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A review on tribological properties of lubricating oil with nanoparticles additives

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Abstract: *In modern machines reduction of friction and wear is crucial to the correct functioning. The machine which operates more intricate requires a stern lubrication. By using a high quality lubricants in machine components enable to withstanding high temperatures and extreme pressures. To reduce surface damage and friction under different conditions additives are added to fluid lubricant to improve the tribological performance. Current research papers have announced that the addition of nanoparticles to lubricant is successful for the reduction of wear and friction in mechanical systems. However, inorganic nano particles very easily collect in many forms and have poor spreading capacity in organic solvents and oil, by this reason applications of many nanoparticles are limited. Anyway the spreading problem can be solved using some chemical and physical approaches. The investigation of tribological properties of nanoparticles used a soil additives have been done.*

Keywords*- Tribological, Additives, Nanoparticles, lubricating oil.*

I. INTRODUCTION

[1]The word tribology was first announced in a landmark report by scientist Sir Jost in 1966. The word is derived from the Greek word tribos meaning rubbing, so the literal translation would be "the science of rubbing."' Its popular English language equivalent is friction and wear or lubrication science, alternatively used. The latter term is hardly all-inclusive. Dictionaries define tribology as the science and technology of interacting surfaces in relative motion and of related subjects and practices. Tribology is the art of applying operational analysis to problems of great economic significance, namely, reliability maintenance, and wear of technical equipment, ranging from spacecraft to household appliances.

Surface interactions in a tribological interface are highly complex, and their understanding requires knowledge of various disciplines including physics, chemistry, applied mathematics, solid mechanics, fluid mechanics, thermodynamics, heat transfer, materials science, lubrication, machine design, performance and reliability. It is only the name tribology that is relatively new, because interesting the constituent parts of tribology is older than recorded history. It is known that drills made during the Paleolithic period for drilling holes or producing fire were fitted with bearings made from antlers or bones, and potters' wheels or stones for grinding cereals, etc., clearly had a requirement for some form of bearings. A ball thrust bearing dated about AD 40was found in Lake Nimi near Rome. From the above, it clearly indicates the two main constituents of tribology: friction and wear, when controlled and reduced, automatically increase the service life of machine elements. This in turn saves money. The awareness of the subject, the identification of Tribological problems and their solution can give rise to significant saving. For this reason many industries are placing emphasis on economical aspects of tribology.

II. CURRENT THEORIES

A brief review of some selected references on various types and there an application of nanoparticles is presented below.

2.1. D.X. Peng et al [2] discussed on Tribological properties of diamond and SiO2 nanoparticles added in which were prepared by surface modification method using oleic acid had been added and observed by scanning electron microscopy (SEM) and infrared spectroscopy (IR). The measurements of the dispersion capacity and the dispersing stability of oleic acid-modified diamond and SiO2 nanoparticles are shows in figure. The tribological properties were evaluated using a ball-on-ring wear tester. The results show that both nanoparticles as additives in liquid paraffin at a tiny concentration have better anti-wear and anti-friction properties than the pure paraffin oil. Also, SEM was used to observe the plowing of nano scale grooves of worn surfaces by diamond and SiO2 nanoparticles. The optimal concentration of diamond particles that minimizes the wear scar diameter is 0.2–0.5wt% and that of SiO2 nanoparticles is 0.1– 1wt%.

2.2. L. Kolodziejczyk et al. [3] reported work reports the employment of metallic nano particles (palladium and gold) with a mean particle size of 2.2nm surface protected with tetraalkylammonium and alkanethiolate chains respectively, as lubricant additives. Dispersions of both types of nano particles (5 wt %) are prepared using tetrabutylammonium acetate (TBA) and paraffin as base oils, respectively. The tribological properties are then evaluated by a ball on disc Tribometer at two different loads (7 and 15N) with excellent results. In order to evaluate the load bearing capabilities of the metallic nano particles an insight of the ball counter faces at the end of the tests was accomplished by SEM analysis as shown in figure below (Fig. 2.3).Summarizes the SEM micrographs taken from the ball surfaces for the studied cases Pd studied cases Pd (a), TBA (b), Au (c) and PAR (d) and conclusion that can be extracted from the observation of SEM images.

2.3. Y.Y. Wu et al. [4] examined tribological properties of lubricating oils an API-SF engine oil and base oil with CuO, TiO2 and Nano-Diamond nanoparticles Jadhav et al., International Journal of Advanced Engineering Technology E-ISSN 0976-3945 Int J Adv Engg Tech/Vol. V/Issue I/Jan.-March.,2014/01-04 used as additives. Friction and wear experiments were performed by using reciprocating Tribometer. CuO added in standard oil exhibit good friction reduction and anti-wear property. The additions of CuO nanoparticles in the API-SF engine oil & the base oil decreased the friction coefficient by 18.4 and 5.8% respectively, and reduced warn depth by 16.7 and 78.8% respectively as compared to the standard oils without CuO nano particles. The anti-wear mechanism is attributed to the deposition of CuO nano particles on the worn surface, which may decrease the shearing stress, thus improving the tribological properties.

III. USED MATERIALS

For this experimental work, proper types of nanoparticles and base oil has been selected as follows.

3.1. Silicon Dioxide (SiO2) properties

- SiO2 layers are easily grown thermally on silicon or deposited on many substrates.
- They block the diffusion of do pants and many other unwanted impurities.
- Also Silicon is a semiconductor
- It has high temperature stability up to 1600°C.

3.2. Base Oil

The finest, highest quality especially SN-500 base oils are used to produce the highest performance, superior quality lubricants from Lubrication Engineers. Although these base oils are expensive, no other type of petroleum base oil can match their performance.

3.3. Preparation of Nano-Oil

Nano particles used as an additive in base oil are called as Nano-Oil. The preparation of Nano- Oil samples according to weight concentration [5] criteria with respect to base oil. Total eight numbers of samples were prepared. Each sample contains 500ml base oil with additive weight concentration such as 0.1%, 0.6%, 0.85% and 1%. The weight of 499.9ml of SN-500 base oil is 431.9gram. Then all samples were prepared according to weight concentration by considering 432 gm weight of SN-500 base oil is considering 100%.

3.4. Test Procedure

The tribological performances of lubricant were evaluated on Pin on disk Tribometer. All tests was undertaken using pin on disk Tribometer set for pure sliding contact with pin on disk configuration at ambient air with relative humidity between 40% to 50% and temperature at 0-34°C. Test pins were run against a counter face of disk which is mirror polished. In an experiment total nine numbers of samples were examined. The test parameter sliding speed of disk 250rpm and wear track radius 30mm were remains constant at all test. Under these conditions, 5N, 25N and 45N loads were applied on disk though pin and analyze the parameter like wear in micron and coefficient of friction with help of computerized data acquisition system. Total twenty seven numbers of tests with 10 minute time period were performed. The wear surfaces of disks were analyzed using scanning electron microscopy.

Fig 3.1 Experimental set up of Pin on Disk Tribometer.

IV. RESULT AND DISCUSSION

Friction-reduction properties In order to confirm the repeatability of experimental data, the friction coefficient was measured in triplicate using the pin on disk tribotester under 5N, 25N and 45N load conditions at 10 minute with concentration of particles constant for respective tests. [6] The friction coefficients of SN-500 base oil without nanoparticles are displayed in fig. 4.1, which show a similar trend for different experimental results, and a maximum standard deviation of 0.1139, 0.1190 and 0.1169 with respect to 5N, 25N and 45N load conditions among all sets of test data.

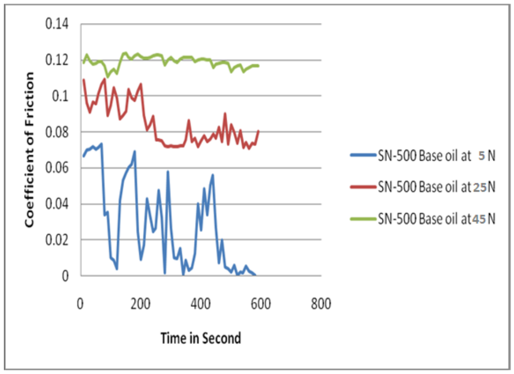

Fig 4.1 Friction coefficient with SN-500 base oil without nanoparticles.

5. CONCLUSION

The lubricating ability of SiO2 nanoparticles as an additive in the SN-500 base oil depends upon experimental conditions. Friction reduction, high load carrying capacity and anti wear can be achieved if nanoparticles are present in SN-500 base oil under increasingly serve conditions such as load, speed and time. [7] The following conclusion can be drawn on the basis of the tribological tests and SEM wear surface analysis conducted in this research.

- The nanoparticles modified by oleic acid exhibit good dispersivity and stability in virgin SN-500 base oil. Because of oleic acid react with nanoparticles and breaking down bonding between us.
- Adhesion between the contact surfaces was reduced with the presence of nanoparticles.

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