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Rheological Properties and Thermal Performance of Suspensions of Microcapsules Containing Phase Change Materials

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Abstract : The increasing cost of energy supply for the purposes of heating and cooling creates a demand for more energy efficient buildings. Improved construction techniques and enhanced material technology can greatly reduce the energy consumption needed for the buildings. Microencapsulated phase change materials (MPCM) suspensions utilized as heat transfer fluids for energy storage and heat transfer applications provide promising potential solutions. A full understanding of the flow and thermal characteristics of microcapsule suspensions is needed to optimize the design of energy storage systems, in order to reduce the capital cost, system size, and energy consumption. The MPCM suspensions exhibited pseudoplastic and thixotropic behaviour, and significantly improved the thermal performance of the suspensions. Three different models were used to characterize the thixotropic behaviour of the MPCM suspensions: the second-order structural, kinetic model was found to give a better fit to the experimental data than the Weltman and Figoni-Shoemaker models. For all samples, the initial shear stress increased, and the breakdown rate accelerated significantly with increasing concentration. The thermal performance and rheological properties, especially the selection of rheological models, will be useful for developing the applications of microcapsules as heat transfer fluids in thermal energy storage system such as calculation of an optimum MPCM concentration, pumping power requirement, and specific power consumption. The effect of temperature on the shear thinning properties of the samples suggests that some of the phase change material is located outside the capsules, and contributes to agglomeration of the samples.

Keywords : latent heat, microencapsulated phase change materials, pseudoplastic, suspension, thixotropic behaviour
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