Journal of Energy Storage 86 (2024) 111373

Contents lists available at ScienceDirect

Journal of Energy Storage

journal homepage: www.elsevier.com/locate/est

Research Papers

Experimental investigation on the performance of binary carbon-based nano-enhanced inorganic phase change materials for thermal energy storage applications

Reji Kumar Rajamony [a,b,*], Johnny Koh Siaw Paw [a], Jagadeesh Pasupuleti [a], A.K. Pandey [c,d,**], Chong Tak Yaw [a], Sieh Kiong Tiong [a], Talal Yusaf [e,f], M. Samykano [g], A.G.N. Sofiah [a], Imtiaz Ali Laghari [h], Oday A. Ahmed [i], K. Kadirgama [f,g,j]

[a] Institute of Sustainable Energy, Universiti Tenaga Nasional (The Energy University), Jalan Ikram-Uniten, Kajang 43000, Selangor, Malaysia
[b] Division of Research and Development, Lovely Professional University, Phagwara, Punjab 144411, India
[c] Research Centre for Nano-Materials and Energy Technology (RCNMET), School of Engineering and Technology, Sunway University, No. 5, Jalan Universiti, Bandar Sunway, Petaling Jaya 47500, Selangor Darul Ehsan, Malaysia
[d] CoE for Energy and Eco-Sustainability Research, Uttaranchal University, Dehradun, India
[e] School of Engineering and Technology, Central Queensland University, Brisbane, QLD 4009, Australia
[f] College of Engineering, Almaaqal University, Basra 61003, Iraq
[g] Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, Gambang 26300, Malaysia
[h] Department of Electrical Engineering, Quaid-e-Awam University of Engineering, Science and Technology, Larkana 77150, Pakistan
[i] Department of Electrical Engineering, University of Technology Iraq, 35299 Baghdad, Iraq
[j] Centre for Research in Advanced Fluid and Processes, Universiti Malaysia Pahang, Pekan 26600, Malaysia

ARTICLE INFO

Keywords:
Phase change materials
Graphene
Multi-walled carbon nanotubes
Thermal conductivity
Energy
Thermal energy storage

ABSTRACT

Phase change materials (PCMs) are considered potential resources for Thermal energy storage (TES) applications. However, the PCMs are limited because of their lower thermal conductivity, resulting in a significant decrease in heat transport and energy storage capability. The foremost objective of the present research is to formulate a novel salt hydrate PCM filled with binary carbon-based nanoparticles (graphene and multi-walled carbon nanotubes) at various weight concentrations and examine the thermophysical properties. A two-step approach is used to formulate binary nanomaterials dispersed salt hydrate PCM. The formulated binary nanocomposite's thermo-physical properties like morphological behaviour, thermal stability, chemical stability, melting enthalpy, optical performance, rate of heat transfer and thermal reliability were characterized. The binary nanoparticle-enhanced nanocomposites can form a decent thermal network, resulting in a remarkable enhancement in thermal conductivity by 160 % (1.2 W/mK) compared to pure salt hydrate. Moreover, a remarkable improvement in optical absorptance and a reduction in optical transmittance by 82.55 % for 0.7 wt% graphene and 0.07 wt% MWCNT enhanced salt hydrate PCM (SAHGrM-0.07) than pure salt hydrate PCM. In addition, the formulated nanocomposites possess excellent heat storage capability, chemical and thermal stability after 300-thermal cycling. The binary carbon-based nanoparticle-enhanced salt hydrate nanocomposites offered acceptable thermal and chemical stability, thermal reliability, and heat transmission characteristics, by this means reflecting its appropriateness for medium-temperature solar TES applications.

1. Introduction

The worldwide energy utilization pattern remains changing from fossil fuel-based energy to renewable energy [1]. Renewable energy and energy storage technology become research hotspots worldwide [2]. It is being trusted that solar power utilization is able to clean energy. However, solar energy's fluctuating and intermittent nature is inevitable [3].

* Correspondence to: R.K. Rajamony, Institute of Sustainable Energy, Universiti Tenaga Nasional (The Energy University), Jalan Ikram-Uniten, Kajang 43000, Selangor, Malaysia.
** Correspondence to: A.K. Pandey, Research Centre for Nano-Materials and Energy Technology (RCNMET), School of Engineering and Technology, Sunway University, No. 5, Jalan Universiti, Bandar Sunway, Petaling Jaya 47500, Selangor Darul Ehsan, Malaysia.
E-mail addresses: reji.kumar@uniten.edu.my (R.K. Rajamony), adarshp@sunway.edu.my (A.K. Pandey).

https://doi.org/10.1016/j.est.2024.111373
Received 7 August 2023; Received in revised form 26 January 2024; Accepted 15 March 2024
Available online 19 March 2024