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# Potential of Nanofluids as Cutting Fluids - An Evolution

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***Abstract* - Heat generation is the common phenomenon associated with machining zone. To protect the workpiece from thermal damage , coolant is required at the cutting zone. Cutting fluids commonly known as coolants limit the energy transferred to the work piece . In the past century various cutting fluids have been developed. Still there is a need to control the temperature of cutting zone. Nanofluids are the latest innovations to enhance the heat carrying capacity of lubricants. This paper reviews the latest developments in nanofluids. The review also highlighted the various challenges for the researchers.**
***Keywords*:Nanofluids, thermal conductivity, coolants.**

## I.INTRODUCTION

Cutting fluids commonly used in machining zone for cooling, lubrication and chip evacuation. Cooling always remains major challenge for the manufacturing industry [1] [2]. Hard materials produced a lot of heat during machining, conventional methods of cooling stretched to their limits [3, 4]. Large quantity of cutting fluids were used for efficient cooling of machining zone. This cooling is referred as flood cooling. Lately questions were arises on the negative effects of excessive use of cutting fluids. They are harmful to workers as they hazardous gases at the cutting zone, also they damaged the soil when appropriately discharged into the ground[5] . There is a need to eliminate traditional cutting fluids and to develop new fluids[6]. Nanofluids is one of the new concept.

## II.NANOFLUIDS

Nanofluids, which are solid–liquid composite materials consisting of nanometer sized solid particles, fibers, rods or tubes suspended in different base fluids , provide a promising technical selection for enhancing heat transfer because of its many advantages besides anomalously high thermal conductivity[7]. Solid metals with high thermal conductivity can be used as nano- particles in base fluid to form nanofluids. Water, oil ethylene glycol are commonly used base fluids. Preparation of nano particles plays a key role in enhancing thermal conductivity. Two popular method of producing nano-particles are one step method and two step method. Eastman et al[8] produced the nanofluids by one-step physical method. Liu[ produced waterbased nanofluid using Cu nanoparticles by chemical reduction method[9]. Hong[10] prepared Fe nanofluids by dispersing Fe nanocrystalline powder in ethylene glycol by a two-step procedure.Thermal conductivity [11] of various metal commonly used for nanoparticles are shown in table1.

TABLE 1 THERMAL CONDUCTIVITY OF VARIOUS NANOPARTICLES AND BASE FLUID

| | Material | W/mK |
|---|---|---|
| Metallic Solids | Cu | 401 |
| | Al | 237 |
| | Ag | 428 |
| | Au | 318 |
| | Fe | 835 |
| Non-Metallic Solids | $Al_2O_3$ | 40 |
| | CuO | 76.5 |
| | Si | 148 |
| | SiC | 270 |
| | CNTs | 3000 |
| Base Fluids | $H_2O$ | 0.613 |
| | Ethylene Glycol | 0.253 |
| | Engine Oil | 0.145 |

## III.THERMAL CONDUCTIVITY OF NANOFLUIDS

Eastman et al. [8], found that effective thermal conductivity of ethylene glycol is shown to be increased by up to 40% for a nanofluid consisting of ethylene glycol containing approximately 0.3 vol% Cu nanoparticles of mean diameter ,10 nm. Liu et al. [9] show that Cu–water nanofluids with low concentration of nanoparticles have noticeably higher thermal conductivities than the water base fluid without Cu. For Cu nanoparticles at a volume fraction of 0.001 (0.1 vol.%), thermal conductivity was enhanced by up to 23.8%. Hwang et al.[12] measured thermal conductivity enhancement of water-based MWCNT nanofluid up to 11.3% at a volume fraction of 0.01. The measured thermal conductivities of MWCNT nanofluids were higher than those calculated with Hamilton–Crosser model due to neglecting solid–liquid interaction at the interface. The results shows that the thermal conductivity enhancement of nanofluids depends on the thermal conductivities of both particles and the base fluid. In comparison with other nano structured materials dispersed in fluids, the nanotubes provide the highest thermal conductivity enhancement, opening the door to a wide range of nanotube applications. Thermal conductivity enhancement of poly oil with the addition of multiwalled carbon nanotubes (MWCNT) at 1% volume fraction was increased by 150% as reported by Choi et al.[13]. Kang et al.[14] measured the thermal conductivity of ethylene glycol with 1.2% (v/v) diamond nanoparticles between 30 and 50nm in diameter . Remarkable results were obtained showing 75% enhancement. Lee et al.[15] revealed thermal conductivity of nanofluids is affected by pH level and addition of surfactant during nanofluids preparation stage. Yu et al. [16] conclude thermal conductivity of ethylene glycol based ZnO nanofluids measured by transient short hot wire technique is found to be increased non-linearly with nanoparticles volume fraction. Shen [17] also concluded that enhancement of thermal conductivity of metallic and non-metallic nanofluids.

## IV.CONCLUSIONS

It has been found that enhanced thermal conductivities of nanofluids have attracted attention of researchers for many potential applications. As heat transfer has been enhanced so many devices can be made more efficient. Nanofluids has the potential to be used as coolant at the machining zone. There are challenges for the researchers regarding stability and production cost of nanofluids.

## REFERENCES

[1] A. M. El-Tamimi and T. M. El-Hossainy, "Investigating the Tool Life, Cutting Force Components, and Surface Roughness of AISI 302 Stainless Steel Material Under Oblique Machining," *Materials and Manufacturing Processes,* vol. 23, pp. 427-438, 2008.

[2] V. N. Gaitonde, S. R. Karnik, L. Figueira, and J. P. Davim, "Analysis of Machinability During Hard Turning of Cold Work Tool Steel (Type: AISI D2)," *Materials and Manufacturing Processes,* vol. 24, pp. 1373-1382, 2009/12/21 2009.

[3] W. J. Deng, W. Xia, C. Li, and Y. Tang, "Ultrafine Grained Material Produced by Machining," *Materials and Manufacturing Processes,* vol. 25, pp. 355-359, 2010/05/28 2010.

[4] D. Kurniawan, N. M. Yusof, and S. Sharif, "Hard Machining of Stainless Steel Using Wiper Coated Carbide: Tool Life and Surface Integrity," *Materials and Manufacturing Processes,* vol. 25, pp. 370-377, 2010/05/28 2010.

[5] M. Soković and K. Mijanović, "Ecological aspects of the cutting fluids and its influence on quantifiable parameters of the cutting processes," *Journal of Materials Processing Technology,* vol. 109, pp. 181-189, 2/1/ 2001.

[6] R. A. Irani, R. J. Bauer, and A. Warkentin, "A review of cutting fluid application in the grinding process," *International Journal of Machine Tools and Manufacture,* vol. 45, pp. 1696-1705, 12// 2005.

[7] M. S. G. Prasad and D. N. Drakshayani, "Studies on Passive Cooling Techniques in Dry Machining," *Materials and Manufacturing Processes,* vol. 25, pp. 360-369, 2010/05/28 2010.

[8] J. A. Eastman, S. U. S. Choi, S. Li, W. Yu, and L. J. Thompson, "Anomalously increased effective thermal conductivities of ethylene glycol-based nanofluids containing copper nanoparticles," *Applied Physics Letters,* vol. 78, p. 718, 2001.

[9] M.-S. Liu, M. C.-C. Lin, C. Y. Tsai, and C.-C. Wang, "Enhancement of thermal conductivity with Cu for nanofluids using chemical reduction method," *International Journal of Heat and Mass Transfer,* vol. 49, pp. 3028-3033, 8// 2006.

[10] T.-K. Hong, H.-S. Yang, and C. J. Choi, "Study of the enhanced thermal conductivity of Fe nanofluids," *Journal of Applied Physics,* vol. 97, p. 064311, 2005.

[11] Y. Li, J. e. Zhou, S. Tung, E. Schneider, and S. Xi, "A review on development of nanofluid preparation and characterization," *Powder Technology,* vol. 196, pp. 89-101, 2009.

[12] Y. J. Hwang, Y. C. Ahn, H. S. Shin, C. G. Lee, G. T. Kim, H. S. Park, *et al.*, "Investigation on characteristics of thermal conductivity enhancement of nanofluids," *Current Applied Physics,* vol. 6, pp. 1068-1071, 10// 2006.

[13] S. U. S. Choi, Z. G. Zhang, W. Yu, F. E. Lockwood, and E. A. Grulke, "Anomalous thermal conductivity enhancement in nanotube suspensions," *Applied Physics Letters,* vol. 79, p. 2252, 2001.

[14] H. U. Kang, S. H. Kim, and J. M. Oh, "Estimation of Thermal Conductivity of Nanofluid Using Experimental Effective Particle Volume," *Experimental Heat Transfer,* vol. 19, pp. 181-191, 2006/09/01 2006.

[15] J.-H. Lee, K. S. Hwang, S. P. Jang, B. H. Lee, J. H. Kim, S. U. S. Choi, *et al.*, "Effective viscosities and thermal conductivities of aqueous nanofluids containing low volume concentrations of Al2O3 nanoparticles," *International Journal of Heat and Mass Transfer,* vol. 51, pp. 2651-2656, 6// 2008.

[16] W. Yu, D. M. France, S. U. S. Choi, J. L. Routbort, and E. Systems, "Review and assessment of nanofluid technology for transportation and other applications," ANL/ESD/07-9; TRN: US200825%%237 United States10.2172/919327TRN: US200825%%237Mon Dec 22 09:37:14 EST 2008ANLENGLISH, 2007.

[17] B. Shen, A. J. Shih, and S. C. Tung, "Application of Nanofluids in Minimum Quantity Lubrication Grinding," *Tribology Transactions,* vol. 51, pp. 730-737, 2008.