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Experimental investigation on the thermophysical properties of Paraffin wax/wheat husk composite for thermal energy storage

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ABSTRACT

Organic phase change materials (PCM) exhibit poor volumetric latent heat storage capacity and have low thermal conductivity. Therefore, this study aims to develop a PCM composite with better thermal conductivity and latent heat by dispersing newly synthesized wheat husk microparticles in Paraffin wax (A-70) PCM via a two-step technique. As per the results, the developed composite materials latent heat and thermal conductivity were 217.1 J/g & 0.45 W/m K, which was 4.57 % and 66.66 % higher than base PCM, respectively. Moreover, after 500 thermal cycles, the newly synthesized composite was found to be thermally and chemically stable.

1. Introduction

Organic phase change materials (OPCMs) are considered the most promising thermal energy storage (TES) option [1] out of all possible options of TES. However, limited volumetric latent heat storage capacity, low thermal conductivity, and high cost of OPCMs restrict their use in TES applications [2]. To overcome the aforementioned problems of OPCMs, the carbon-rich materials derived from bio-waste with large surface areas and high pore volume [3] are utilized with OPCMs to improve the thermal conductivity and latent heat and reduce cost [4]. Hence, the present investigation aims to synthesize wheat husk (WH) microparticles to minimize the use of commercial nanoparticles and improve the thermal properties of the A-70 PCM, which has not been investigated in the literature. In addition, a comparison table based on the thermal properties of the PCM composites and current research work is presented in the supplementary document [please see the (S1) supplementary document]. In an ongoing study, A-70 is selected as PCM and WH as microparticles to increase latent heat, improve thermophysical properties, and lower the cost of PCM composites. Herein, the carbonization process (facile method) is used to synthesize WH microparticles, and the ultrasonication method is used to develop PCM composites. Furthermore, newly developed PCM composites morphological, chemical, optical, and thermal properties were investigated. Moreover, 500 thermal cycles were carried out to ensure the thermal stability of PCM composites.

2. Experimental

2.1. Materials

The WH is a waste part of a wheat plant obtained from India, converted into bio-based microparticles using a facile method, as elaborated in Fig. 1(a). Plusice A70 is used as a base PCM obtained from PCM Products Ltd.

2.2. Preparation of BM and PCM composite

The research aims to green synthesis of WH microparticles. WH was broken into 10–20 mm pieces and washed with deionized water. Afterwards, WH particles were dried at 130 °C for 20 h in a vacuum oven. Subsequently, WH residual particles go through carbonization in a N_2 atmosphere at 1000 °C, followed by repeated wet ball mill process

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