Sensitivity of Thermocline-Based Thermal Storage to Flow Disturbances (CSP-5)

A joint India-U.S. research consortium funded under the *Joint Clean Energy Research & Development Center (JCERDC)*

Scientific Achievement:

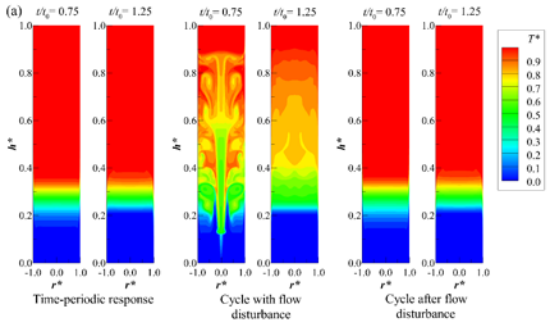
Using numerical simulation, we studied the short- and long-term effects of flow disturbances on the performance of thermocline-based thermal energy storage systems. We observed that the thermocline tank is resilient to flow disturbances for high Atwood number values and oscillation frequencies in the thermocline region are lower than Brunt-Väisälä frequency.

Significance and Impact:

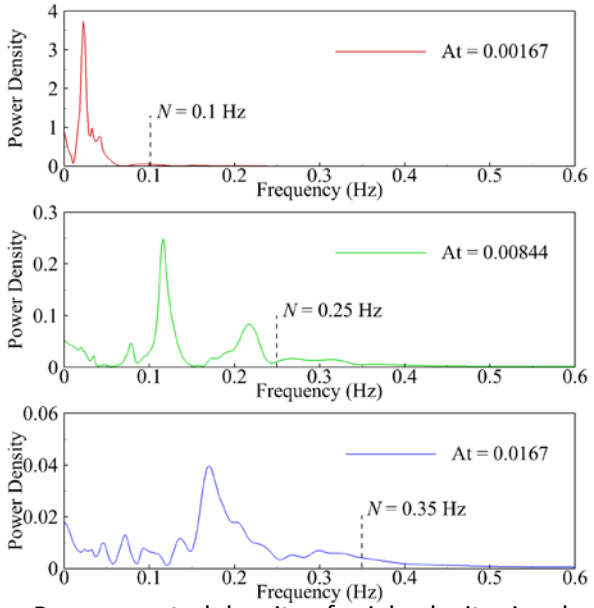
Understanding the thermocline response to flow disturbances helps in designing thermal energy storage systems. A resilient thermocline tank preforms better against flow disturbances, resulting in a low loss of stored energy due to mixing.

Research Details:

- Study was conducted for three different cases of Atwood numbers with adiabatic boundary wall conditions.
- Disturbance fluid was introduced at a lower temperature value with parabolic velocity profile from the inlet.
- A time periodic thermal response was achieved after charging-discharging cycles.
- Thermocline response was quantified with damping time constant and power spectral density analysis of axial velocity signal.
- Energy storage performance was assessed with first law efficiencies.



Temperature contours inside thermocline tank: before, during, and after the introduction of disturbance for At = 0.00167



Power spectral density of axial velocity signal

Publication: S. Hatte, C. Mira-Hernández, S. Advaith, A. Tinaikar, U. Kumar Chetia, K. V. Manu, K. Chattopadhyay, J. A. Weibel, S. V. Garimella, V. Srinivasan, and S. Basu, Short and long-term sensitivity of lab-scale thermocline based thermal storage to flow disturbances, Applied Thermal Engineering, 2016. DOI: 10.1016/j.applthermaleng.2016.04.138

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