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HEAT TRANSFER BEHAVIOURS OF PARALLEL SQUARED CHANNEL SYSTEM FOR LATENT HEAT THERMAL ENERGY

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ABSTRACT Systems for the energy management and storage are broadly used in many industrial and commercial applications to supply thermal energy. The energy demand in these applications is not always constant and therefore a Thermal energy storage (TES) system represents a good opportunity to cover such problem. Lately TES systems for thermal applications, such as space and water heating, air-conditioning, cooling, etc. have received much attention.

Solar energy is an important renewable energy source that is increasingly used. One of the main drawbacks in the solar energy application is its working periodic time. therefore, solar applications require TES system to store exceed energy and release it when it is demanded. Although the TES systems could be used for many applications, it is particularly recommended for solar systems. TES can improve the efficiency of a solar system because it works as a thermal buffer to cover a mismatch between the energy supply and energy demand. Various TES systems have been investigated for heating and cooling applications, industrial applications and power plants.

In TES system, energy is stored by changing the temperature of a storage medium or employing the latent heat of Phase Change Material (PCM). For a TES system, it is important to have a charging velocity rather high, because for an assigned system size, it is possible to obtain greater amount of stored energy in less time. therefore, the heat transfer between the working fluid and the TES system should be improved by increasing the surface exchange area. A solution of this problem could be a hybrid system realized partially by PCM in solid matrix where a working fluid passes through. The system have a honeycomb shape, filled with PCM in checkerboard way.

In the present work a computational investigation of transient thermal control device using Phase Change Material (PCM) is accomplished. The system is a honeycomb solid checkerboard matrix filled with Phase Change Material. The honeycomb is set of different parallel squared channels and half of them are filled with PCM and the others are passed through by the working fluid. Various configurations are investigated for different channels per unit of length (CPI), different heat fluxes and inlet velocities. A comparison between the direct honeycomb model and a porous medium model is made. The porous medium is modelled with the Darcy law and to evaluate the heat exchange between the solid and the fluid zones a Local-Thermal Non-Equilibrium assumption is used. The analysis have the aim of estimate an optimized configuration in term of channels per unit of length (CPI) as a balance between pressure drop and heat transfer rate inside the honeycomb system. Numerical simulations were carried out using the Ansys-Fluent 15.0 code. Results in terms of melting time, temperature fields, stored energy as function of time are presented.