© 2017 IJSRST | Volume 3 | Issue 3 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Preparation and Experimental Investigation of CUO Nanoparticles Based Engine OILS

Sk Salman Basha
Mechanical Engineering, Sasi Institute of Technology & Engineering, Tadepalligudem, Andhra Pradesh, India

ABSTRACT

This paper aimed to characterization of like thermal conductivity, viscosity, flash point and fire point tests of CuO based engine oils. CuO based engine oils are synthesized nanoparticles. XRD and TEM analytical techniques are used in preparation in nanoparticles and three different types of (0.1%, 0.2% and 0.5%) mass concentrations of CuO nanoparticles are mixed to commercially available engine oil for the experimental investigations. KD2 pro thermal property analyzer, Redwood Viscometer–I and Cleveland open cup apparatus are used to evaluate quality parameters like thermal conductivity, viscosity, flash and fire point of nanoparticle engine oil.

Keywords: Thermal conductivity, Viscosity, Flash point, Fire point, CuO Nanoparticles, XRD, TEM, KD2 pro thermal property analyzer, Redwood Viscometer–I and Cleveland open cup apparatus.

I. INTRODUCTION

Nanofluid is an engine lubricant produced by mixing, of CuO nanoparticles as additive into commercial available SAE 20W 40, 10W 30 and 15W 40 three different types of Engine oil's. Recent investigations into nanofluids show that they have improved thermo physical properties over the conventional fluids like water, ethylene glycol etc. In spite of best thermal design, materials, and the performance of any engine oil is restricted due to its inherited poor thermal conductivity. Solution to this problem can be sort out from the newly discovered nano materials based nanolubricant. It has been also observed that nanofluids have potential to improved thermo physical properties over the conventional fluids.

II. BACKGROUND OF STUDY

The use of petroleum products in the transportation sector has been steadily increasing, which contribute in a larger extent to the rapid depletion of the natural resources. Even a 10% increase in the efficiency of engines by decreasing friction is considered to be a significant improvement. Lubrication is essential to reduce friction and wear in engine parts thus minimizing the associated dissipative energy loss. Thermal conductivity is the most important property of lubricating oil, which accounts for its heat transferring ability. Other important properties of lubricating oil include the flash point and the pour point, which are related to oil storage and handling. These properties of lubricant can be further improved by the use of various wear reducing agents. With the invention of nano structured materials in the recent years, this project concentrated to use nanoparticles as lubricant additives to improve their lubrication properties.

Recent manufacture technology provides excessive opportunities to process different material at nanometer scales. Nano-structured or nanophase materials have made of nanometer-size substances engineered on the atomic or molecular scale to produce either new or greater physical properties not showed by conventional solids. All physical mechanisms have a critical length scale below which the physical properties of materials are changed. Therefore solid particles smaller than 100 nm have properties different from those of conventional solids. Many kinds of liquids, such as water, ethylene glycol, and oil, have been used as host liquids in nanofluids. There are different types of nanoparticles used to disperse in fluids as given below.

1) Metallic nano particles.
2) Non-metallic nano particles.
3) Metallic and non-metallic oxides.
4) Carbon nano tubes.
5) Ceramics and composites.

Materials for base fluids and nano particles are varied. Stable and highly conductive nanofluids can be produced by one-step production and two-step production methods. These both methodologies for making nano particle suspensions suffer from agglomeration of nano particles, which is an important issue in all technology containing nano powders. Therefore, production and suspension of closely non-agglomerated or mono dispersed nano particles in liquids is the important to important enhancement in the thermal properties of nanofluids.

III. METHODS AND MATERIAL

In this preparation process 400ml of deionised water is taken in a 1000ml of the beaker to these 10grams of Copper chloride was added along with 20grams of sodium hydroxide pellets. The reaction mixture was heated along with magnetic stirring and the process is carried out for one hour at 900C. The pH value 7 of the so formed copper oxide wet precipitate is neutralized by adding droplets of Hydrochloric acid. Washed the wet precipitate copper oxide with deionised water to remove the impurity ions present in the solution. Copper oxide nanofluids are obtained by dispersing the wet precipitate into the required amount of deionised water under ultrasonic vibration for about 4hours to have uniform dispersion of copper oxide nanoparticles. Copper oxide particles with fluid are washed with distilled water and acetone for 3 to 4 times and by using centrifugation method and the fine particles are collected. Obtained Wet copper oxide paricles are kept in muffle furnance at 3500C for 3hours to remove impurity ions known as "Calcination". The obtained CuO particles removed from muffle furnance and make fine nanopowder by using ball milling method at for 3hours.The fine Copper oxide nanoparticles are in brownish-black in colour as shown in figure 3.1. As a result, the color of the solution changes from blue to black after the reaction, and then the mixture were cooled to room temperature the chemical reaction can be represented as

$$CuCl_2+2NaOH \rightarrow CuO\downarrow+NaCl+H_2O\uparrow$$

Figure 3.1: Snapshots of Synthesis of CuO Nanoparticles

The synthesized CuO nanoparticles are mixed into three different types of engine oils with 0.1wt%, 0.2wt% and 0.5wt% concentrations by using probe sonication for 12hours as shown in figure 3.2.

Figure 3.2: Weighing and Probe sonication of CuO-Engine oils.

IV. RESULTS AND DISCUSSION

4.1 XRD (X-Ray Diffraction):

The average particle size of the CuO nano particles is calculated by Debye scherrer formula and it is found that 25-30nm. Lattice parameters of unit cell of CuO are found to be a = 4.446 Å, b = 3.628 Å, c = 5.228Å reported in ICDD Card. The HKL values (111), (111), (202), (020), (202), (113), (310), (220) are in accordance with the literature values reported in JCPS file.

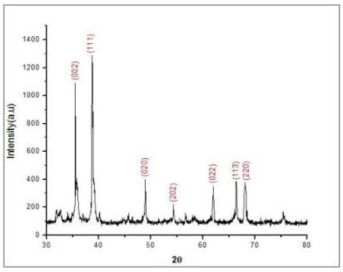

Figure 4.1: XRD of CuO powder

4.2 TEM (Transmission Electron Microscope):

The formation of CuO nanoparticles with accurate dimensions can be studies by using TEM. The image shows that the average size of CuO nanoparticles is found that 27 ± 1.52 nm as shown in figure 4.2.

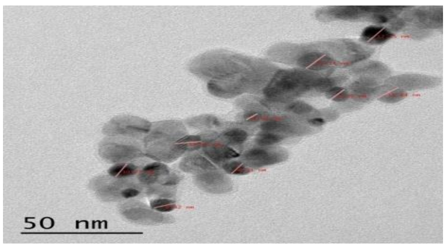

Figure 4.2: TEM inage of CuO powder

4.3 Thermal conductivity:

KD2 pro thermal property analyzer consists of a platinum wire as needle which is used a sensor needle to find the thermal conductivity of nanofluid at room temperature as shown in fig 4.3. The range of the sensor needle 0.2–2 W/mK with an accuracy of ±5% can be used for measuring thermal conductivity of fluids. Each measurement cycle consists of 90 seconds. During the first 30 seconds, the instrument will equilibrate which is then trailed by heating and cooling of sensor needle for 30 seconds each.

Figure 4.3: KD2 pro thermal analyzer

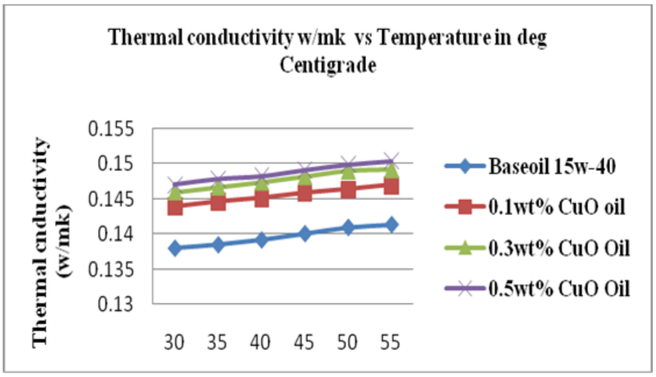

Figure 4.4: Thermal conductivity vs Temp. 15W-40/CuO NP's

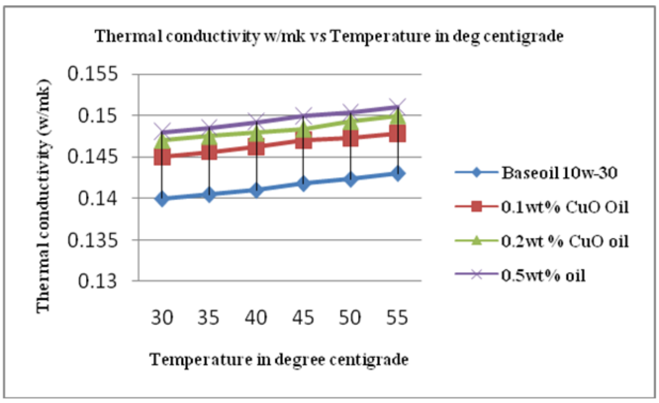

Figure 4.5: Thermal conductivity vs Temp. 10W-30/CuO NP's

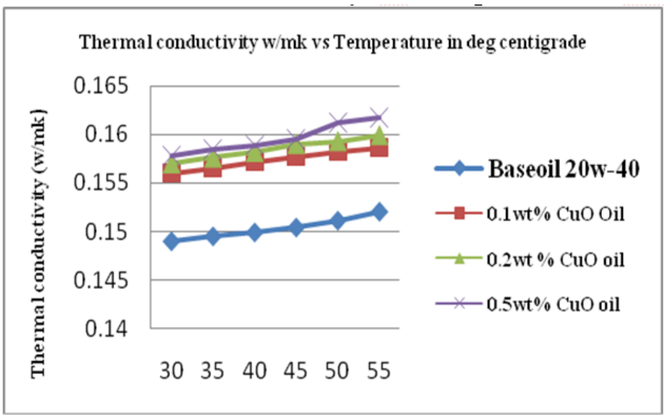

Figure 4.6: Thermal conductivity vs Temp. 20W-40/CuO NP's

4.4 Viscosity:

For the measurement of viscosity of CuO nanoparticles in engine oil's Redwood viscometer is used and experimental procedure is followed by standard laboratory technique as shown in figure 4.7. The rate of oil resistance against flowing is called viscosity, which is one of the most important factors for selecting engine oil. Because of the importance of viscosity for a nanofluid, we have done experimentally for the finding of viscosity.

Figure 4.7: Redwood viscometer-I

The below tables 1, 2 & 3 shows the obtained experimental values of kinematic viscosity at 40^0C and 100^0C of 20W 40, 10W 30 & 15W 40 engine oils with CuO mass concentrations.

TABLE 1

VISCOSITY OF 20W 40 ENGINE OIL WITH CUO NP'S

S.no	Oil samples	Kinematic viscosity	Kinematic viscosity

		(cSt) 40^0c	(cSt) 100^0c
1.	20w 40 oil	138.8	15.68
2.	20w 40 oil + CuO 0.1wt%	141	15.84
3.	20w 40 oil + CuO 0.2wt%	144.77	15.92
4.	20w 40 oil + CuO 0.5wt%	146	16.12

TABLE 2

VISCOSITY OF 10W 30 ENGINE OIL WITH CUO NP'S

S.no	Oil samples	Kinematic viscosity (cSt) 40^0c	Kinematic viscosity (cSt) 100^0c
1.	10w 30 oil	141.25	15.96
2.	10w 30 oil + CuO 0.1wt%	143.3	16.24
3.	10w 30 oil + CuO 0.2wt%	145	16.45
4.	10w 30 oil + CuO 0.5wt%	146.58	17

TABLE 3

VISCOSITY OF 15W 40 ENGINE OIL WITH CUO NP'S

S.no	Oil samples	Kinematic viscosity (cSt) 40^0c	Kinematic viscosity (cSt) 100^0c
1.	15w-40 oil	139	15.93
2.	15w 40 oil + CuO 0.1wt%	142.44	16.13
3.	15w 40 oil + CuO 0.2wt%	144.77	16.92
4.	15w 40 oil + CuO 0.5wt%	146.35	16.98

4.5 Flash and Fire point:

Flash and fire point measurement is experimentally done on Cleveland open cup apparatus. In this experiment, the sample is warmed up according the methods. When the flash point is reached, there is a blue color flame produced at above the sample. The sample to be heated continuously until permanent flame is detected which is known as Fire point. Temperature readings are to be noted for flash and fire points using high capacity thermometers.

Figure 4.8: Cleveland open cup apparatus

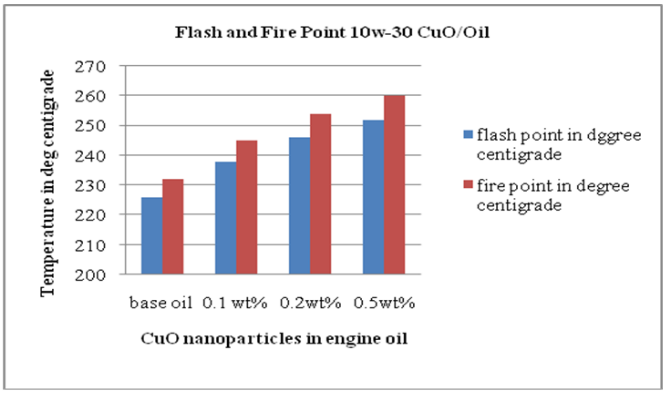

Figure 4.8: Flash and Fire point of 15W 40 CuO/Oil

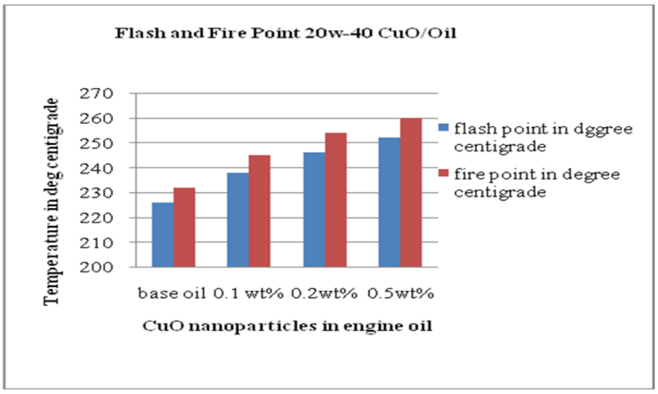

Figure 4.9: Flash and Fire point of 15W 40 CuO/Oil

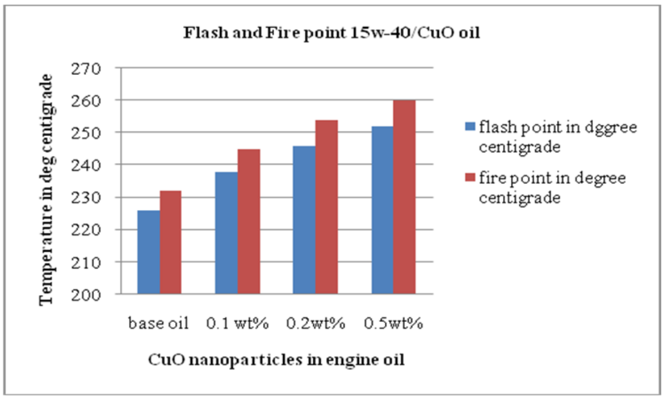

Figure 4.10: Flash and Fire point of 15W 40 CuO/Oil

V. CONCLUSIONS

- Thermal conductivity of three different types of engine oils (base fluid) and engine oils with CuO nanoparticles increases almost linearly with temperature (30 to 45 ºC).
- At differentt mass concentration of CuO nanoparticles, the improvement in thermal conductivity is gradually increasing with respect to temperature. This rise in the thermal conductivity is more at high temperature (30ºC to 45 ºC). Same is true for higher value of mass concentration of nanoparticles.
- But in the visual inspection it seems that at 0.5wt% CuO, it is difficult to mix with engine oil due to the formation of agglomeration. However, at 0.1wt% and 0.2wt% CuO nanoparticles with engine oil shows nearly 5.7% of improvement in thermal conductivity.
- The results show that viscosity increases with the nanoparticles concentration, while going from 0.1 to 0.5% mass concentration and due to increase in concentration of nanoparticle, particle to particle bonding increase which results in more rise in viscosity.
- On the basis of size effect, viscosity of engine oil with nanoparticles increases with the increases size of nanoparticles at constant temperature. The results show that all the three types of oils with CuO nanoparticles viscosity increases at constant temperature.
- Adding CuO nanoparticles to the base oil causes an increase in the flash and fire point of the base oil because CuO nanoparticles have high melting point.
- The rate of change in flash point of the CuO nanoparticles with engine oils at 0.1 wt. % concentration with respect to the base oil is nearly 7.5%, and the highest amount of increase is at 0.5 wt. % sample, which is nearly 13%.

VI. REFERENCES

[1] T.–H. Hong, H.-S. Yang, and C. J. Choi (2005). “Study of the Enhanced Thermal Conductivity of Fe Nanofluids.” Journal of Applied Physics vol. 97: 064311.

[2] Chopkar, M. P. K. Das, & I. Manna 2006, “Synthesis and characterization of nanofluid for advanced heat transfer applications”, Scr. Mater, vol. 55, pp. 549–552.

[3] Hwang YJ, Ahn YC, Shin HS, Lee CG, Kim GT, Park HS, Lee JK (2006) “Investigation on characteristics of thermal conductivity enhancement of nanofluids”. Curr Appl Phys vol.6: pp.1068–1071

[4] Sarit k. Das, Stephen U.S. Choi, Wenhua Yu & T. Pradeep, 2007, “Nanofluids science & technology”, A John Wiley & Sons, Inc., Publication.