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Fayaz, H.[a] , Ramesh, S.[a b] , Afzal, A.[c] , Ağbulut, Ü.[d] , Afghan Khan, S.[e] , Asif, M.[f] , Raja, V.[g h] , Linul, E.[i]

Investigation of numerical phase transition of nano-enhanced SiC/paraffin wax PCM in solar-assisted water desalination system

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[a] Institute of Power Engineering (IPE), Universiti Tenaga Nasional, Selangor, Kajang, 43000, Malaysia
[b] Centre of Advanced Manufacturing & Materials Processing (AMMP), Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, Kuala Lumpur, 50603, Malaysia
[c] University Centre for Research & Development, Department of Mechanical Engineering, Chandigarh University, Gharuan, Punjab, Mohali, India
[d] Department of Mechanical Engineering, Faculty of Mechanical Engineering, Yildiz Technical University, Istanbul, Turkey
[e] Department of Mechanical and Aerospace Engineering, Faculty of Engineering, International Islamic University, Selangor, Kuala Lumpur, 53100, Malaysia
[f] Department of Chemical Engineering, King Saud University, P.O. Box 800, Riyadh, 11421, Saudi Arabia
[g] Department of Aeronautical Engineering, Kumaraguru College of Technology, Tamil Nadu, Coimbatore, 641049, India
[h] Division of Research and Development, Lovely Professional University, Punjab, Phagwara, 144401, India
[i] Department of Mechanics and Strength of Materials, Politehnica University Timisoara, Timisoara, 300222, Romania

Abstract
Adding nanoparticles in phase change material (PCM) is a new trend for enhancing their thermal energy-storing ability as well as thermal conductivity. From this point of view, a numerical study is carried out to examine the addition of silicon carbide nanoparticles in paraffin wax PCM, used as heat energy storing material in a semi-cylindrical solar water desalination system. The PCM temperature is maintained at 52 °C and the semi-cylindrical tubular section has a wall temperature of 85 °C. The top plane section of the tubular solar collector is made up of graphite material. A semi-circular cross-section is selected for numerical analysis. A finite volume solver is used for solving thermal and fluid flow governing equations. A pressure staggering option algorithm is applied for pressure–velocity coupling. The temporal parameters like temperature, velocity contours, melting fraction, enthalpy, and entropy of nano silicon embedded paraffin wax PCM are widely discussed. The results clearly show that the phase transition of solid PCM to fluid PCM is greatly influenced by nanoparticle addition and enhances the rate of heat transfer. Initially for the first 60 min the melting fraction and temperature of PCM remain uniform as the time step increases above 60 min the behavior of PCM changes abruptly which clearly indicates the random distribution of nanoparticles within the PCM. A critical time and temperature limit exists for nanoparticles-based PCM beyond which, the thermal efficiency of the solar water desalination system gets influenced. © 2024 Elsevier Ltd

Author Keywords
Enthalpy; Entropy; FVM; SiC/paraffin wax PCM; Solar water desalination

Index Keywords
Desalination, Enthalpy, Flow of fluids, Heat transfer, Melting, Nanoparticles, Paraffins, Phase change materials, Silicon carbide, Temperature, Thermal conductivity, Water filtration; Desalination systems, FVM, Heat energy, In-phase, Melting fraction, SiC/paraffin wax phase change material, Solar assisted, Solar water desalination, Solar waters, Water desalination; Entropy

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Correspondence Address
Fayaz H.; Institute of Power Engineering (IPE), Selangor, Malaysia; email: fayaz.hussain@uniten.edu.my

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