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Experimental Analysis of Tribological Behavior of Lubricating Oil with CuO & TiO2 Nanoparticles

Miss. Shinde D. R.[1], Prof. N. V. Hargude[2]

[1]PG Student, Mechanical Engineering Department, PVPIT Budhgaon, Sangli, Maharashtra (India)
[2]Associate Professor, Mechanical Engineering Department, PVPIT Budhgaon, Sangli, Maharashtra (India)

Abstract - *Lubricants play a vital role in machine performance, machine life, reducing wear and friction and preventing component from failure. Poor performance of lubricant can cause significant energy and material losses. To improve the lubricating properties of bearing oil, nanoparticles can be added in bearing oils. In this research copper oxide (CuO) and Titanium Dioxide (TiO_2) nanoparticles were added into the SN-500 base oil and tribological properties were examined. The concentrations of CuO and TiO_2 nanoparticles prepared in SN-500 base oil are 0.1 wt. %, 0.5 wt. %, 0.75 wt. % and 1 wt. %. The trials of friction and wear were carried out on a pin on disc tribotester, with varying the concentration of nanoparticle and by varying load from 10 N to 50N. The obtained results compared between CuO nano oil, TiO2 nano oil and SN-500 base oil. The result shows for friction reduction test 1 wt. % & for wear 0.5 wt. % TiO_2 was an optimum concentration.*

Key Words: tribotester, nanoparticles, Titanium Dioxide, bearing oils, base oil. Copper oxide

1. INTRODUCTION

Nanotechnology is regarded as the most revolutionary technology of the 21st century. It can be used in many fields and ushers material science into a new era. There have been many investigations on the tribological properties of lubricants with different nanoparticles added.

Tribology is defined as 'the science and technology of interacting surfaces in relative motion and related subjects and practices. The subject Tribology generally deals with technology of lubrication, friction, and wears prevention of surfaces having relative motion under load. The successful design of machine elements depends upon essentially on the understanding tribological principles like wear and friction.

Materials are tested in pairs under nominally non-abrasive conditions. The pin specimen is pressed against the disk at a specified load usually by means of an arm or lever and attached weights. Wear results are reported as volume loss in cubic millimeters and linear dimensional loss for the pin and the disk separately.

Wu e t al. [1] examined tribological properties of lubricating oils as API-SF engine oil and base oil with CuO, TiO2 and Nano-Diamond nanoparticals used as additives. Friction and wear experiments were performance by using tribotester. CuO added in standard oil exhibit good friction-reduction and anti-wear property. The addition of CuO nanoparticals 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. Glycol was used as the solvent, for CuO and TiO2 nanoparticles in order to prevent the nanoparticles from oxidizing with air. Each lubricant comprised 90% standard oil and 10% additive solution (lubricants modified with CuO and TiO2 were composed of 9.9% glycol and 0.1% nanoparticles). Friction and wear experiments were performance by using Plint-TE77 reciprocating sliding friction tribotester as shown in fig.

In this experimental analysis we have added CuO & TiO2 nanoparicals separately with Oleic Acid to base oil by proper method to get very good dispersibility. Nanoparicals act as third body particals. The results of this experimental studies shows that nanoparticals increase the tribological properties of base oil.

2. EXPERIMENTAL SETUP

1. Selection of Nanoparticles

In this present research two nanoparticles were shortlisted and studied viz.

1. Copper oxide (CuO)
2. Titanium Dioxide (TiO2)

On the bases of availability, properties and cost, Copper oxide (CuO) & Titanium Dioxide (TiO2) nanoparticles were selected and purchased from Sigma-Aldrich Company, India. The properties of CuO & TiO2 nano particles as per the manufactures specification are given below.

Nanoparticles	Properties
CuO (Copper Oxide)	Size: <100 nm Shape : nearly spherical Purity 99.95% trace metal basis
TiO2 (Titanium Dioxide)	Size: <100 nm Shape : nearly spherical Purity 99.95% trace metal basis

2. Selection of Base Oil

In this research, the SN-500 engine oil manufactured by Pure lubricants ltd., Chennai, India was used as the base oil. The

conventional Pure lubricants engine oil contains some additives for friction reduction and anti-wear, but the Base oil purchased does not. Pure lubricants are manufacturers of industrial lubricant, automobile oil and greases. It is a British Standards certified company.

PROPERTY	Range
Viscosity Kin., @40°C	101 mm2/s
Viscosity Kin., @100°C	10.5 mm2/s
Viscosity Index	95
Density @ 40°C	864-875 kg/m3
Flash Point (°C)	240
Pour Point (°C)	-6

3. Nano-Oil Preparation

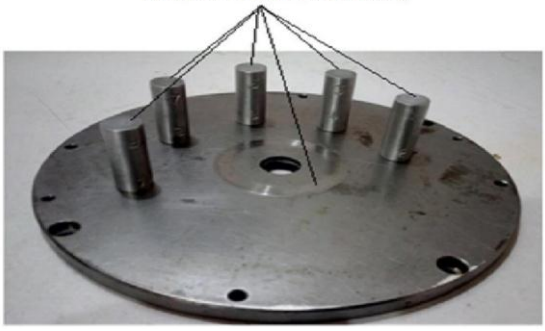
Nano particles used as an additive in base oil are called as Nano-Oil. The preparation of Nano-Oil samples is done according to weight concentration criteria with respect to base oil. Total four numbers of samples were prepared. Each sample contains 500ml base oil with additive weight concentration such as 0.1%, 0.5%, 0.75% and 1%. The weight of 500ml of base oil is 430 gm. Then all samples were prepared according to weight concentration by considering 430 gm weight of base oil.

According to above weight concentration criteria eight samples were prepared by adding respective quantity of nanoparticles.

4. Fabrication of Disc and Pin

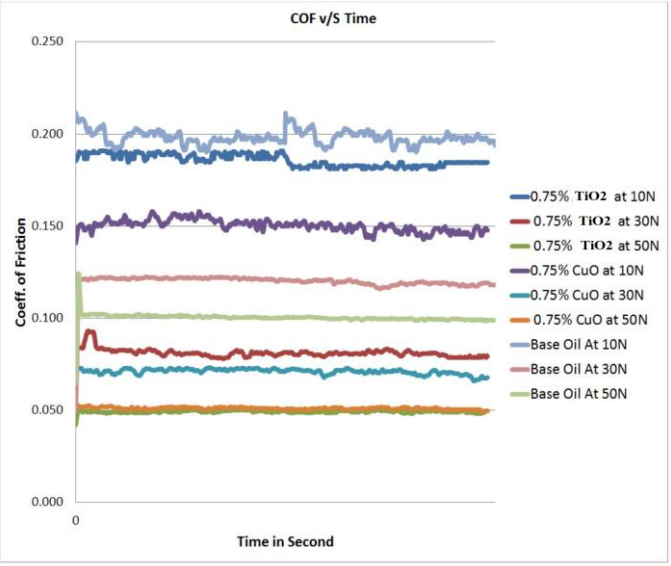
pins have manufactured to size Ø10 mm×30 mm. These total 10 number pins have then polished using Double disk polishing machine of make S.S.P Enterprise pune.

Finished Pins and Disc for Testing



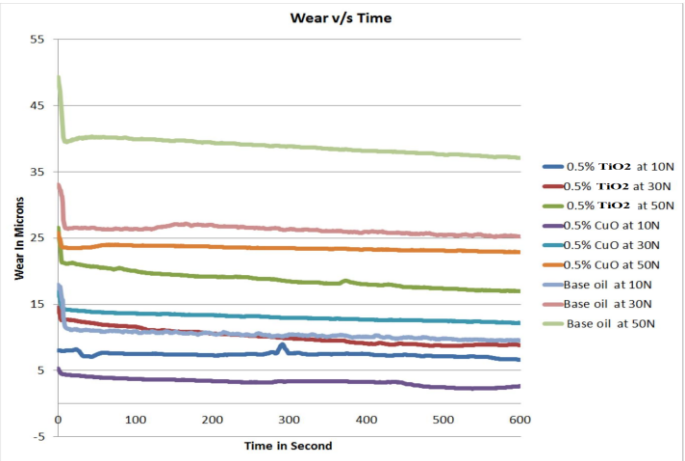
3. EXPERIMENTAL PROCEDURE

1. Friction Reduction Properties



In above fig. nanoparticles concentration increasing up to 0.75% then CuO nanoparticles shows improvement of friction-reduction properties by comparing SN-500 base oil without nanoparticles. By the comparing values 0.048<0.100 of CuO nanoparticles with SN-500 base oil and SN-500 base oil without nanoparticles respectively. Therefore nanoparticles can improve load carrying capacity and Friction-reduction properties.

2. Anti-wear Properties



In above fig. show that graph of wear verses time at 0.5% particle nanoparticle concentration. When load gradually increases then wear of nanoparticles samples decreases. So for 0.5% particle concentration both samples can show wear improvement comparison with SN-500 base oil without nanoparticles. Therefore for 0.5% both CuO and TiO2 nanoparticles show anti-wear property. Also for CuO and TiO2 nanoparticles sample, as the time increase but wear decreases.

4. CONCLUSIONS

- Base oil with CuO & TiO2 nanoparticles increased tribological properties in terms of load carrying capacity, anti-wear and friction reduction than SN-500 base oil without nanoparticles. The results showed that 0.75wt% for CuO nano fluid & 0.5wt% for TiO2 nano fluid concentration was an optimum concentration for wear.
- For the friction reduction test, when CuO nanoparticles were added into base oil, the coefficient of friction reduced at 1wt% concentration as compared to SN-500 base oil without nanoparticles.

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