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Nanofluids and Stability

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ABSTRACT

Nanofluid is a kind of new engineering material consisting of solid nanoparticles with sizes typically of 1–100 nm suspended in base fluids. In this study, Al2O3- H2O and CuO –H2O nanofluids is synthesized and stabilized by using Ultrasonic vibration and magnetic stirrer procedure. We used each procedure for 2hrs. For this experiment we used Sodium dodecyl sulphate (SDS) as a surfactant to provide better dispersion property. Results shows that for Al2O3 and CuO nanoparticles dispersed in DI water as a base fluid with SDS as a surfactant followed by ultrasonic vibration and magnetic stirrer for 2hrs gives stability for 5 days.

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I. INTRODUCTION

Nanoparticles are particles between 1 and 100 nanometres in size. In nanotechnology, a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties. Particles are further classified according to diameter. Ultrafine particles are the same as nanoparticles and between 1 and 100 nanometers in size. Coarse particles cover a range between 2,500 and 10,000 nanometers. Fine particles are sized between 100 and 2,500 nanometers. Low thermal conductivity of process fluid hinders high compactness and e€ectiveness of heat exchangers, although a variety of techniques is applied to enhance heat transfer. Improvement of the thermal properties of energy transmission fluids may become a trick of augmenting heat transfer. An innovative way of improving the thermal conductivities of fluids is to suspend small solid particles in the fluids. Several of powders such as metallic, non-metallic and polymeric particles can be added into fluids to form slurries. The thermal conductivities of fluids with suspended particles are expected to be higher than that of common fluids [1]. For a two-phase system, there are some important issues we have to face. One of the most important issues is the stability of nanofluids, and it remains a big challenge to achieve desired stability of nanofluids [2]. The nanofluids have often been synthesized either by a twostep approach that first generates nanoparticles and subsequently disperses them into base fluids [10]. The zeta potential and particle size of the particles were measured and the Derjaguin–Landau–Verwey–Overbeek (DLVO) theory was used to calculate attractive and repulsive potentials. The thermal conductivity was measured by a hot disk thermal constants analyser .

PROPERTIES OF COMMERCIAL MATERIALS

Figure1 and 2shows the TEM images of the selected nanoparticles. The particle sizes of CuO and Al2O3 observed in SEM image is 50nm and100nm respectively indicating that these commercial metal oxide particles are in the nanoscale range.

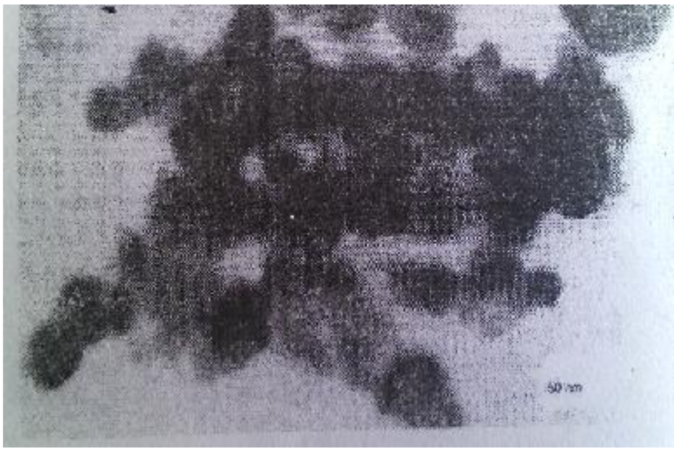

Fig.1TEM analysis of CuO nanopowder

Fig.2 TEM analysis of Al2O3 nanopowder

II. PREPARATION METHODS FOR NANOFLUIDS

1. Two-Step Method:Two-step method is the most widely used method for preparing nanofluids. Nanoparticles, nanofibers, nanotubes, or other nanomaterials used in this method are first produced as dry powders by chemical or physical methods. Then, the nanosized powder will be dispersed into a fluid in the second processing step with the help of intensive magnetic force agitation, ultrasonic agitation, high-shear mixing, homogenizing, and ball milling. Two-step method is the most economic method to produce nanofluids in large scale, because nanopowder synthesis techniques have already been scaled up to industrial production levels. Due to the high surface area and surface activity, nanoparticles have the tendency to aggregate. The important technique to enhance the stability of nanoparticles in fluids is the use of surfactants. However, the functionality of the surfactants under high temperature is also a big concern, especially for high-temperature applications [2].

2. One step method: Few methods exist for the preparation of nanofluids through a one step process. These methods include the thermal decomposition of an organometallic precursor in the presence of a stabilizer, chemical reduction, and polyol synthesis. The polyol method is one of the most well-known pathways to noble metal nanoparticles. In the polyol process, a metal precursor is dissolved in a liquid polyol (usually ethylene glycol), after which the experimental conditions are adjusted to achieve the reduction of the metallic precursor by the polyol, followed by atomic metal nucleation and metal particle growth. The direct evaporation. Technique was developed by Choi et al. It consists of a cylinder containing a fluid which is rotated. In the middle of the cylinder, a source material is vaporized. The vapour condenses once it comes into contact with the cooled liquid. The drawbacks of this technique however, are that the use of low vapour pressure liquids are essential and only limited quantities can be produced. Various single-step chemical synthesis techniques can also be employed to produce nanofluids. For example, Brust and co-workers developed a technique for producing metallic nanoparticles in various solvents by the reduction of metal salts to produce colloidal suspensions for a wide range of applications, including studies of thermal transport. Excellent control of size and very narrow size distributions can be obtained by using such methods. A submerged arc nanoparticle synthesis system (SANSS) was developed to prepare CuO nanoparticles dispersed uniformly in a dielectric liquid (deionised water). The method successfully produced a stable nanofluid. In principle, a pure copper rod is submerged in a dielectric liquid in a vacuum chamber. A suitable electric power source is used to produce an arc between 6000 - 12000 °C which melts and vaporizes the metal rod in the region where the arc is generated. At the same time, the deionised water is also vaporized by the arc. The vaporized metal undergoes nucleation, growth and condensation resulting in nanoparticles dispersed in deionised water. Nanofluids containing CuO particles of size 49.1 ± 38.9 nm were obtained.

III.THE STABILITY OF NANOFLUID

The agglomeration of nanoparticles results in not only the settlement and clogging of micro channels but also the decreasing of thermal conductivity of nanofluids. So, the investigation on stability is also a key issue that influences the properties of nanofluids for application, and it is necessary to study and analyze influencing factors to the dispersion stability of nanofluids. For stability of nanofluid we added 0.5%wt of surfactant for dispersion stability. For stability of nanofluids following procedure is followed

1. Magnetic stirrer:
A magnetic stirrer or magnetic mixer is a laboratory device that employs a rotating magnetic field to cause a stir bar (also called "flea") immersed in a liquid to spin very quickly, thus stirring it. The rotating field may be created either by a rotating magnet or a set of stationary electromagnets, placed beneath the vessel with the liquid. Since glass does not affect a magnetic field appreciably (it is transparent to magnetism), and most chemical reactions take place in glass vessels (i.e. see beaker (glassware) or laboratory flasks), magnetic stir bars work well in glass vessels. On the other hand, the limited size of the bar means that magnetic stirrers can only be used for relatively small (under 4 liters) experiments. In this experiement we used this procedure for 2hrs.

Fig.3 Magnetic stirrering of Al2O3 nanofluid

Fig.4 Magnetic stirrer of CuO nanofluid

2. Ultrasonic Vibration:
In this procedure ultrasonic vibration is produced to provide better dispersion stability. It consist of pot for which ultrasonic machine is attached. Depending upon requirement of vibration, we can adjust the vibration ability of pot. In this experiment we used procedure for 2hrs.

Fig.5 Ultrasonic vibration of Al2O3 nanofluid

IV. RESULTS AND CONCLUSIONS

In this paper we given different types of procedure required for nanomaterial stability. By using 2hrs magnetic stirrer and 2hrs ultrasonic vibration respectively, we can obtain 4 days stability. For the stability procedure we used 0.02%wt of surfactant for dispersion stability.For further research there is requirement of more study which will provide more better stability in less experimental time.

REFERANCES

[1] YiminXuan ,Qiang Li,2000, "Heat transfer enhancement of nanofluids", International Journal of Heat and Fluid Flow 21, pp58-64.

[2] Wei Yu and HuaqingXie, 2012, "A Review on Nanofluids: Preparation, Stability Mechanisms, and Applications", Journal of Nanomaterials, Volume 2012, Article ID 435873.

[3] W.C. Williams, I.C. Bang, E. Forrest, L. W. Hu*, J. Buongiorno, 2006, "Preparation and Characterization of Various Nanofluids", NSTI-Nanotech, ISBN 0-9767985-7-3 Vol. 2.

[4] L.H. Bac, J.S. Kim and J.C. Kim, "Size, optical and stability properties of gold nanoparticles synthesized by electrical explosion of wire in different aqueous media", Rev. advanced material science 28, pp 117-121.

[5] Ho Jin Kim, In Cheol Bang, JunOnoe, "Characteristic stability of bare Au-water nanofluids fabricated by pulsed laser ablation in liquids", Optics and Lasers in Engineering 47,pp532–538.

[6] Dongsheng Zhu, Xinfang Li, Nan Wang, Xianju Wang, JinweiGao, Hua Li, "Dispersion behavior and thermal conductivity characteristics of Al2O3–H2O nanofluids",Current Applied Physics 9pp 131–139.

[7] M. Farahmandjou1, S. A. Sebt, S. S. Parhizgar, P. Aberomand1, M. Akhavan, "Stability Investigation of Colloidal FePt Nanoparticle Systems by Spectrophotometer Analysis", Chinese Physical Society and IOP Publishing Ltd, Vol. 26, No. 2, 027501.

[8] Xuefei Yang, Zhen-hua Liu, "A Kind of Nanofluid Consisting of Surface Functionalized Nanoparticles", Nanoscale Res Letter, 5, pp1324–1328.

[9] N. S. Souza, S. Sergeenkov, C. Speglich, V. A. G. Rivera, C. A. Cardoso, H. Pardo, A. W. Mombrú, A. D. Rodrigues, O. F. de Lima, and F. M. Araújo-Moreira, "Synthesis, characterization, and magnetic properties of room-temperature nanofluid ferromagnetic graphite", APPLIED PHYSICS LETTERS, 95, 233120.

[10] Xiaohao Wei, Haitao Zhu, Tiantian Kong, Liqiu Wang, "Synthesis and thermal conductivity of Cu2O nanofluids", International Journal of Heat and Mass Transfer 52,pp 4371–4374.

