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Effect of Temperature and CuO Nanoparticle Concentration on Thermal Conductivity and Viscosity of a Phase Change Material

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Abstract : The main results of an experimental study of the effect of temperature and nanoparticle concentration on thermal conductivity and viscosity of a nanofluid are shown. The nanofluid was made by using octadecane as a base fluid and CuO spherical nanoparticles of 75 nm (MkNano). Since the base fluid is a phase change material (PCM) to be used in thermal storage applications, the engineered nanofluid is referred as nanoPCM. Three nanoPCM were prepared through the two-step method (2.5, 5.0 and 10.0%wv). In order to increase the stability of the nanoPCM, the surface of the CuO nanoparticles was modified with sodium oleate, and it was verified by IR analysis. The modified CuO nanoparticles were dispersed by using an ultrasonic horn (Hielscher UP50H) during one hour (amplitude of 180 μm at 50 W). The thermal conductivity was measured by using a thermal properties analyzer (KD2-Pro) in the temperature range of 30ºC to 40ºC. The viscosity was measured by using a Brookfield DV2T-LV viscosimeter to 30 RPM in the temperature range of 30ºC to 55ºC. The obtained results for the nanoPCM showed that thermal conductivity is almost constant in the analyzed temperature range, and the viscosity decreases non-linearly with temperature. Respect to the effect of the nanoparticle concentration, both thermal conductivity and viscosity increased with nanoparticle concentration. The thermal conductivity raised up to 9% respect to the base fluid, and the viscosity increases up to 60%, in both cases for the higher concentration. Finally, the viscosity measurements for different rotation speeds (30 RPM - 80 RPM) exhibited that the addition of nanoparticles modifies the rheological behavior of the base fluid, from a Newtonian to a viscoplastic (Bingham) or shear thinning (power-law) non-Newtonian behavior.

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