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Hoseinzadeh, S., Ghasemiasl, R., Havaei, D., Chamkha, A.J.

Numerical investigation of rectangular thermal energy storage units with multiple phase change materials
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Abstract
Latent heat thermal storage (LHTS) using phase change materials (PCMs) is one of the efficient and useful technologies in conservation and retention of thermal energy. One of the main advantages of this technology is the utilization of such systems in cooling/heating applications where the air is the heat transfer fluid (HTF). Generally, the heat transfer rate in a LHTS unit and its efficiency depends on the difference between the melting temperature of the PCM and the HTF temperature. If a single PCM is used, the temperature difference between the PCM and the HTF along the flow direction will be decreased. This leads to a decrease in the heat transfer rate and efficiency. In this case, nearly a constant temperature difference between the PCM and the HTF can be maintained during phase change. Therefore, the heat transfer rate to/from the PCM is constant. This work presents a two-dimensional numerical investigation of the performance of the LHTS unit which is composed of several rectangular PCM slabs. The enthalpy method is used to solve the governing equations for the melting process in PCMs. The convective heat transfer inside the air channels is analyzed by solving the energy equation, which is coupled with the heat conduction equation in the PCM wall. The general equations of temperature and the local liquid fraction are discretized with the finite difference method and are solved by a fully implicit scheme. The effect of geometrical parameters of storage such as the PCM slab thickness and the length as well as the effect of air flow rate in the outlet air temperature of storage are investigated. © 2018 Elsevier B.V.

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