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Impact of Nanoparticles in Enhancement of Thermal Conductivity of Phase Change Materials in Thermal Energy Storage and Cooling of Concentrated Photovoltaics

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Abstract : Phase change materials (PCM) are an ideal thermal storage medium. They are characterized by a high latent heat, which allows them to store large amounts of energy when the material transitions into different physical states. Concentrated photovoltaic (CPV) systems are widely recognized as the most efficient form of Photovoltaic (PV) for thermal energy which can be stored in Phase Change Materials (PCM). However, PCMs often have a low thermal conductivity which leads to a slow transient response. This makes it difficult to quickly store and access the energy stored within the PCM based systems, so there is need to improve transient responses and increase the thermal conductivity. The present study aims to investigate and analyze the melting and solidification process of phase change materials (PCMs) enhanced by nanoparticle contained in a container. Heat flux from concentrated photovoltaic is applied in an attempt to analyze the thermal performance and the impact of nanoparticles. The work will be realized by using a two dimensional model which take into account the phase change phenomena based on the principle of enthalpy method. Numerical simulations have been performed to investigate heat and flow characteristics by using governing equations, to ascertain the impacts of the nanoparticle loading. The Rayleigh number, sub-cooling as well as the unsteady evolution of the melting front and the velocity and temperature fields were also observed. The predicted results exhibited a good agreement, showing thermal enhancement due to present of nanoparticle which leads to decreasing the melting time.

Keywords : thermal energy storage, phase-change material, nanoparticle, concentrated photovoltaic
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