Simulation of PCM Melting Process in a Rectangular Enclosure Differentially Heated

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Abstract

The relevance of Phase Change Materials (PCM) in solar energy applications is becoming more and more crucial. Because of their favorable thermo-dynamical characteristics, such as high density, specific heat and latent heat of fusion, PCM are usually employed as working fluids and for thermal storage. This study deals with a numerical investigation of the melting process of a PCM in a rectangular enclosure differentially heated. COMSOL Multiphysics is used in order to numerically solve Navier-Stokes and energy equations in the considered system. Adopting an enthalpy formulation, one single equation is used to solve transient conduction and convection heat transfer in both the solid and liquid phase. The solid-liquid interface location, the liquid flow patterns and the thermal maps obtained for several transient heating conditions well highlight the natural convection effect, enhancing heat transfer in the top portion of the cavity. The results carried-out by simulations are successfully compared with experimental data previously published in literature and concerning an analogue system. The shapes of the melt front obtained at various times from computations well fit with experiments. Also, quantitatively comparison between numerical and experimental results show good agreement. From comparisons, the proposed numerical approach appears validated and suitable for use in the pre-design of PCM storage systems.