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Enhancing Lubrication Performance by Nano powder

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Abstract:
Scientists are focusing more to apply upgraded Nano-technology to enhance the performance and efficiency of I.C. Engine by reducing friction and wear with proper lubrication. We analysed the tribological behaviour of Nanoparticles as additives in SN500 base oil and compared results with standard base oil. We found the appropriate concentration of Nanoparticles for better tribological properties.

Keywords **—friction, wear, Nanoparticles, concentration, base-oil.**

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I. INTRODUCTION

15% of total input energy in an I.C. engine is lost due to friction of sliding or reciprocating components in contact. This loses can be effectively reduced by using additives like nanoparticles in lubricating oils [1]. Addition of Nano powders in lubricants results in formation of harder and rougher layer of lubrication between two sliding surfaces [2]. 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[3]. Addition of nickel Nano particles to PAO6 results in a decrease in friction and wear and an increase in the load-carrying capacity of base oil.The friction reduction was between 7% and 30% and wear was decreased between 5% and 45%[4]. $CaCO_3$ nanoparticles can dramatically improve the load carrying capacity, as well as the anti-wear and friction-reduction properties of PAO base oil[5].

Outcome of review

1. Nano particles used as additives in lubricating oil exhibits good friction reduction and anti-wear behaviour.
2. The anti-wear mechanism is attributed to the deposition of Nanoparticles on the worn surface, which may decrease the shearing stress, thus improving the tribological properties.
3. Lubrication film that form on worm surfaces and Nano particles in the film not only bear the loading, but also separates rubbing faces and avoid direct contact.

II. SPECIFICATIONS

A. Technical Specifications

1. Normal load range- up to 200N

2. Wear measurement range- 0-4 with tare facility
3. Maximum Speed- 2000rpm
4. Test Speed- 1000rpm
5. Preset timer range- up to 99:59:59
6. Wear disc diameter and thickness- 165mm and 8mm
7. Wear disc track diameter- 50mm
8. Specimen pin diameter- 12mm
9. Pin length- 30mm
10. Sliding Velocity- 5m/s

B.Specimen

Specimens	Material
Disc	Grey Cast Iron, hardness=130BHN, d=165mm, t=8mm, E=66-157Gpa, v=0.26
Pins	Aluminium alloy hardness=100BHN, d=12mm, L=30mm, E=73Gpa,v=0.33

Table 1. Properties of disc and pins

C.Base Oil-SN500

Property	Range
Viscosity Kin., @40□(cSt)	101 mm^2/s
Viscosity Kin., @100□(cSt)	10.5 mm^2/s
Viscosity Index	95
Density @ 40□	864-875 kg/m^3
Flash Point (□)	240
Pour Point (□)	-6
TAN (Mg KOH/gr)	<0.002
Carbon Residue (%wt.)	0.12
Color	1.5

Table 2. Properties of SN500 Base Oil

III.EXPERIMENTATION and PREPARATION of OIL

The Pin on Disk Friction & Wear Testing Machine designed and developed by Ducom, which is used to conduct trials. This machine is primarily intended for determining the tribological characteristics of wide range of materials under conditions of various normal loads & temperatures (optional). A stationary pin mounted on a pin holder is brought into contact against a rotating disk at a specified speed as the pin is sliding, resulting frictional force acting between the pin and disk are measured by arresting the deflecting pin holder against a load cell. Both normal load and speed can be set as desired.

Figure 1. "Test Setup "Pin on Disc Tribometer"

A.Preparation of Nano-Oil

1. Stabilization of nanoparticles
2. Oleic Acid as a surfactant
3. The weight of 500ml SN-500 Sample = 432 gram
4. Add 0.432 gm (1 wt.%) al203 nanoparticles into 50ml Oleic acid
5. Mix 0.432 gram Nano powder into oleic acid
6. Keep it on Magnetic stirrer for 20 min
7. Taking SN-500 Base oil with 450ml Quantity.
8. Mix Oleic Acid into Base Oil
9. Magnetic Stirrer for 45 min

Total 4 samples were prepared by using following weight concentration

Sample Name	% of weight of Nano particles (gm)
0.1 wt.% AL_2O_3Nano particles+SN500 Base oil	0.432
0.5 wt.% AL_2O_3Nano particles+SN500 Base oil	2.16
0.75 wt.% AL_2O_3Nano particles+SN500 Base oil	3.24
1.0 wt.% AL_2O_3Nano particles+SN500 Base oil	4.32

Table 3. Sample Names and its percentage weight concentration of Nano particles in gram.

IV.OBSERVATION and RESULT

Observation	Percentage of AL_2O_3Nanoparticles by weight					
	0.10%			0.50%		
	Load			Load		
	10N	30N	50N	10N	30N	50N
Coefficient of Friction	0.18	0.13	0.09	0.097	0.094	0.09
Wear (microns)	8	23	36	7	9	18

Observation	Percentage of AL_2O_3Nanoparticles by weight					
	0.75%			1.00%		
	Load			Load		
	10N	30N	50N	10N	30N	50N
Coefficient of Friction	0.19	0.08	0.058	0.17	0.056	0.05
Wear(microns)	4	15	29	4.5	20	31

Table 4. AL_2O_3Nanoparticles added in SN500 Base Oil

SN500 Base Oil

Observation	Load		
	10N	30N	50N
Coefficient of Friction	0.19	0.12	0.10
Wear(microns)	11	26	38

Table 5. SN500 Base Oil

V. CONCLUSION

1. 0.5wt.% for AL2O3 Nano fluid concentration was an optimum concentration for wear
2. The wear in microns of SN-500 base oil without nanoparticles are 10 µ, 26 µand 38 µ with respect to load conditions 10N, 30N and 50N respectively among all sets of test data.
3. The anti-wear property at 0.5 wt. % Al2O3 concentration of the base oil sample drastically improved the wear reduction at 10N, 30N and 50N loading conditions and the values are 7µ, 9 µ and 18 respectively.
4. For the friction reduction test, when Al2O3 nanoparticles were added into base oil, the coefficient of friction reduced by 19%, 35% & 52% at 1wt% concentration as compared to SN-500 base oil without nanoparticles.
5. Rolling ability of nanoparticles could significantly restrict the increase in the friction force, especially under higher loading conditions. As a result, especially, wear between components remains reduced.
6. As a lubricant, friction-reduction properties of base oil can be enhanced by the addition of Al2O3 nanoparticles to particular concentration.

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