

Comparative Analysis of Dual- and Single- Media Thermocline Tanks for Energy Storage (CSP-5)



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Scientific Achievement:

Using numerical simulation, we performed a detailed thermal analysis of thermocline tanks with molten salt and quartzite rock (dual-media), and with only molten salt (single-media). Both tank designs have high thermal performance: we observed greater flow disturbance in the single-media tank, and diffusive thermal losses inside the dual-media tank.

Significance and Impact:

Inclusion of low-cost filler materials in thermocline tanks has the potential risk of thermomechanical failure by successive thermal ratcheting. Tanks with only molten salt can be more reliable, but internal mixing can reduce the quality of stored thermal energy. Thermal assessment serves to determine applicability of both energy storage alternatives in concentrating solar power plants.

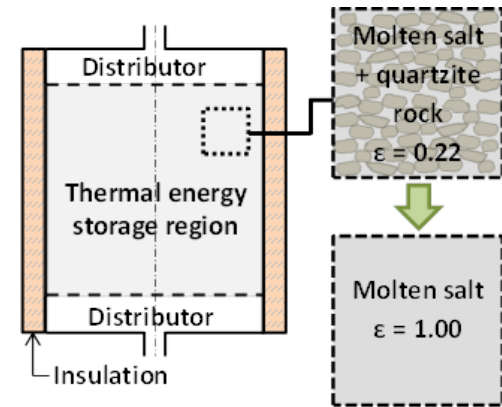
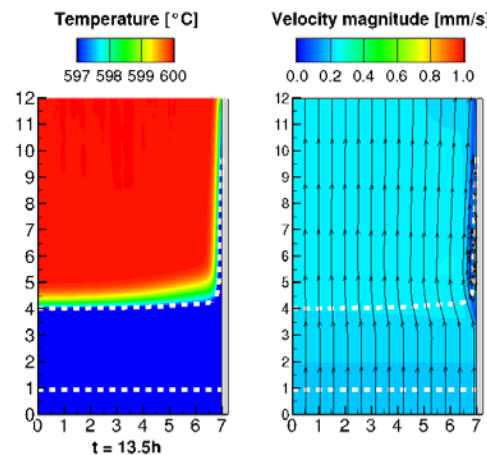


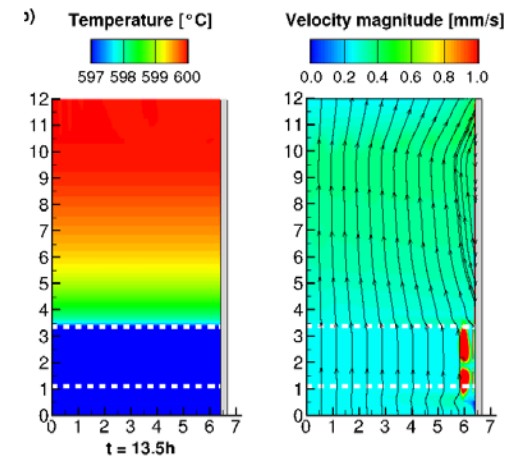
Illustration of dual- and single-media thermocline tank design

Research Details:

- Adiabatic and non-adiabatic thermal conditions are considered; behavior analyzed under cycles with and without dwell time.
- Two-dimensional axis-symmetric numerical simulation.
- Effective thermocline thickness during cycle is used as metric of thermal stratification.
- Energy storage performance is assessed with first- and second-law efficiencies.
- Mechanistic explanation of thermal behavior.



Dual-media thermocline tank



Single-media thermocline tank

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