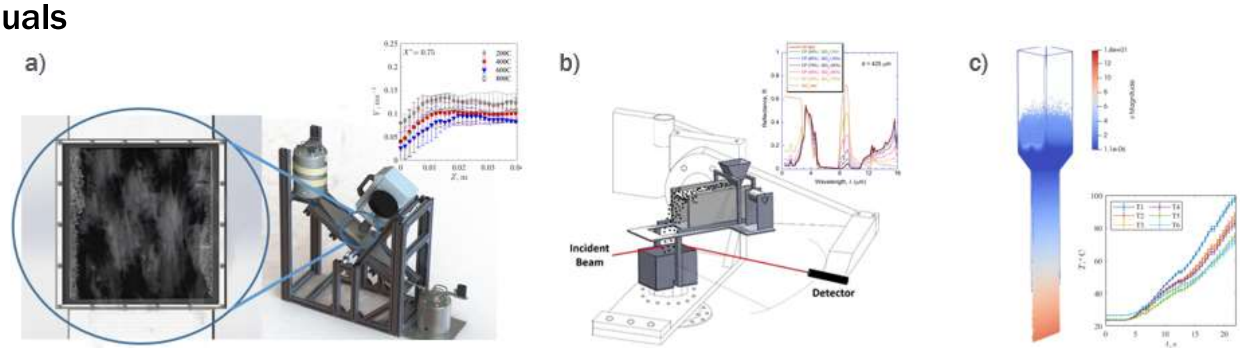

Figure 1. Schematic of the(a) tilt-flow, (b) radiative scattering and (c) vertical-plate test stands used to measure particle properties and validate flow and heat and mass transfer models.