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Thermal Stability Analysis of Paraffin/SEBS based Form-Stable Phase Change Material

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Introduction: Phase change materials (PCM) for latent heat thermal energy storage is widely considered to be the most effective method of the energy conservation process. They provide high energy storage densities at a nearly constant temperature (1,2). The high latent heat of PCMs has made them one of the most promising materials in many advanced applications. In this work, paraffin is used as a phase change material because paraffin has a higher energy storage density, is available in a wide range of melting temperatures and has low supercooling. Since the utilization of PCM in thermal storage systems is restricted by leakage. To solve this problem, SEBS, a tri-block copolymer has been used. SEBS provides the form stability and restricts the free flowage of paraffin above its melting point within the composites. Moreover, the solubility parameter of EB block in the polymer is quite comparable to paraffin, therefore a direct mixing method has been adopted to develop the form-stable PCM.

Methods: The SEBS/PA shape stable PCMs have been prepared through the following procedure (3): (i) the paraffin is dissolved in hot cyclohexane; thereafter measured amount of SEBS has been mixed into it with mechanical agitation and raising the temperature to about 120°C. (ii) excess methanol is used to obtain the precipitate of SEBS/paraffin composites. After filtration, the composites have been dried in a hot air oven for 48 hours to remove the residue cyclohexane and methanol. In this way, a series of form-stable PCMs synthesized, which contained 10wt%, 15wt%, and 20wt% of SEBS triblock copolymer. The thermal stability and form stability has been analyzed through thermogravimetric analysis (TGA) and leakage test. Leakage tests have been conducted at 80°C to ensuring the complete melting of paraffin within composites.

Results & Discussions: TGA curves showed one step degradation of paraffin and SEBS, while their blends showed two step-degradation. The TGA results revealed that the prepared composites maintain good thermal stability above the temperature of 250°C. From the leakage test it is observed that, when the weight percentage of SEBS reached 20wt%, no leakage of paraffin has been observed above its melting point, because paraffin trapped in the EB rich microdomain of SEBS which restrict the chain movement of paraffin within the matrix, hence reduce the leakage of paraffin inside the composites.

Conclusions: In this work, the paraffin/SEBS shape stable PCM has been successfully prepared by direct mixing method through mechanical stirring. The outcomes of TGA results indicated the good thermal stability of composites over the temperature of 250°C. The high thermal stability of these composites made them a potential candidate for thermal energy storage applications. On the other side, the leakage of paraffin is effectively reduced by increasing the mass fraction of SEBS copolymer. In this work the mass ratio of PA: SEBS =4:1 is chosen as a better one for its relatively high thermal stability with negligible leakage of paraffin. At last, this synthesis approach has the capability of enormous scaled creation and the products can be effectively prepared by the ordinary mechanical assembly.

Keywords: Phase change material, Thermal stability, Leakage, Form- stability

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