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Tribological performance of silicone oil based $CaCO_3$ nanofluid

Syed Ismail*, Soumya Ranjan Guru and Vivek Janu

Department of Mechanical Engineering, National Institute of Technology Warangal
* Email: syedismail7@nitw.ac.in

Over the decades, different lubricants like oils and greases are used for smooth running of one surface over another surface in many practical applications. However, due to recent developments towards micro and nano level applications there is always a need for better lubricant technologies. In recent years, a lot of work is carried out on addition of nano-particles to the base oil for better tribological characteristics, which has been looked upon of having great potential as lubricant additives [1]. The nanoparticles are classified as organic and inorganic nanoparticles. The inorganic nanoparticles shows better result but the problem is, the particles will agglomerate once it is mixed with the base oil. To overcome this problem, hybrid nanoparticles are developed in which organic coating will be done on inorganic nanoparticles, which can reduce aggregation of nanoparticles to a large extent [2].

In the present work, silicone oil is selected as base oil because it has excellent viscosity-temperature characteristics, thermal and chemical stability, environmental friendly, shear breakdown resistance and also excellent water repellence. The nanoparticles used in the analysis are of $CaCO_3$, which is an inorganic in nature. The $CaCO_3$ nanoparticles are prepared by chemical situ method [3]. After that, it has been synthesized with an eco-friendly or green modifier to give good dispersible nature in the base oil.

The size of the nanoparticle is characterized by using XRD and the obtained graph is shown in the Figure 1.

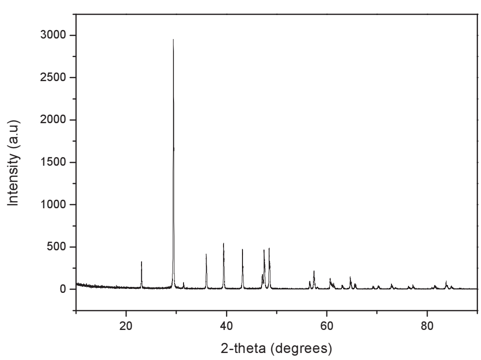

Figure 1: XRD graph of $CaCO_3$ nanoparticle

Now the size of the particle is calculate by using Scherrer's equation as shown in equation (1).

$$D_p = \frac{0.94\lambda}{\beta_{1/2}\cos\theta} \quad (1)$$

where λ is X-ray wavelength which is 1.54 A°, $\beta_{1/2}$ is full width at half maximum of XRD peak in radians, θ is peak angle. By using this equation, the size of nanoparticle is calculated as 120 nm.

The developed nanofluid with different concentrations of $CaCO_3$ nanoparticles are used in four ball tester to study the maximum load support of the lubricant that can withstand without film rupture and also coefficient of friction of the lubricant.

In four ball tester, four chrome alloys balls of diameter 12.7 mm will be used. Three balls will be kept in the ball pot and tighten with a torque of 58 N-m to resist the rotation and relative motion of balls with each other. The forth ball will be placed in the spindle and it rotates against the three balls in the presence of nanofluid between the contact of ball surfaces. The variable parameters in the present work are normal load, speed, time and temperature. To find the maximum load support of the lubricant, the test was carried out as per ASTM - D2783 standards in which speed is specified as 1760±40 rpm, time is 10 sec and temperature is 27±8 °C. The coefficient of friction of the lubricant is determined by conducting the test as per ASTM - 5183 standards. Initially the test is carried out at a load of 392.4 N, speed of 600±30 rpm, time of 3600±60 sec and temperature of 75±2 °C. Then without unclamping the balls from the ball pot, clean thoroughly and pour fresh oil. Now run the machine continuously by increasing the load of 98.1 N till seizure occurs.

The results indicated that silicone oil based $CaCO_3$ nanofluid gives better tribological performance as compared to pure base oil.

References

1. Zhang, Z. J., Simionesie, D., & Schaschke, C. (2014). Graphite and hybrid nanomaterials as lubricant additives. *Lubricants*, *2*(2), 44-65.
2. Kim, D., & Archer, L. A. (2011). Nanoscale organic−inorganic hybrid lubricants. *Langmuir*, *27*(6), 3083-3094.
3. Mishra, S., Sonawane, S. H., & Singh, R. P. (2005). Studies on characterization of nano CaCO3 prepared by the in situ deposition technique and its application in PP-nano CaCO3 composites. *Journal of Polymer Science Part B: Polymer Physics*, *43*(1), 107-113.