Simulation of Thermocline Formation in an Experimental Molten-Salt Energy Storage System for Concentrating Solar Power Applications (CSP-5)

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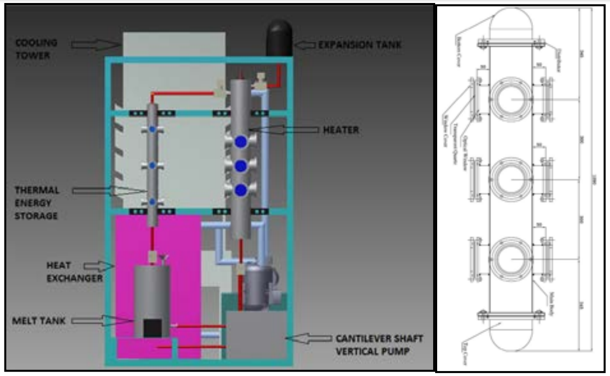
Scientific Achievement:

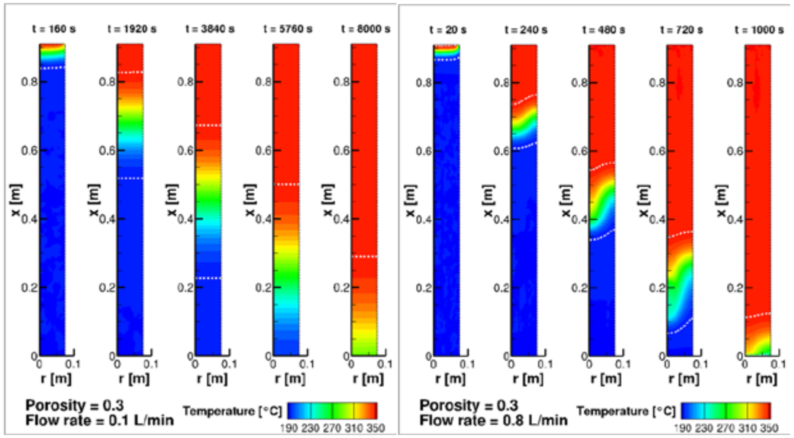
Thermal analysis at Purdue University of the experimental thermocline tank at IISc Bangalore; simulations are performed at flow velocities below and above a flow rate that induces instability in the thermocline region to identify a stability criterion.

Significance and Impact:

It is critical to maintain a narrow thermocline region inside the tank to prevent significant losses in storage efficiency. A critical stability velocity exists inside tanks that contain low-cost filler material based on the opposing effects of viscous forces and buoyancy forces. Low velocities are stable; high velocities cause deconstruction by viscous fingering. A performance tradeoff exists in the operational velocity due to thermocline expansion by either diffusion (low velocities) or viscous deconstruction (high velocities).



High-temperature molten-salt loop (left) and thermocline tank (right)



Temperature contours inside lab-scale thermocline tank with flow rate below (left) and above (right) the critical velocity during discharge

Publication(s): C. Mira-Hernandez,[1] V. Patel,[2] P. Deepu,[2] S. Dawande,[2] J. A. Weibel,[1] S. Basu,[2] and S. V. Garimella,[1] "Simulation of thermocline formation in an experimental molten-salt energy storage system for concentrating solar power applications," ASME 8th International Conference on Energy Sustainability, Boston, MA, USA, June 30-July 2, 2014.

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