EFFECT OF ADDITION OF NANO PARTICLES ON TRIBOLOGICAL PROPERTIES OF LUBRICANTS- A REVIEW

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Abstract- Lubricants play an important role in performance of machine. Lubricants also enhance the machine life, reducing wear and tear, decrease friction and preventing component from failure. But, if the performance of lubricant is poor that can cause significant losses in material and energy. To enhance the lubricating properties of gear oil, engine oil, and bearing oil, nanoparticles can be added in gear oil, engine oil and bearing oils. This paper will present brief study and survey of Tribological properties such as anti-wear and friction reducing properties of nano- lubrication oils are studied. And in the studied papers Nano- lubrication oils are made by adding different -different types of nanoparticles such as Cu nanoparticles, TiO2 nanoparticles CuO nanoparticles, SiO2 nanoparticles, Boron nitride nanoparticles and Ag nanoparticles to different lubricating base oils/engine oils in varying proportions.

Keywords: Cu nanoparticle, Copper Oxide (CuO) nanoparticles, TiO2 nanoparticles Tribology, base oil, Coefficient of friction, wear.

INTRODUCTION-

The subject Tribology generally deals with technology of lubrication, friction, and wears Prevention of surfaces having relative motion under load. The word tribology was first reported in a landmark report by Jost (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. There have been many investigations on the tribological properties of lubricants with different-different nanoparticles added. Generally lubricants contain 90% base oil (Natural Oils derived from vegetable oils and animal fats) and less than 10% additives. The friction-reduction and anti-wear behaviors are dependent on the characteristics of nanoparticles, such as shape, size, and concentration. The size of nanoparticles is mostly in the range of 2–120 nm [1-3].

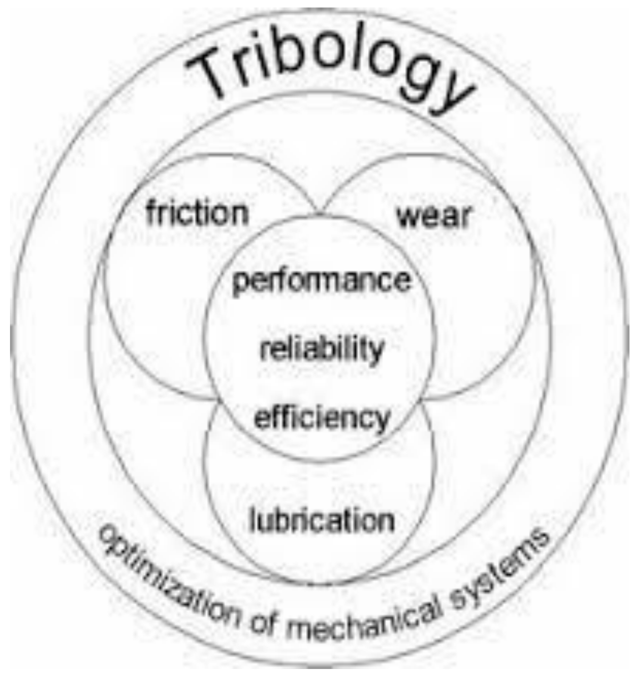

Fig.1 Tribological System [4]

LITERATURE REVIEW:

He-long et al. [5] Studied wear and friction properties of surface modified Cu nanoparticles used as additives in 50CC. The impact of temperature on tribological properties of Cu nanoparticles turned into investigated on a four-ball tester. The morphologies, regular detail distribution and chemical states of the worn surfaces were characterized by SEM, EDS and XPS, respectively. A good way to in addition check out the tribological mechanism of Cu nanoparticles, a nano-indentation tester changed into utilized to degree the micro mechanical properties of the worn surface. The outcomes suggest that the higher the oil temperature carried out, the better the tribological properties of Cu nanoparticles are. It is able to be inferred that a thin copper protective film with decrease elastic modulus and hardness is shaped on the worn surface, which results inside the top tribological performances of Cu nanoparticles, specially whilst the oil temperature is higher.

Ingole et al. [6] Presented the effects of titanium dioxide additives at the lubricated friction and put on behavior of self-mated E52100 bearing metal the use of a reciprocating pin-on-disk equipment (TR-281M-M6). It creates a bidirectional sliding motion among samples even as a loading mechanism applies acknowledged load on the test samples. The decrease pattern is desk bound consisting of flat surface or a cut pattern of an engine liner and higher sample is movable and usually a spherical ball. The friction and wear characteristics had been tested at a constant applied load and rate of reciprocation. All concentrations of P25 (aggregate of rutile and anatase levels and TiO2 with only anatase section) improved the coefficient of friction, however the addition of TiO2 nanoparticles reduced the variety and stabilized the frictional behavior.

S. Baskar et al. [7] investigated the tribological properties friction and wear behavior of journal bearing material. with three different lubricating oils i.e. synthetic lubricating oil (SAE20W40), chemically modified rapeseed oil (CMRO), chemically modified rapeseed oil with Nano copper oxide (CuO) (40 nm). Wear tests were carried out at maximum load of 200 N and sliding speeds of 2 – 10 m/s as per ASTM by using a pin-on-disc tribometer.. Behavior of the journal bearing material has changed according to the sliding conditions and lubricating oils. The journal bearing material has a lower friction coefficient for CMRO with Nano CuO than other two oils. Higher wear of journal bearing material was observed in SAE 20W40 and CMRO. Worn surfaces of the journal bearing material with three lubricating oils were examined using scanning electron microscope (SEM) and wear mechanisms were discussed.

D.X. Peng et al [8] investigated the Tribological properties of diamond and SiO2 nanoparticles brought in which were were prepared by surface modification method using oleic acid had been added and determined by means of scanning electron microscopy (SEM) and infrared spectroscopy (IR). The measurements of the dispersion potential and the dispersing stability of oleic acid-modified diamond and SiO2 nanoparticles are determine. The tribological properties were evaluated the usage of a ball-on-ring put on tester. The consequences display that each nanoparticles as additives in liquid paraffin at a tiny attention have higher anti-put on and anti-friction homes than the natural paraffin oil. Also, SEM became used to study the plowing of nano scale grooves of worn surfaces by using diamond and SiO2 nanoparticles. The most reliable attention of diamond particles that minimizes the wear and tear scar diameter is 0.2–0.5wt% and that of SiO2 nanoparticles is 0.1– 1wt%.

Wan, Q et al. [9] Investigated the tribological properties of lubricant oil containing boron nitride nanoparticles (nanolubricant). The nano-lubricant had been formulated the usage of a two-step approach. A rheometer was used to measure the rheological Behaviour of the lubricant oil, while the anti-wear and anti-frictional performance of the nano-lubricant was investigated using a tribo-tester. Through comparing the friction coefficient and line roughness of the wear surface, an optimum concentration of nanoparticles turned into observed to be round 0.1wt.%. Atomic force microscopic and scanning electron microscopic analyses of morphology of wear tracks and x-ray electricity dispersive spectroscopic analyses of detail distributions on the worn surface indicated that the lubricant oil with a small quantity of boron nitride nanoparticles may want to showcase fantastic tribological performance.

Ma, J.et al [10] investigated the tribological behavior of MACs base oil and with the addition of Ag nanoparticles as additives. Monodisperse Ag nanoparticles with a particle size of about 6–7nm and low volatile multialkylated cyclopentanes (MACs) lubricant were prepared. The tribological properties such as friction–reduction and antiwear behaviors of the Ag nanoparticles and MACs base oil investigated by using Optimal SRV oscillating friction and wear tester. The morphology and elemental distribution of the worn surface of both the steel ball and steel disc and the chemical feature of typical element thereof were analyze by using a , energy dispersive X-ray analyzer attachment (EDS) and X-ray photoelectron spectroscope (XPS), scanning electron microscope (SEM). Friction and wear test indicates that the wear resistance and load-carrying capacity of MACs base oil were markedly raised and friction coefficient minimum when 2%Ag nanoparticles were added in MACs base oil. This Ag nanoparticles acts as a boundary film. The kind of protective sort metal film had low shearing stress and contributed to preventing the steel-to-steel contact from severe adhesion, scuffing, and seizure.

CONCLUSIONS-

As lubrication oils are popularly used to reduce friction, prevent wear and carry loads needed to keep the machines operating at top efficiency. Nanoparticles put into lubricating oils can improve the properties of extreme pressure, anti-wear and friction reducing. Efficiency and service life of the machine were also improved.

1. As a lubricant, friction-reduction properties of 50 CC base oil are enhanced by the addition of Cu nanoparticles to a moderate concentration.

2. The wear and friction properties of TiO2 nano-lubricant found using Four-ball testerShowed good results in wear resistance.

3. The anti-wear mechanism is attributed to the deposition of SiO2 nanoparticles on worn surfaces, which may decreases the shearing stress, thus improving tribological properties

7. SiO2 nanoparticles and Oleic acid-surface-modified diamond in liquid paraffin exhibit better tribological properties in terms of load-carrying capacity, anti wear and friction reduction as compare to the pure liquid paraffin.

5. The nano-BN oils could significantly improve the anti-friction and anti-wear properties of the base oil, and lower nanoparticle concentration exhibited better tribological performance.

2. Ag nanoparticles as additives in MACs base oil significantly improve its wear performance and load-carrying capacity of and have slight effect on its friction property.

REFERENCES-

[1] Bharat Bhushan "Principle and application of tribology" A wiley-Interscience Publication (1999) ISBN 0-471-59407-5.

[2] Li Chang, Klaus Friedrich "Enhancement effect of nanoparticles on the sliding wear of short fiber-reinforced polymer composites" Tribology International, Vol. 43, pp 2355-2364, Sept.2010.

[3] Y.Y. Wu & W.C. Tsui "Experimental analysis of tribological properties of lubricating Oils with nanoparticles additives" Wear 262 (2007) 819–825, 10 October 2006

[4] Singh, K. and Suhane, A., 2016. Effect of additive addition in base oil of a lubricant–A Review.

[5] He-long YU, Yi XU, Pei-jing SHI, Bin-shi XU, Xiao-li Wang, Qian LIU "Tribological properties and lubricating mechanisms of Cu nanoparticles in lubricant" Transactions of Nonferrous Metal Society of China, Volume 18, Issue 3, June 2008, pp 636–641.

[6] Sudeep Ingole, Archana Charanpahari, Amol Kakade, S.S.Umare, D.V.Bhatt, Jyoti Menghani, "Tribological behavior of nano TiO2 as an additive in base oil", Journal of Wear, Vol.301 (Jan 2013), pp.776–785.

[7] S. Baskar, G. Sriram "Tribological Behavior of Journal Bearing Material under Different Lubricants", Tribology in Industry, Vol. 36, No. 2 (2014) pp 127 – 133.

[8] D.X. Peng "Tribological properties of diamond and SiO2 nanoparticles added in paraffin" Tribology International 42 (2009) 911–917.

[9] Wan, Q., Jin, Y., Sun, P. and Ding, Y., 2015. Tribological behaviour of a lubricant oil containing boron nitride nanoparticles. Procedia Engineering, 102, pp.1038-1045.

[10] Ma, J., Mo, Y. and Bai, M., 2009.Effect of Ag nanoparticles additive on the tribological behavior of multialkylated cyclopentanes (MACs). Wear, 266(7-8), pp.627-631.