Phase Change Materials for Thermal Energy Storage

Phase Change Materials

Phase change materials (PCM) has shown to have great potentials for thermal energy storage due to its high latent heat. In this project, a conjugate mathematical model of water flow in a pipe coupled with PCM storage is derived and studied using computational fluid dynamics (CFD) approach which serves two main purposes: (*i*) to study the fundamental aspect of flow behavior and heat transfer performance for both charging (melting) and discharging (solidification) processes and; (*ii*) to enhanced heat transfer performance of PCM storage.

Mathematical model

The mathematical model comprises two component, viz., water flows in pipe and PCM storage, which allows for a conjugate heat transfer between carrier fluid and PCM.

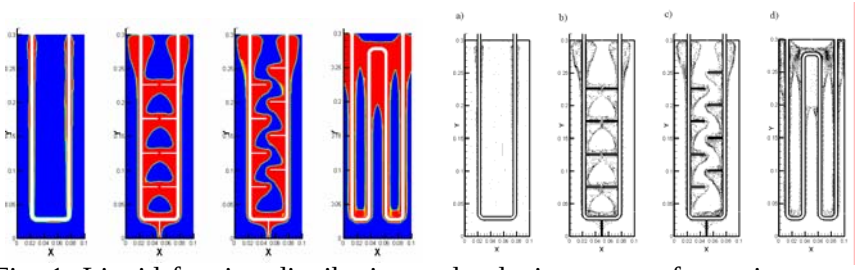

Fig. 1. Liquid fraction distribution and velocity vectors for various PCM configuration, e.g. U-pipe, U-pipe with in-line fins, U-pipe with staggered fins and serpentine pipe at t = 600 s.

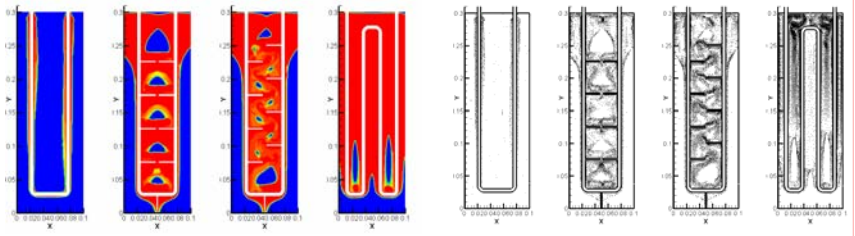

Fig. 2. Liquid fraction distribution and velocity vectors for various PCM configuration, e.g. U-pipe, U-pipe with in-line fins, U-pipe with staggered fins and serpentine pipe at t = 1200 s.

Effect of pipe design

Three different water pipe designs in PCM storage were investigated, namely U-pipe, U-pipe with in-line fins, U-pipe with staggered fins and serpentine pipe. The results suggest that serpentine pipe yields the highest heat transfer rate between water and PCM, followed by U-pipe with and without fins designs.

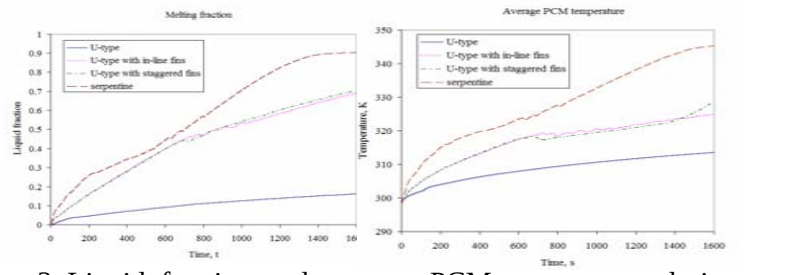

Fig. 3 Liquid fraction and average PCM temperature during melting process.

Effect of multiple PCM

To enhance heat transfer performance of PCM storage, we propose to employ multiple PCM with various arrangement, e.g., vertical and horizontal, in serpentine water pipe-PCM. The results indicate that placing multiple PCM improves heat transfer rate significantly.

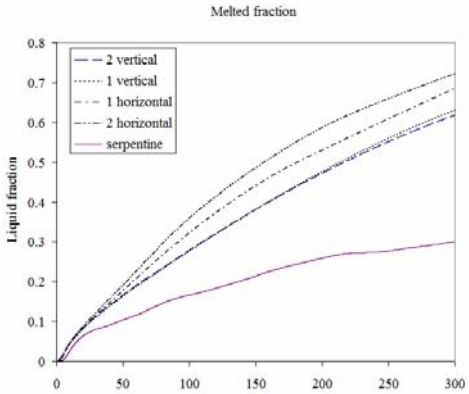

Fig. 4 Liquid fraction during melting process for multiple PCM.

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