THERMAL CONDUCTIVITY AUGMENTATION OF ZnO NANOFLUIDS FOR COOLANT APPLICATIONS

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ABSTRACT

The ZnO Nano particles are Synthesized by using metal organic complex of Zinc using microwave radiation. The nanoparticles are blended with distilled water by sonication and improvement in thermal conductivity is measured for different concentrations of nanoparticles

Key words: Nanofluids, Microwave radiation, Thermal conductivity

I. INTRODUCTION

The heat transfer is everyday phenomenon which depends on thermal conductivity of the medium through the flow of heat occurs. The other factors like temperature gradient and area through which heat transfer takes place are fixed and most of the times cannot be modified. Nanofluids are effective and efficient for improving heat flow. The nanofluids are synthesized by either single step are two step. In single step the evaporated metal is made combine with a thin film of base fluid placed on rotating ring. The nanofluids can also be produced by micro reactor in which precursors are made to flow through tubes of very small diameter bore bringing the reactants very close to each other and micro reactor can be placed in hot water bath if heat is needed to bring about the reaction. The two-step method, which is widely used consists of preparation of nanoparticles and later blending them with different base fluids and can be customized to specific applications**.** Cooling is one of the most important technical challenges facing many diverse industries, including microelectronics, transportation, solid-state lighting, and manufacturing. Technological developments such as microelectronic devices with smaller (sub-100 nm) features and faster (multi-gigahertz) operating speeds, higher-power engines, and brighter optical devices are driving increased thermal loads, requiring advances in cooling. The conventional method for increasing heat dissipation is to increase the area available for exchanging heat with a heat transfer fluid. However, this approach requires an undesirable increase in the thermal management system's size. There is therefore an urgent need for new and innovative coolants with improved performance. The novel concept of 'nanofluids' – heat transfer fluids containing suspensions of nanoparticles has been proposed as a means of meeting these challenges[1].

Nanofluids are solid-liquid composite materials consisting of solid nanoparticles or nanofibers with sizes typically of 1-100 nm suspended in liquid. Nanofluids have attracted great interest recently because of reports of greatly enhanced thermal properties. For example, a small amount (<1% volume fraction) of Cu nanoparticles or carbon nanotubes dispersed in ethylene glycol or oil is reported to increase the inherently poor thermal conductivity of the liquid by 40% and 150%, respectively[2, 3]. Conventional Particle-liquid suspensions require high concentrations (>10%) of particles to achieve such enhancement. However, problems of rheology and stability are amplified at high concentrations, precluding the widespread use of conventional slurries as heat transfer fluids. In some cases, the observed enhancement in thermal conductivity of nanofluids is orders of magnitude larger than predicted by well-established theories. Other perplexing results in this rapidly evolving field include a surprisingly strong temperature dependence of the thermal conductivity[4,5] and a three-fold higher critical heat flux compared with the base fluids[6,7]. These enhanced thermal properties are not merely of academic interest. If confirmed and found consistent, they would make nanofluids promising for applications in thermal management. Furthermore, suspensions of metal nanoparticles are also being developed for other purposes, such as medical applications including cancer therapy[8]. The interdisciplinary nature of nanofluids research presents a great opportunity for exploration and discovery at the frontiers of nanotechnology[9]. A two-step process works well in some cases, such as nanofluids consisting of oxide nanoparticles dispersed in deionized water[10]

II. EXPERIMENTAL WORK

The ZnO nanorods are synthesized by using a metal organic complex of zinc[11]. The schematic molecular structure of Zn(acac)2 is as shown in fig.1 The zinc acetylacetonate Zn (acac) 2. is mixed with ethanol and stirred by using magnetic stirrer. The surfactant SDS (sodium dodecyl sulphate) is added to ethanol and metal organic complex mixture. The mixture is subjected to microwave radiation for 1min and colloidal white nanoparticles are separated by centrifugation The dried sample is subjected to XRD and Scanning electron microscopy analysis. The XRD of the sample is as shown in fig.1 and SEM photographs are shown in fig.2. All the diffraction peaks could be indexed to ZnO hexagonal structure (JCPDS File No – 05-0664). The thermal conductivity is measured by using KD2 Pro Thermal analyzer

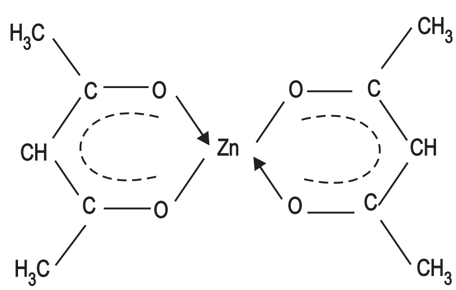

Fig. 1. The schematic molecular structure of Zn(acac)2.

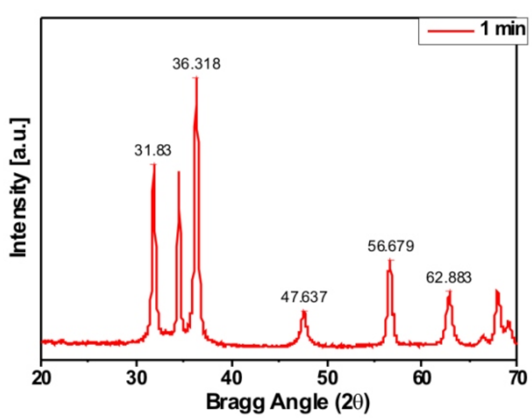

Fig. 2. XRD of sample for 1min

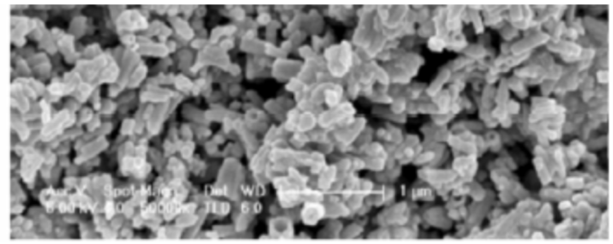

Fig. 3. SEM analysis of Sample

III. RESULTS AND DISCUSSION

The improvement in Thermal conductivity of water containing nano rods of Zno is evident from experimental results as shown in fig.4. The improvement in conductivity is attributed to increased surface area of nano particles and Brownian motion of nano particles dispersed in base fluid.

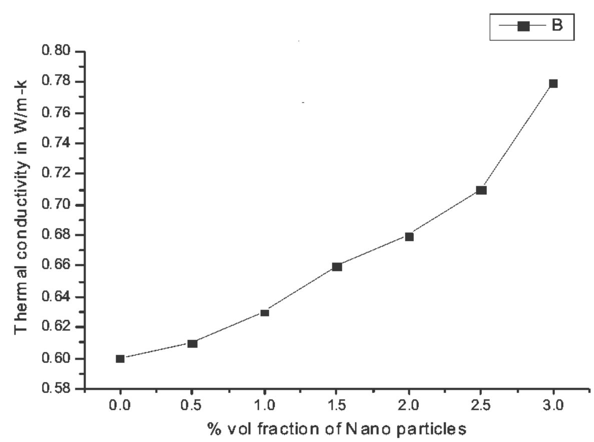

Fig. 4. Thermal conductivity for different concentrations of particle loading

The experiments were carried out at room temperature and further rise in conductivity can be expected with rise in temperature.

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