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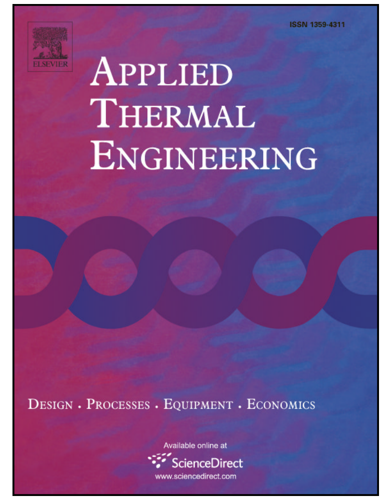

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Numerical analysis of heat transfer processes in a low-cost, high-performance ice storage device for residential applications

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Abstract

A concept for a small-scale ice storage device, suitable for residential applications, is proposed. The device is based on a layered structure of alternating ice packs and flow channels, consisting, respectively, of thermally sealed polyethylene water bag and corrugated plastic sheeting, with thickness for each layer on the order of several millimeters. A water / glycol mixture is used as the heat transfer medium. The mixture is cooled by a mechanical refrigeration system, and is used to freeze the ice packs during charge. During discharge, the ice packs absorb heat from the water glycol mixture as it is warmed by passing it through an air-to-liquid coil.

An efficient numerical scheme to analyze the device is developed. This makes use of a hybrid analytical approach combined with a finite difference formulation that delivers an accurate solution at a very low computational cost. To simultaneously illustrate the use of the numerical scheme, and assess the concept, a device sized to provide the same energy and power characteristics of a well-known battery system is analyzed. The analysis shows that the thermal device can outperform the battery system, even before any optimization is implemented. A basic analysis also shows that the cost of a standalone device,

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