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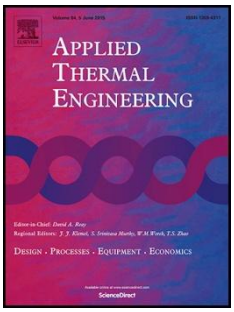


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# Experimental study of a phase change thermal energy storage with copper foam

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## Highlights

- A shell-and-tube paraffin/copper foam latent storage unit is studied
- The test rig enables visualization of the melting/solidification front
- The best injection side is determined among top/bottom and vertical/horizontal
- An experimental method to estimate charge/discharge times is proposed
- A tube surrounded by copper foam is compared to classical heat exchangers

## Abstract

Thermal energy storage is an attractive option for effectiveness in many applications such as concentrated solar thermal power or district heating network, since it gives flexibility and reduces energy consumption and costs. The objectives of the present study is to assess copper foam interest as thermal conductivity enhancement technique for latent heat thermal energy storage and to compare copper foam with other heat transfer enhancement systems for shell-and-tubes heat exchangers. The best heat transfer fluid injection side is sought for charge and discharge. Besides, a method is proposed to estimate the characteristic time for melting/solidification and enable comparison between various tests conditions and heat exchanger geometries.

In this paper, a copper foam is implemented in a shell-and-tube heat exchanger as phase change thermal energy storage unit and studied experimentally. Visualization enables the melting/solidification front to be seen, followed and recorded. Bottom and top injection for charge and discharge are compared, vertically and horizontally. It appears that vertical charge and discharge are faster than horizontal ones and that top charge and discharge are faster than bottom ones, thus assessing the significance of volume expansion and natural convection for heat transfer in the phase change material. Moreover, the tested copper foam enhanced geometry is compared with other heat exchangers such as finned copper tube, tube surrounded by carbon foam and a simple tube. It is shown that copper foam combines low-density with high heat transfer performance since it is as efficient as copper fins with half the copper mass, and far more efficient than other presented heat exchangers. Besides, a method for estimating solidification and melting time is proposed. Based on a thermocouple network, this method rests upon measured temperatures inside the phase change material.

## Keywords

Phase Change Material
Copper Foam
Thermal Energy Storage
Experimental
Injection side
Visualization