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A review of organic phase change materials and their adaptation for thermal energy storage

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Abstract

Organic phase change materials (O-PCMs) such as alkanes, fatty acids, and polyols have recently attracted enormous attention for thermal energy storage (TES) due to availability in a wide range of temperatures and high latent heat values. However, low thermal conductivity and leakage problems during the phase transition of O-PCMs are of great concern. To overcome the long-standing drawbacks of O-PCMs, we critically discussed the preparation techniques of macro encapsulation phase change (MaPCM), micro-encapsulation phase change materials (MPCM), shape stabilized phase change materials (SSPCM), eutectic phase change materials (EPCM), nano-enhanced phase change materials (NePCM) along with the morphological insights, thermal property enhancements & molecular dynamics (MD) simulation of the prepared composite PCMs. The article also discusses fundamental thermal property increments in phonon interaction, Van der Waals forces of attraction, aspect ratio, thermal conductive path, temperature agglomeration, surfactant effect, and thermal resistance of O-PCMs. The current ongoing review manuscript consolidates the variation in thermal properties with different concentrations of nanoparticles, considering the variety of references to provide valuable insight to the researchers. Carbon-based nanoparticles dispersed with the O-PCMs are the best way to reduce the low thermal conductivity problem. The π-π stack interaction between the O-PCMs and the nanoparticles decreased the leakage problems of O-PCMs during encapsulation and shape stabilization. The authors observed that the highest increment in the thermal conductivity and the latent heat of the OPCMs is 1008.33% and 60%, respectively. Finally, the present review provides a new vision and draws more attention to the material reliability of O-PCMs-based applications in the future, particularly regarding TES.

Keywords

organic phase change materials, thermal energy storage, nano additives, synthesis techniques, molecular dynamics

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- O-PCMs exhibit good thermal properties for TES with no supercooling
- Advanced preparation techniques with merits and demerits of O-PCMs have been concise
- Encapsulation & foam stabilization methods are effective solutions for leakage issues
- Morphological insights of O-PCMs are systematically reviewed
- Molecular dynamic simulation effect on the thermal properties is conferred

Introduction

Need for energy storage

On the current trend, out of all renewable energy sources, solar energy is one of the quickest replacements for many conventional energy sources, such as coal, petroleum, fuel wood, and natural gases.[1] Nevertheless, solar energy is harnessed effectively during the day, whereas energy storage

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