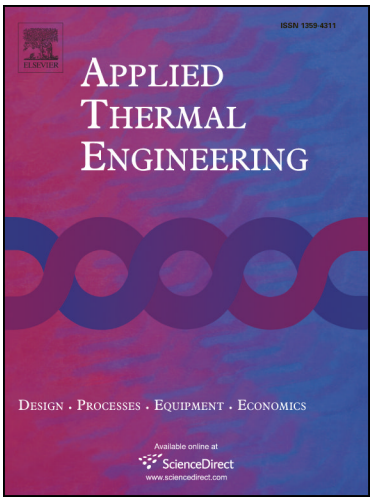

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Non-uniform heat transfer suppression to enhance PCM melting by angled fins

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Abstract

We present numerical investigations on a thermal energy storage system with phase change materials (PCMs) vertically heated from one side of a rectangular enclosure. A transient numerical model is developed to study the heat transfer and melting behaviors, and the natural convection is accounted. To suppress the non-uniform heat transfer for the PCM melting enhancement, fins with the inclined angle of 0°, +15°, +30°, −15° and −30° are proposed. The melt fraction contours with the natural convection driven flow are performed and compared, as well as the temperature distributions. Results show that the fins in a downward angle of −15° accelerate the PCM melting faster than the others, as the part of heat is well transferred to the bottom of container along the fins and the original non-uniform melting caused by natural convection is reduced. Contrarily, the upward fins in +15° and +30° deepen the non-uniform heat distribution and slow down the melting. The saved PCM melting time is defined on the basis of the No Fin PCM case. It is found that saved melting time of PCMs with −15° fins increases 23.8% on the 0° fins, while decreases 45.2% and 71.4% with the +15° and +30° fins. The fin length and heat flux input are also examined for the PCM melting. The fin length shows the significant influences on the PCM melting with the tilted fins. As the length ratio of fin to container increases to 0.75, the non-uniform melting is obviously suppressed due to the addition of the −15° fins, and temperature contours inside the PCM domain show much more uniform, by comparing with 0° fins. The PCM melting rate with −15° fins also increases greatly and the saved melting time rises about 62.7%. Besides, the enhancement ratio reveals that the melting enhancement by the fins mainly appears at the second half of the entire process, based on the PCM solid-liquid interface formed at the first half.

Keywords: Thermal energy storage, phase change materials, heat transfer enhancement,

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