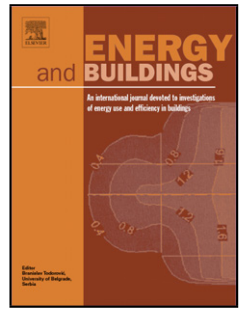

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Synthesis and characterization of lauric acid/expanded vermiculite as form-stabilized thermal energy storage materials

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Abstract: Lauric acid(LA)/expanded vermiculite(EVM) form-stable phase change materials were synthesized via vacuum impregnation method. In the composites, lauric acid was utilized as a thermal energy storage material and the expanded vermiculite behaved as the supporting material. XRD and FT-IR results demonstrate that lauric acid and expanded vermiculite in the composite do not undergo a chemical reaction and only undergo a physical combination. Microstructural analysis indicates that lauric acid is sufficiently absorbed in the expanded vermiculite porous network, while displaying negligible leakage even under the molten state. According to DSC results, the 70 wt. % LA/EVM sample melts at 41.88^{o}C with a latent heat of 126.8 J/g and solidifies at 39.89^{o}C with a latent heat of 125.6 J/g. Thermal cycling measurements show that the form-stable composite PCM has adequate stability even after being subjected to 200 melting/freezing cycles. Furthermore, the thermal conductivity of the composite PCM increased by approximately 78% with the addition of 10 wt.% expanded graphite (EG). Thus, the form-stable composite PCM is a suitable option for thermal energy storage for building and solar heating system applications.

Keywords: lauric acid, expanded vermiculite, Form-stable composite material, thermal properties, thermal reliable, thermal conductivity

1. Introduction

In recent decades, energy storage applications have attracted much attention due to the shortage of fossil fuel energy and the low utilization rate of energy [1]. The various mechanisms of energy storage include thermal energy, electrical energy and chemical energy. Thermal energy storage (TES) is recognized as one of the key technologies for energy supply for the future. There are three types of prevalent TES methods: (1) sensible heat storage, (2) latent heat storage, and (3) reversible chemical reaction heat storage. Among said methods, latent heat energy storage realizes the use of a phase change material (PCM) as the most effective technique because of its advantages of high energy storage density and isothermal characteristics [2-5].

Up to now, the research of PCMs has been primarily focused on the use of organic phase change materials for heat storage, mainly consisting of paraffin and fatty acids [6]. Various investigations have explored composite PCMs composed of a PCM with porous materials to improve thermal properties and thermal conductivity while decreasing PCM leakage. For example, Xia [7] conducted an experimental investigation of the EG/paraffin composite PCM with a mass fraction of EG varying from 0 to 10 wt.%; their results revealed that in comparison with pure paraffin, the heat storage/retrieval durations for EG(10) /paraffin(90) composite decreased by