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A Review of heat transfer enhancement using Nano fluids with different base fluids

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ABSTRACT:- *Heat transfer enhancement techniques refer to different methods used to increase the rate of heat transfer without affecting much the overall performance of the system. These techniques are used in manufacturing industries. Some of application of cooling of electronics, cooling of transformer oil, improving diesel generator efficiency, cooling of heat exchanging devices based on results available in the literatures, It has been found nano fluids have much higher and strongly temperature – dependent, thermal conductivity at very low particle concentration than conventional fluids. So many researchers have shown that the thermal conductivity and the convection heat transfer co-efficient of the fluid can largely enhance by suspended nano particles. The most of the oxide nanofluids are ineffective as heat transfer liquids and certain CNT nanofluids are effective.*

Keywords:*NanofluidsBasefluids,Stability,MWCNT,Sonication.*

INTRODUCTION

Machining experiences high temperatures due to friction between the tool and work piece. Temperatures can be controlled by reducing the friction between tool-work piece and tool-chip interface with the help of effective lubrication. Nano-particles are an excellent media to increase the thermal conductivity of the base fluids [1, 2]. Nano fluids have also been used in a variety of mechanical machining processes. Nano fluids were first innovated by Choi [3] in 1995 at the Argonne National Laboratory, USA. Compared with traditional slid-liquid suspensions containing millimetre or micrometer sized particles, nanofluids as coolants in the heat exchangers have shown better heat transfer performance because of small size of suspend solid particles. Many research groups experimentally reported that the thermal properties of carbon nanotubes CNT suspensions were much higher than those of other nanoparticles with the small volume fraction [4-6]. The addition of CNT improves the thermal conductivity of nanofluids but it can also increase the dynamic viscosity and affect the density and the heat capacity. This shows that these properties are closely correlated. In fact, a significant increase in viscosity can lead to a significant pressure drop which can reduce the practical benefits of nanofluids in some industrial applications [7, 8]. Ding et al. [9] found that thermal conductivity of CNT based nanofluid increases significantly with the temperature by 15% at 20 ^{o}C, 30% at 25 ^{o}C and by 79% at 40 ^{o}C at the same volume fraction. Meng et al. [10] showed that the relative thermal conductivity of CNT based nanofluid is independent of temperature for temperature range from 15 to 55 ^{o}C. These results are consistent with those found by Yu et al. [11] and Chen et al. [12]. To promote the performance of machine tools and to regulate the machining conditions, different kinds of cutting fluids have long been used in machining. The cutting fluids are found to improving the machining quality by their cooling effect (through the reduction in localised heating zone, thermal expansion and distortion of the work-piece) and by their lubrication effect (in the reduction of cutting force, extension of tool life, etc.).

PAST REVIEW OF WORK

P.Vamsi Krishna et.al [13]:- This paper describes a specific study on the application of nanosolid lubricant suspensions in lubricating oil in turning of AISI 1040 steel with carbide tool. SAE-40 and coconut oil were taken as base lubricants and Boric acid solid lubricant of 50nm particle size as suspensions. The volume concentration of nanoparticle is from 0.25% to 5%. From the result, Thermal conductivity increased and specific heat decreased with percentage increase in nanoboric acid in base oil. Heat transfer coefficient increased slightly with increase in percentage of nanoboric acid in base oil and cutting speed. However, cutting temperatures, tool flank wear and surface roughness were decreased significantly with nanolubricants compared to base oil due to the lubricating action of boric acid. In all the cases, coconut oil based nanoparticle suspensions showed better performance compared to SAE-40 based lubricant, due to the better lubricating properties of the base oil. Further, in both the lubricants, performance were better in terms of cutting temperatures, tool wear and surface roughness at 0.5% nanoboric acid suspensions.

Navid Bozorgan et.al [14]:- This article reports an experimental investigation on application of CuO-Water Nanofluid in Automotive Diesel engine radiator. 20nm CuO-Water nanofluid with volume concentration of 0.1 to 2% was taken as a coolant in a radiator of Chevrolet Suburban diesel engine. It shall be noted that metal oxides such as CuO nanoparticles are chemically more stable than their metallic counterparts. The results was show that for CuO-Water nanofluid at 2% of volume concentration circulating through the flat tubes with Re_{nf}=6000 while the automotive speed is 70 km/hr, the overall heat transfer coefficient and pumping power were approximately 10% and 23.8% more than that of base fluid for given condition, respectively.

Rosari Saleh et.al [15]:- reported that the thermal conductivity and viscosity were studied experimentally for Titanium Dioxide nanoparticle dispersed in distilled water. the volume concentration of nanoparticle is from 0.05% to 5% and the working temperatures ranging between 10 and 60 ^{o}C. The result of this experiment was the relative thermal conductivity of distilled water is significantly increased with the addition of Titanium Dioxide nanoparticles and with temperatures. Viscosity measurements indicated that the relative viscosity increased with increasing nanoparticle volume fraction. However, the results show that nanofluids viscosity is independent of temperature.

Salma Halefadl et.al [16]:- This paper experimentally investigated the thermo-physical properties of water based nanofluids containing carbon nano tubes (CNT) and stabilized by SDBS as surfactant. The influence of particles concentration from 0.0055% to 0.278% and temperature from 20 ^{o}C to 40 ^{o}C. On the density, thermal conductivity and viscosity of the nanofluids were presented and discussed. Based on this experiment, the density was independent of temperature and increases with particle volume fraction. A similar trend is reported for the relative density, the relative thermal conductivity increases with nanoparticle volume fraction and temperature. The relative viscosity of nanofluid was affected by both the increase in nanoparticle volume fraction and shear rate. In laminar regime, the nanofluids became efficient at 30 ^{o}C and for Reynolds numbers ranging from 180 to 330. Increasing the temperature to 40 ^{o}C, the efficiency of nanofluid is increased to higher range of Reynolds numbers. In turbulent regime, the efficiency of the nanofluid was dependant to both the decrease in particle volume and the increase in temperature.

Bizhan Rahmati et.al [17]:- This article reported, the Morphology of surface generated by end milling AL6061-T6 using molybdenum disulfide (MoS_2) nanolubrication in end milling machining. The nanolubricants were prepared by mixing Mos_2 nanoparticles (average particle size of 20 – 60 nm) with the mineral oil (ECOCUT HSG 905S) and stirred for 48 hrs followed by ultrasonication (240W, 40 kHz, 500W) for 48 hrs in order to homogenously suspended the nano particles in the mixture. The concentration of Mos_2 nanoparticles in base oil were 0.0, 0.2, 0.5 and 1.0 wt%. In case of 0.0 wt% concentration, it was purely minimal quantity lubrication (MQL) process. This experiment result showed that, the presence of MoS_2 nanoparticles in the tool–work piece interfaces, improved the quality of the machined surface. The machining of AL6061-T6 alloy with nanolubricants containing 0.5 wt% MoS_2 improved the surface roughness by 3.87% compared with pure oil in an ordinary machining process. When the nanoparticle concentrations continued to increase up to 1.0 wt% the residual content of MoS_2 was decreases.

Yabin Zhang et.al [18]:- describes experimental evaluation of MoS_2 nanoparticles in jet MQL grinding with liquid paraffin, palm oil, rapeseed oil, and soybean oil as base oil and the work piece material is C45 steel. MoS_2 with a diameter of 50nm was used as the nanoparticles. Nanoparticles are excellent media to increase the thermal conductivity of base fluid. In addition, nanoparticles have a ball/roll bearing effect, they significantly enhanced tribological and have characteristics. MoS_2 is an important solid lubricant with excellent anti-friction and anti-wear effect under high temperature and high pressure. The nanoparticle jet MQL grinding process using MoS_2 and CNT nanoparticles, and showed that nanofluids could effectively improve surface finish and reduce specific grinding energy. From the results, conclusions are, compared with liquid paraffin, palm oil has lowed coefficient of friction and specific grinding energy in nanoparticle jet MQL grinding. Therefore, vegetable oil can replace mineral oil as the base oil of nanoparticle jet MQL grinding. Compared with liquid paraffin, palm oil, soybean oil, and rapeseed oil have lower coefficient of friction and specific grinding values in the nanoparticle jet MQL grinding condition. In consideration of the difference in fatty acid type and content in three kinds of vegetable oils, the lubricating property of the three kinds of vegetable oils had the following order: palm oil < rapeseed oil < soybean oil. The difference in lubrication effect for three types of vegetable oils as base oil was small, particularly the coefficient of friction value, which only has a 0.04 difference between rapeseed oil and palm oil values. However, soybean oil viscosity was only 20% of palm oil viscosity. A low grinding temperature can be attaining using soybean oil as base oil. In such case, considering the slight influence of viscosity is more suitable as the base oil of nanoparticle jet MQL grinding. The addition of MoS_2 nanoparticles in soybean oil increases nanoparticle concentration, and nanoparticle jet MQL grinding viscosity increases correspondingly with the increased acting force among molecules. High viscosity can produce a good lubricating property, and the increase in nanoparticle concentration can optimize the lubricating property. Nanoparticle concentration has the best range, but the addition of excessive MoS_2 nanoparticles might have resulted in nanoparticle agglomeration that reduces the good lubricating property. The optimal concentration of nanoparticle MoS_2 measured in the experiment was 6%. Vegetable oil contained abundant unsaturated bonds and carbon-carbon double bonds, which are easily oxidized by oxygen in air and lead to vegetable oil degradation. Therefore, antioxidants such as Vitamin E should be added during the experimental process to maintain oil stability.

Thadathil S. Sreeremya et.al [19]:- this article experimentally investigated the synthesis and characterization of cerium oxide based nanofluids: an efficient coolant in heat transport application. Used surface modified ceria nanoparticles for fabrication of a highly stable and thermo conductive fluid. Surface modified and well dispersed ceria nanocrystals of cubic morphology have been successfully synthesized by a comparatively simple method involving the thermolysis of respective oleate precursor. The surface functionalized nanocrystals were ideal for nanofluid preparation as they offered long term stability. The enhanced thermal conductivity offered by ceria nano fluid could be attributed to small sizes of particles and the compatibility of surfaced modified nanoparticles with the base fluid. The results of the experiment were, ceria-oil nanofluids exhibited long term stability > 5 months. Less amount of vol% of nanoparticle concentration gave good result in thermal conductivity. Oil-based nanofluids containing ceria nanoparticles showed shear-thinning behaviour and produced 14.6% enhancement in thermal conductivity at 50 ^{o}C with 0.7 vol% solid loading.

CONCLUSION

By refer the above journals we conclude that,
1. Nano fluids had more thermal conductivity than compared to conventional fluids.
2. The overall heat transfer co-efficient and pumping power eas increased by using nanofluids.
3. Quality of the machined surface was increase due to nano fluids.

From the above statements we conclude that the thermal conductivity & heat transfer co-efficient was increased by using the single wall CNT nanofluids than conventional fluids.

When we used the Multi Wall CNT nanofluids instead of using single wall CNT, the properties like thermal conductivity & heat transfer co-efficient should have been increased more than single wall CNT nanofluids.

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