Effects of Hydrogen Bonding, Viscosity, and Polarity on Heat Transfer Nanofluids Containing Fe_2O_3 Nanoparticles

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It has been shown that the alignment of Fe_2O_3 nanoparticles in H_2O can enhance the thermal conductivity of nanofluids. To better understand solvent (base fluid) effects such as hydrogen bonding, viscosity, and polarity, nanofluids were prepared by mixing Fe_2O_3 nanoparticles and various base fluids (H_2O, ethanol, 1-propanol, isopropanol, 2-propanone, hexane, cyclohexane, ethylene glycol, glycerol, etc), the dispersions and alignments of the Fe_2O_3 nanoparticles in these solvents with and without an applied magnetic field were investigated using an optical microscope. The microscope images indicated that inter-molecule hydrogen bonding of the base fluids with one OH group (H_2O, ethanol, 1-propanol, isopropanol) could help to disperse and align the Fe_2O_3 nanoparticles. The intra-molecular hydrogen bonding causes a dramatic increase in viscosity for fluids with multiple OH groups, such as ethylene glycol and glycerol, and makes the dispersion and alignment difficult. Adding water to those fluids could lead significantly reduced viscosity and make the particles disperse and align well. Polarity studies indicated that higher polarity yields better dispersion and alignment of the Fe_2O_3 nanoparticles. Thermal studies showed that thermal conductivity of nanofluids with hydrogen bonding existed in base fluid is enhanced compared to the theoretically calculated data. Intermolecular hydrogen bonding between water and ethylene glycol increases the thermal conductivity value of nanofluids while decrease the fluid viscosity. As high thermal conductivity enhancement with minimal viscosity increase is the goal of heat transfer nanofluids, the current research may open new door to better understanding fundamental nature of nanofluids.