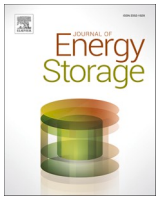
Journal of Energy Storage 103 (2024) 114368

Contents lists available at ScienceDirect

Journal of Energy Storage

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



Research Papers

Thermal characterization of shape-stable phase change material for efficient thermal energy storage and electric to thermal energy conversion

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ARTICLE INFO

Keywords:
Form stable phase change materials
Expended graphite
Thermal energy storage
Thermal stability
Leakage
Electric-to-thermal conversion

ABSTRACT

Phase change materials (PCMs) are an essential advancement in thermal energy storage (TES) systems. However, PCMs low thermal conductivity and leakage problem hindered their widespread use in TES applications. In the present research, a newly synthesized porous structured 3-D expanded graphite (EG) additive is used to improve low thermal conductivity and provide shape stability to a PCM. Herein, EG particles were synthesized using expandable graphite with the help of a tube furnace at 900 °C for 35 min. Further, shape-stable phase change materials (SS-PCMs) were developed by infusing EG particles into liquid A70 (PCM) using the vacuum impregnation method. The experimental results revealed that EG particles improved the low thermal conductivity and reduced the leakage problem of PCMs. The newly developed SS-PCMs demonstrate an outstanding thermal conductivity of 1.59 W/(m·K), increased by 657.16 % compared to base (A70) PCM. Additionally, 500 thermal cycles were carried out on the SS-PCM composites. The composite showed a minimum change in the thermophysical properties based on the results. Moreover, an electro-thermal energy conversion experiment was conducted to analyze the developed SS-PCM thermal energy efficiency, and the SS-PCM composite achieves a transformation capability of 70.89 % when operated at 4.8 V. In conclusion, superior thermal conductivity is shown by newly developed SS-PCMs with 3D expanded graphite, which are perfect for ensuring efficient thermal management in electronic devices and energy storage systems.

1. Introduction

Organic phase change materials (OPCMs) are capable of phase transition to store or release energy at a constant temperature. Due to this, OPCMs are considered an excellent material in thermal energy storage management [1]. Further, polyethylene glycol [2], fatty acids [3], and paraffin [4] are several examples of OPCMs. However, these phase change materials (PCMs) are not widely used in thermal energy storage (TES) applications because of their poor thermal conductivity [5] and leakage issues during the solid-to-liquid phase [6]. Recently, much attention has been given to improving the thermophysical properties of OPCMs [7]. In an ongoing study, the shape-stabilized phase change material (SS-PCM) composite was developed by utilizing expanded graphite (EG) as an additive particle and A70 as the base PCM. However, the low thermal conductivity, thermal instability, and phase transition leakage issues with A70 PCMs make them unsuitable for various TES applications. Accordingly, the main objectives of the current research were to address these challenges, such as increasing thermal conductivity, decreasing thermal instability, and preventing leakage during the phase transition. Recent research has concentrated

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https://doi.org/10.1016/j.est.2024.114368
Received 25 June 2024; Received in revised form 30 September 2024; Accepted 21 October 2024
Available online 1 November 2024