Enhanced Heat Transport and Phase Change Behavior of Nanocomposites for Thermal Energy Storage Applications

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Abstract The utilization of latent heat thermal energy storage system based on phase change materials (PCMs) has obtained a substantial attention among various types of thermal energy storage systems owing to its higher energy storage density and the isothermal nature of storage process. Due to lower thermal conductivity of phase change material, practical application of such system is limited. Such limitations can be overcome by seeding nanomaterials of high thermal conductivity. The present study deals with augmentation of phase change rate using spherical (nano diamond), one dimensional (single walled carbon nanotube) and two-dimensional (graphene nanosheets) carbon based nanostructured PCM in shell-tube thermal energy storage systems. Comparison of the melting dynamics of thermal energy storage system with and without nano carbon-enhanced PCM is numerically calculated. The role of interfacial thermal transport between the carbon based nanostructure and the surrounding PCM is taken into consideration. It is found that spherical nano inclusions do not substantially increase the melting rate of PCM due to high interfacial thermal transport. However, 1D and 2D nanostructures significantly enhance the melting rate with increasing volume concentration. It was found that the melting time is decreased by a factor of ~3 at 3 vol % loading of graphene nanostructures.