Preparation and Evaluation of PCM-in-Water Nanoemulsions for Heat Transfer Applications

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Over the last decades, phase change materials, PCMs have seen increased attention for their high densities of energy storage and the quasi-isothermal nature of their phase transitions. However, most organic PCMs exhibit low thermal conductivities, which can prolong storage and releasing processes. PCM-in-water emulsions with nanometric droplets have been proposed as a promising strategy to face this limitation, since these materials combine the excellent heat transfer properties and low viscosity of water with the storage capabilities of bulk PCMs [1]. Micro- or nano- emulsion drops are desirable in order to obtain long-term stabilities and moderate viscosities. However, homogeneous nucleation and crystal growing in PCM drops can be prevented by size reduction. Thus, a nucleating agent is usually required to promote heterogeneous nucleation and avoid excessive sub-cooling of nanoemulsions.

This study aims to develop and experimentally investigate phase change characteristics and transport properties of aqueous nanocolloids of commercial PCMs prepared from solvent-assisted emulsification. Sodium dodecyl sulfate, cetyl trimethylammonium bromide, and different non-ionic polyethoxylated surfactants from Tween and Span series were consider as emulsifiers, while PCMs with higher melting temperatures were tested as nucleating agents. The appropriate PCM-surfactant combination was selected based on a systematic study of the influence that surfactant type and concentration have on PCM droplet size and polydispersity over time and under freeze-thaw cycles. Melting and freezing transitions were studied together with isobaric heat capacity to evaluate thermal energy storage characteristics. Finally, thermal conductivity and dynamic viscosity were also determined in order to preliminarily analyze the transfer and flow behavior of proposed nanoemulsions.

References:

[1] Shao et al. *Energ. Buildings* 94 (2015) 200-217.