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Experimental Evaluation of Vegetable Oil Based Copper Oxide Hybrid Nano Fluid as a Lubricant in Turning

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***Abstract* - This thesis represents a brief report on synthesis and characterization of CuO nano particles and hybrid nanofluid are produced by mixing of CuO nanoparticles as additive into the mixture of soyabean and castor oil in the ratio 1:1 and nano particles were synthesized by solgel method later these CuO nanoparticles are characterized by X-RD and FESEM with EDX analysis, after confirmation of elemental analysis and nano particles size, copper oxide nano particles 0patsized were dispersed into hybrid base fluid of different concentrations of wt.% (0.0wt1%, 0.02wt%,0.03wt%,0.04wt%,0.05wt%) Experimental analysis was carried on these five samples including base fluid such as contact angle is measured by using Goniometer, viscosity studies at different temperature using Redwood Viscometer-II, turning performance were analyzed by measuring tool tip temperature, cutting forces in x,y,z direction and surface finish of the final machined work piece was measured by using surface roughness tester**

***Index Terms* - vegetable oil, copper oxide, nano fluid, lubricant**

INTRODUCTION

Nanofluids are two phase mixtures engineered by dispersing nanometre sized particles with sizes ranging below 100 nm in base fluids (Sarit K. Das et al. 2008). The nanometer sized particles are used for the dispersion in base fluids are nanoparticles, nanofibers, nanotubes and nanorods. Materials generally used as nanoparticles include metal oxides (e.g., silica, alumina, titania, zirconia), oxide ceramics (e.g. Al2O3, CuO), chemically stable metals (e.g. copper, gold), carbon in various forms (e.g., diamond, graphite, carbon nanotubes, fullerene) metal carbides (e.g. SiC) and functionalized nanoparticles. The base fluid types include oils, water, organic liquids such as glycols, refrigerants, polymeric solutions, bio fluids, lubricants and other common liquids.

1.PREPARATION METHODS FOR NANOFLUIDS

The initial key step in experimental studies with nanofluids and the optimization of nanofluid thermal properties requires successful preparation methods for producing stable suspensions of nanoparticles in liquids. Some special requirements are essential that means negligible agglomeration of particles, durable,uniform and stable suspension and no chemical change of the fluid, etc. There are two main techniques adopted for the preparation of nanofluids: single-step method and two-step method.

1.1 Single step method

Single step method simultaneously produces and disperses nanoparticles directly into the base fluid medium which is suitable for metallic nanofluids. The aggregation problem can be much reduced with direct evaporation condensation method. The inert-gas technique involves the vaporization of source material in a vacuum. In this process of preparation, the condensation forms nanoparticles through direct contact between the base fluid and vapour.

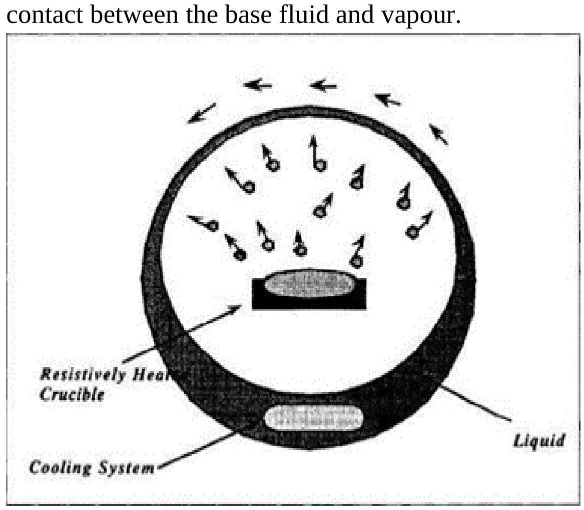

Fig 1.1 Schematic representation of one-step method of nanofluid preparation

The continuous circulation of base fluids minimise the agglomeration of nanoparticles. The schematic representation of direct evaporation condensation technique is shown in figure 1.1. The researchers from Argonne National Laboratory reported another interesting technique is laser ablation technique, in which the metal nanoparticles in deionized water are synthesized by using multi-beam laser ablation in liquids, where the laser parameters controls the size and distribution of nanoparticles.

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1.2 Two step method

Two-step method is the most common method for preparation of nanofluids and its schematic representation is shown in figure 1.2. Nanosized solid particles such as nanorods, nanofibers, nanotubes or other functionalized nanomaterials are used in this method. Nanoparticles are initially synthesized in powder form by physical or chemical methods. Then, the nanosized powder particles are dispersed in base fluid in the successive processing step with the aid of intensive ultrasonication method or by using surfactants. This method is most widely used economic method for large scale production of nanofluids, since nanoparticle synthesis techniques were scaled up to industrial production levels.

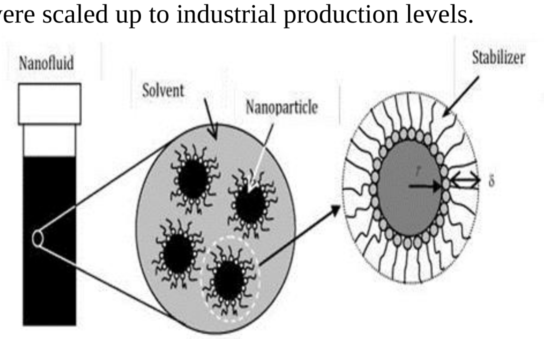


Figure 1.2 Schematic representation of two-step method of nanofluid preparation

when it moves from a high temperature region to low temperature region and gives up this energy through collisions with lower energy molecules. Thermal conductivity of some typical liquids is high. Thermal energy will be conducted in solids by two modes: transport by free electrons and lattice vibration.

1.3 PREPARATION OF NANOFLUID

Nanofluids are new class of fluids powered by dissolving nanometer sized materials such as nanoparticles, nanofibers, nanotubes in base fluid. Nanofluid is used as heat transfer fluid prepared by dispersing nanoparticle in water/ethylene glycol to enhance thermal conductivity and also heat transfer performance. The thermal conductivities of metal nano fluids like Al, Cu, Ag, Mg, and Fe are higher in nature. Thereby, fluids having solid metallic particles are suggestively improved thermal conductivities which will be useful for conventional heat transfer fluids. Normal fluids have low heat transfer properties compared to most metallic fluids. The improvement of thermal characteristics in heat transfer nanofluid will solve the thermal issue of energy devices. Still researchers are working in synthesis and characterization of nano fluids to find out better thermal property. So nanofluids are suitable to use under flow conditions and the flow of suspension. But these Nano fluids are different from normal heat transfer fluids which have Newtonian characteristics. The rheological properties of nanofluid will ensure the heat transfer property and thermal characteristics. To develop the mechanism of heat transfer enhancement, the fluid-particle and particle- particle interactions within the fluid should have been widely studied. The rheological properties of micro particles under both static and dynamic conditions are completely different from the rheological properties of nanoparticles. The rheological property of nanofluids is studied to understand the mechanism of heat transfer enhancement. In this research, we investigated the optimum thermal conductivity and rheological properties of copper oxide nanofluid dispersed in water/ethylene glycol.

1.4 SELECTION OF NANOPARTICLES:

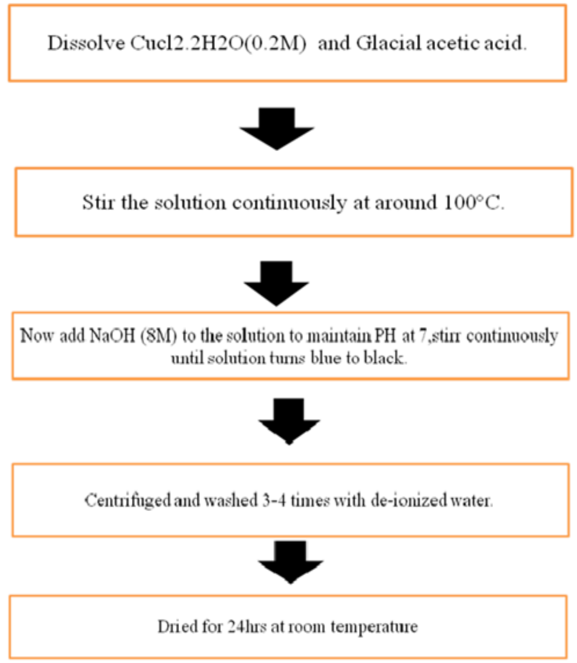
The thermal conductivity of heating or cooling fluids is a very important property in the development of energy efficient systems. The thermal conductivity of the fluids is one of the basic properties taken into account in designing and controlling the process. Materials used for nanoparticles include chemically stable metals (e.g., Aluminium, Gold,Copper,silver) metal oxides (e.g., Alumina, Copper oxide,silica, Zirconia, Titanium) and carbon in various forms (e.g., Diamond, Graphite, Carbon nanotubes etc.). Prime factors to be considered are ease of availability, costs, thermal conductivity, tendency of the particles to hold them into base fluid with negligible agglomeration etc. Even though metal particles have better thermal conductivity, they have more inclination to agglomerate compared to metal oxides. Present in this work Silica and Tungsten oxide were used.

METHODOLOGY

Introduction: In these present experimental studies, nanofluids are prepared in a two-step process. The main advantage of this two-step preparation method is that it produces nanoparticles under clean conditions, without undesirable surface coatings and other contaminants. The fabrication of nanomaterials with well-defined structures and precisely controlled sizes is crucial to the development of nanotechnology. Therefore, rapid research developments have been made in the field of metal oxide nanostructures in terms of their growth and applications. In this chapter, the information about the preparation of copper oxide and hybrid base fluid is taken which means mixture of two or more fluids i.e. castor oil and soybean oil and studied about viscosity at different temperatures

MATERIALS USED FOR PREPARING NANOPOWDER

1. Copper chloride ($CuCl_2$)
2. Sodium Hydroxide (NaoH) Pellets
3. Distilled water
4. Glacial acetic acid
5. Hydrochloric acid (HCl)
6. Acetone
7. Ultrasonic cleaner
8. Magnetic stirrer
9. Muffle furnace
10. Planetary ball mill



Magnetic Stirrer

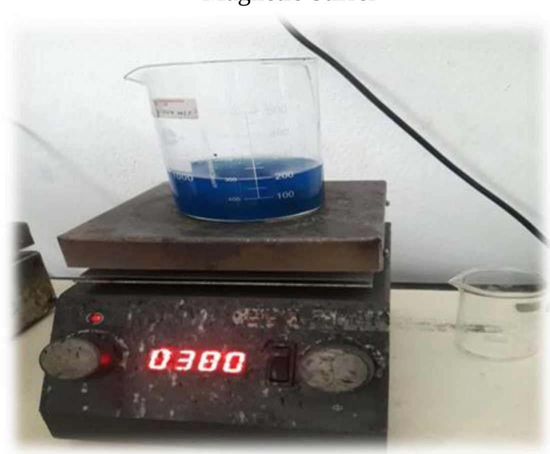


Fig $CuCl_2$ solution on Magnetic stirrer

Fig Adding 8M NaoH solution dropwise, Color is changing bluish Green to black precipitate

Fig Filtration process

Fig 3.6 Hand grinding process

Weight percentage	CuO in grams	Castor oil soybean oil (1:1 ratio)
0.01%	0.00935	50ml+50ml
0.02%	0.01803	50ml+50ml
0.03%	0.02811	50ml+50ml
0.04%	0.0468	50ml+50ml

Hybrid nano fluids

Fig: Visual inspection day by day (day1)

Fig: Particles settled down (day11) by visual inspection

Fig: FESEM

CONCLUSION

The investigation has been carried out on hybrid-nanofluid with weight percentage of copper oxide (0.01%,0.02%,0.03%,0.04% and 0.05%) with base fluids soybean oil and castor oil in the ratio 1:1, copper oxide is prepared by using sol gel method, for the confirmation of particle and crystalline size X-RD and FESEM will be done then nano particles were dispersed into base fluid after that contact angle, tool tip temperate, cutting forces during the machining process and surface roughness were measured which defines the quality of the product

The experimentation is carried gives the following results:

- X-RD testing gives the crystalline size gives 22nm(approx.)
- FESEM and EDX gives size of the nano particles under the range of 45-60 nm
- Viscosity is studied by using Redwood Viscometer-II which gives base fluid with 0.05% of CuO shows more viscosity when compared to remaining all fluids
- The contact angle of nanofluids has decreased with increase in concentration of nanoparticles in base fluid, and 0.05 wt.% nanofluid has the least contact angle. The decrease in contact angle increases the wetting area thereby increasing the lubrication effect.
- Tool tip temperature has decreased when nanofluids were used as cutting fluids, compared to base fluid (castor + soybean oil). The least tool tip temperature was recorded when 0.05 wt.% nanofluid was used as cutting fluid.

- When compared to base fluid, fluid with 0.02wt% gives least cutting forces
- Surface finish has enhanced at CuO 0.03% with base oil, when compared to so hybrid base fluid

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