Investigation of thermal conductivity and viscosity of Fe_3O_4 nanofluid for heat transfer applications

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Nanofluids, colloidal suspensions of nanoparticles in liquid carrier fluids, exhibit unusually large thermal conductivities. Therefore, nanofluids have attracted great interest from many researchers due to their potential benefits for numerous applications such as microelectronics; energy supply; transportation and heating, ventilating and air conditioning (HVAC), and they have been proposed as the next generation heat transfer fluids. Many researchers are now focusing on the measurement of thermal properties of ferrofluids, because of the unique magnetic property of these fluids. Water based magnetic nanofluid thermal conductivity and viscosity data is not available in the literature. So, the present work focuses on the estimation of properties of magnetic nanofluid.

To fully understand the heat transfer capabilities of magnetic nanofluids, it is necessary to understand the thermo-physical properties like thermal conductivity, absolute viscosity, density and specific heat at different volume concentrations and temperatures. All these properties are very important for heat transfer applications of magnetic nanofluids inside a tube. In the present work we develop magnetic Fe_3O_4/water nanofluid (Fig. 1a-d). Thermal conductivity of different volume concentrations nanofluid is shown in Fig. 2 (a-b) along with the based fluid.

The thermal conductivity of the nanofluids increases with increase of percentage of volume concentration and temperature. In our experiment higher thermal conductivity enhancement of 48% was observed with 2.0% volume concentration at 60OC temperature compared to base fluid. Fe_3O_4/water nanofluid exhibited Newtonian behaviour under the tested volume concentration range. Viscosity of nanofluid increases with increase of particle volume concentration. Higher viscosity enhancement of 2.96 times was observed with 2.0% volume concentration at 60OC temperature compared to base fluid. Under the same volume concentration and temperature, viscosity enhancement to more compared to thermal conductivity enhancement. In addition to this, theoretical equations were developed to predict thermal conductivity and viscosity of nanofluids without resorting to the well established Maxwell and Einstein models, respectively. The proposed equations show reasonably good agreement with the experimental results.

REFERENCES

The details of this work published in reputed Elsevier (*International Communications in Heat and Mass Transfer, Volume 44, May 2013, Pages 7-14*; http://dx.doi.org/10.1016/j.icheatmasstransfer.2013.02.014; also cited in top 25 hottest articles in July-September).

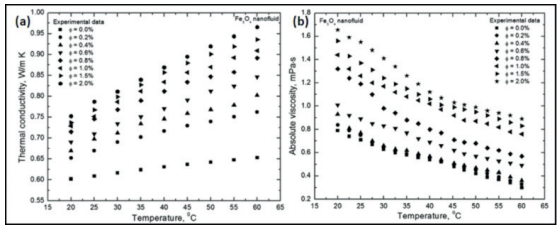

FIGURE 1
(a) XRD pattern of Fe_3O_4 nanoparticles; (b) TEM results; (c) dispersion of nanoparticles in water; (d) separation of particles from the water with magnet.

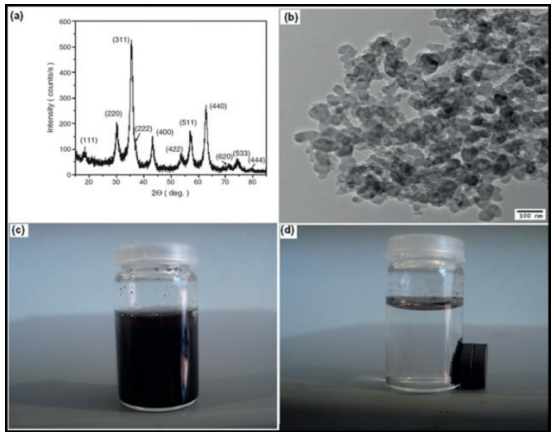

FIGURE 2
(a-b) Experimental thermal conductivity and viscosity of nanofluid with effect of volume concentration and temperature.