REDUCTION OF COEFFICIENT OF FRICTION IN I.C ENGINES BY USING NIO AND CUO NANOPARTICLES AS ADDITIVE IN ENGINE OIL

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Abstract

One of the major losses occurring in the engine of an automobile is due to friction between its moving parts. This misfortune is huge and around 15% of the absolute loss of vitality and directly affects the productivity and toughness of the motor. This work results shows there is significant reduce in friction due to addition of nano particles to the base oil. Nickel and copper nanoparticles are added at 0.2%wt, 0.3%wt, 0.4%wt to base oil (Castrol SAE 10W30 4T engine oil) by stirring and later sonication was done by sonicator machine for 3 hours. Anti-wear properties were obtained using pin on disc machine under different loads and sliding speed of 1m/s for 2 min. This study led to following conclusion that at 0.4%wt of NiO and 0.4%wt of CuO Nano lubricant exhibited reduction in coefficient of friction when compared to other composition of lubricating oil. Mechanical efficiency and Brake thermal efficiency of four stroke single cylinder diesel engine results was evaluated and compared.

Keywords: Nickel oxide, copper oxide, coefficient of friction, Efficiency of engine;

I. Introduction

This lubrication reduces friction which in turn makes moving parts more efficient lasts longer remain cooler and use less energy, a good general lubricant neutralizes acid minimizes corrosion and even has a cleaning effect on the engine, in fact it helps your fancy engine of yours stay fancy, with no oil film to protect the moving metal parts they grind and weather this once glorious machine becomes hotter and less efficient needing to work harder and harder just to maintain its performance. Those moving parts begin to corrode and they move the worse.

Greasing up the motor, the oil isn't propping it up for perform effectively, it's protective it and halting harm oil starts its journey within the engine's sump, the oil pump is vital to the life of engine, the bearings supporting the crank shaft on a continuous film of oil pistons cool down and clean by the oil

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detergent action and the valve train is protected by the oils anti wear system, loads in valve train are the highest in the engine, this is where the oil experience the most stress to avoid friction and damaging wear, these fast moving, metal components must be lubricated, the oil is the only thing preventing metal-metal contact this whole journey take as little as 5sec

Throughout the oils journey, its primary function is to protect .it does this in many ways reducing friction and metal to metal contact, reducing wear throughout the drive and reducing harm full deposits.

II. Experiment on PIN Disc Tribometer

Castrol 10W30 4T engine oil, a mineral based multi – grade oil is used to perform this study. The pin to be used on pin on disc tribometer is fabricated from 6036 grade aluminum. The additives were purchased from Nano Research Labs. CuO nanoparticles of grain size 30-50 nm and NiO nanoparticles of grain size 10 nm are utilized as added substances to the oil. The bulk density of CuO nanoparticles is found to be 0.79 g/cm$^3$

The tribological properties of the lubricant are studied using a pin on disc tribometer (ASTM – G99) with a system (a load cell) to measure the friction force for friction coefficient determination. The apparatus consists of a revolving disc which is held by a chuck and a driven spindle. The pin is held by a lever arm device and other attachments are used to force the pin on the revolving disc with a controlled load. There wears track on the disc with multiple passes of wear on it was circular.

Fabrication of Pin

Aluminum of grade 6036 is used to fabricate the pin with a cutting saw to produce circular pieces. The pieces are then machined on a lathe to the dimensions of 10 mm diameter and a length of 50 mm which is as per the ASTM – G99 size.

Preparation of Nano Lubricant

By using Electronic Balance (accuracy up to 1000th gram) NiO and CuO Nanoparticles are weighted at 0.2 %wt, 0.3 %wt and 0.4 %wt of base oil. These weighted nanoparticles are added to base oil and mixed with stirrer (Fig.1) for two hours at 900 to 1100 rpm. Oleic acid also added to decrease the aggregation of nanoparticles in base oil. Then by using sonicator of 30 kHz Nano lubricant was mixed for one hour. After 30 minutes some particles are sediment these are removed by filter paper.
Pin on disc Test
Coefficient of friction property determine by using pin on disc tribometer (Fig 4.) for base oil and NiO, CuO nanoparticles with 0.2%wt, 0.3%wt and 0.4%wt to base oil. To figure out the optimal concentration of nanoparticles to base oil, observations were carried out at various ratios of NiO and CuO nanoparticles. Sliding speed, load, time, on the disc tribometer the structure of nano particles were viewed by changing loads.

Pin on disc testing parameters range are following.
Sliding speed: 273 rpm (1 m/s).
Load: 20N, 35N, 50N.
Disc track width: 70mm.
Nanoparticles concentration of NiO and CuO: 0.2%wt, 0.3%wt, 0.4%wt.
All the experiments are done for 120 seconds.
Initially pin was made flat circular surface of diameter of 90mm and length 50mm using lathe. Later it was cleaned and waits until it dried. Pin was fitted in Jaws against counter surface disc through a load by wire string. Pin was positioned at 70mm of track width of rotating disc. Rotating was cleaned by Acetone and grinded by sand paper of 400 grit size to make even surface. Then base oil was applied on disc up to certain region and test was carried out. Finally, Coefficient of friction was shown on Electronic display (Fig 3.). For every experiment same producer was carried. Test was started when load is applied on disc. By electric motor desired speed was maintain, when required revolution are obtained motor was stopped and readings are note down. WinDucom 2010 software was used to take graphs of Coefficient of friction.

III. Testing of Lubricant Oil in 4-Stroke I.C Engine

This test we calculate the thermal efficiency and mechanical efficiency in four stroke single cylinder diesel Engine with band brake dynamometer for Nano lubricating oil with more Coefficient of friction reduction and to SAE 10W-30 base oil.

The aim of designing an engine is cost reduction, improvement of power output and reliability. In trying to achieve these goals various design concepts have to be tried. To find the effects on engine performance of a particular design concept testing has to be restored too.
A. Procedure
Before staring the diesel engine, we ensure fuel level was up to mark. Pour the Nano lubricating oil with more Coefficient of friction reduction into engine sump. Open the three-way cock so that fuel flows into the engine. Rotate the flywheel with the help of the handle and rotate the decompression lever so that engine starts. Then turn on the cooling pipe line to engine cylinder. Apply tension and take the readings of time taken of consuming 10cc of fuel. After that take readings when engine was fill with SAE 10W-30 base oil in engine sump. While starting the engine the decompression lever should not be engaged as it damages the value and engine load. Continuous fuel supply must be ensured to the engine. Otherwise an air lock may be setup in the fuel supply system.

B. Specifications of Engine

- Engine: single cylinder, four stroke, diesel engine.
- Brake horse power/KW: 6/4.41.
- Bore diameter: 110 mm.
- Stroke length: 130 mm.
- Circumference of wheel: 190 cm.
- Brake specific fuel consumption: 209 gm/bhp-hr.

Testing of lubricant oil was performed under this specification of diesel engine with bank brake dynamometer.

IV. Result and Discussion

Results on Pin on Disc Tribometer

Progressions of investigations were done to study the Coefficient of friction using Pin on disc tribometer. Results are taken by applying base oil and NiO, CuO nanoparticles with 0.2%wt, 0.3%wt and 0.4%wt to the base oil on the pin on disc.
Machine. Coefficient of friction was noted for each sample at 20N, 35N, 50N loads which are applied on pin.

| Percentage of NiO and CuO nanoparticles by weight in base oil (%wt.) | Coefficient of friction(μ) | Percentage decrease with base oil (%) |
|---------------------------------------------------------------|-----------------------------|--------------------------------------|
| 0% wt.+0% wt.(base oil)                                      | 0.087                       | 0                                    |
| 0.2% wt.+0.2% wt.                                           | 0.065                       | 25.28                                |
| 0.3% wt.+0.3% wt.                                           | 0.041                       | 52.87                                |
| 0.4% wt.+0.4% wt.                                           | 0.030                       | 65.51                                |

**Table I: Comparison of Coefficient of friction at 20N load**

| Percentage of NiO and CuO nanoparticles by weight in base oil (%wt.) | Coefficient of friction(μ) | Percentage decrease with base oil (%) |
|---------------------------------------------------------------|-----------------------------|--------------------------------------|
| 0% wt.+0% wt.(base oil)                                      | 0.103                       | 0                                    |
| 0.2% wt.+0.2% wt.                                           | 0.072                       | 31.10                                |
| 0.3% wt.+0.3% wt.                                           | 0.044                       | 57.28                                |
| 0.4% wt.+0.4% wt.                                           | 0.032                       | 68.93                                |

**Table II: Comparison of Coefficient of friction at 30N load**

| Percentage of NiO and CuO nanoparticles by weight in base oil (%wt.) | Coefficient of friction(μ) | Percentage decrease with base oil (%) |
|---------------------------------------------------------------|-----------------------------|--------------------------------------|
| 0% wt.+0% wt.(base oil)                                      | 0.602                       | 0                                    |
| 0.2% wt.+0.2% wt.                                           | 0.442                       | 26.57                                |
| 0.3% wt.+0.3% wt.                                           | 0.243                       | 59.63                                |
| 0.4% wt.+0.4% wt.                                           | 0.159                       | 73.58                                |

**Table III: Comparison of Coefficient of friction at 40N load**

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Table-I Compares the Coefficient of friction of base oil and Nano lubricant. NiO, CuO nanoparticles with 0.2%wt, 0.3%wt and 0.4%wt to base oil significantly decrease the coefficient of friction by 25.28%, 52.87% and 65.51% respectively. The highest percentage reduction was observed at 0.4%wt of NiO and 0.4%wt of CuO nanoparticles to base oil. At this stage, coefficient of friction was cut down to 65.51% compared with base oil.

Table-II Compares the Coefficient of friction of base oil and Nano lubricant. NiO, CuO nanoparticles with 0.2%wt, 0.3%wt and 0.4%wt to base oil significantly decrease the coefficient of friction by 31.10%, 57.28% and 68.93% respectively. The highest percentage reduction was observed at 0.4%wt of NiO and 0.4%wt of CuO nanoparticles to base oil. At this stage, coefficient of friction was cut down to 68.93% compared with base oil.

Table-III Compares the Coefficient of friction of base oil and Nano lubricant. NiO, CuO nanoparticles with 0.2%wt, 0.3%wt and 0.4%wt to base oil significantly decrease the coefficient of friction by 26.57%, 59.63% and 73.58% respectively. The highest percentage reduction was observed at 0.4%wt of NiO and 0.4%wt of CuO nanoparticles to base oil. At this stage, coefficient of friction was cut down to 73.58% compared with base oil.

Fig. 6: Coefficient of friction at 20N load
Results of I.C Engine

In this we calculate the brake power, Indicated power, fuel consumption, Mechanical efficiency, Brake thermal efficiency for Diesel engine for Nanolubricant and base oil at various tensions. For calculating various parameters
Fuel consumption (F.C): \((10\text{cc} \times \beta)/\text{time}\)\(= (8\times10^{-3}) / \text{time}\) kg/s.
Brake power: \((2\pi NT)/60\) Watts.
Indiacted power = Friction power + Brake power. Watts.
Mechanical effectiveness = (Brake control)/(Indicated control).
Brake thermal efficicency = \((\text{Brake power} \times 100) / (\text{Fuel consumption} \times \text{Cv})\).
Table IV: comparison of fuel consumption, brake power, indicated power for base oil and nano lubricant at various loads

| Tension (N) | Fuel consumption (kg/s) | Brake power (watts) | Indicated power (watts) |
|-------------|-------------------------|---------------------|-------------------------|
|             | Base oil | Nano lubricant | Base oil | Nano lubricant | Base oil | Nano lubricant |
| 8.88        | 1.29*10^-4 | 1.11*10^-4 | 604.97 | 729.83 | 2504.9 | 2475.8 |
| 17.77       | 1.63*10^-4 | 1.45*10^-4 | 1209.9 | 1331.27 | 3109.3 | 3077.27 |
| 26.66       | 1.9*10^-4 | 1.69*10^-4 | 1814.9 | 1936.54 | 3714.9 | 3682.54 |
| 35.55       | 2.22*10^-4 | 2.02*10^-4 | 2419.9 | 2542.16 | 4319.5 | 4288.16 |

Table V: comparison of fuel mechanical efficiency, brake thermal efficiency for base oil and nano lubricant at various loads

| Tensions (N) | Mechanical efficiency (%) | Brake thermal Efficiency (%) |
|--------------|----------------------------|----------------------------|
|              | Base oil | Nano lubricant | Base oil | Nano lubricant |
| 8.88         | 24.1    | 29.45           | 11.03    | 15.13          |
| 17.77        | 38.9    | 43.32           | 17.46    | 21.09          |
| 26.66        | 48.8    | 52.58           | 22.47    | 26.35          |
| 35.55        | 56      | 59.28           | 25.65    | 29.64          |

We pour base oil with 0.4%wt of NiO and 0.4%wt of CuO to Diesel engine for better Coefficient of friction. From fuel consumption and brake power graph we can calculate the frictional power. For base oil frictional power was 1900 watts and by using Nano lubricant frictional power reduced to 1746 watts.

Finally by using Nano lubricant we can reduce the fuel consumption and approximately 4% was increase for both Mechanical, Brake thermal efficiency of four stroke single cylinder diesel engine.

I.C Engine efficiency depends upon various parameters like indicated power, brake power, mechanical efficiency, indicated thermal efficiecy, brake thermal efficiency,
volmetric efficiency, fuel consumption, brake mean effective pressure, indicated mean effective pressure, frictional horse power.

Overall efficiency of I.C engine was increased by

1. Run the engine gas-lean, that is, use extra air. It is widely known that gasoline-lean strolling improves the performance Higher compression ratio
2. We need new cycles put into practical use.
3. Run the engine at optimum conditions, meaning low friction (modest engine speed) and low pumping work air throttle more open.

V. Conclusion

The following conclusions can be drawn from the above results:

- All nanoparticles suspended lubricants exhibited reduction in coefficient of friction and frictional force
- The suspensions with 0.4%wt CuO and 0.4%wt NiO exhibited high reduction in coefficient of friction and frictional force
- The trend of increasing the Mechanical efficiency and Brake thermal efficiency was observed.

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