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Electrical conductivity of ceramic and metallic nanofluids

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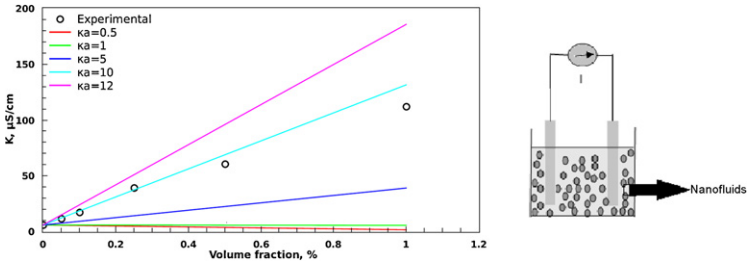
HIGHLIGHTS

- Nanofluids are prepared using water and ethylene glycol followed by ultrasonication.
- The electrical conductivity of nanofluids is studied with various parameters.
- Results are compared with existing models such as Maxwell and O'Brien model.
- The stability of nanofluids depends critically on surface charge of nanoparticles.

GRAPHICAL ABSTRACT



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ABSTRACT

An extensive experimental evaluation of electrical conductivity of nanofluids containing metallic and ceramic particles (Cu, Al_2O_3, and CuO) with different volume fractions in the dilute regime, particle sizes, electrolyte effect, temperature and base fluids has been carried out. It is observed that, in both water- and ethylene glycol (EG)-based nanofluids, the electrical conductivity increases with increasing particle concentration and reducing particle size. It is argued that the effective dielectric constant and density are at the root of the counterintuitive observation that the electrical conductivity enhancement of ceramic nanofluids is more than that of metal-based ones which is substantiated by the Clausius–Mossotti relation for the polar fluids. The influence of surfactant is found to increase the stability and decrease the electrical conductivity of the nanofluids by increasing its viscosity. There is a rise in electrical conductivity of nanofluids having low electrolyte concentration whereas a decrement is observed in nanofluids of high electrolyte concentration due to reduced surface conductance. These experimental observations on alumina nanofluids are compared with the theoretical model proposed by O'Brien [19] for electrical conductivity of dilute suspensions. It has also been observed that there is no significant effect of fluid temperature on the electrical conductivity in the range 30–60 °C. This clearly indicates that enhancement mechanism for electrical conductivity is completely different from that of thermal conductivity in nanofluids.

1. Introduction

Nanofluids are the dilute suspension of nano-sized particles in base fluids including water, ethylene glycol, transformer oil, kerosene, etc. Lasers, high power X-rays and optical fibres are essential components of present computation, scientific measurement, material processing, and medicine and communication devices. Generally the conventional base fluids which are usually used in cooling are not sufficient to meet the growth in these fields particularly in electronic chip and computing technologies. For this increasing demand, intensive research on nanofluids has been triggered using various types of nanoparticles. As the particle size decreases, the surface area increases. This property enhances the heat transfer capability of the nanoparticles which in turn enhances

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