



Lubrication properties of bio based oils compared with mineral oil and determining the effect of wear

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Abstract— Lubrication is essential in increasing a mechanical device's service duration and minimizing wear. Though synthetic and petrol-based oils are generally used in lubricants today, natural oils which are pollution-free, biologically decomposable, and whose waste does not give harm to the environment have also begun to be used as lubricants recently thanks to an increasing awareness of the environment. So, this study is investigated on wear performance of bio based oil. In this research bio based lubricant oil are compared with mineral lubricant oil of SAE20W40. Wear study involved with experiment of PIN ON DISC test apparatus at different speed of 150r.p.m, 300r.p.m, 450r.p.m, 600r.p.m and different load of 50N. Then the surface changes are inspected using optical microscope.

Index Terms— Bio based oil, Environment-friendly, Lubricant, Pin on disc.

I. INTRODUCTION

Every machine parts will have wear and tear due to the friction between the moving parts of the machine component. These friction leads to the material loss and the temperature rises [1][2]. It causes a lot of wear and tear on the surfaces of moving parts. Any substance introduced between the two moving surfaces with a view to reduce the friction (or frictional resistance) between them, is known as a lubricants. The process of reducing friction between moving surfaces, by the introduction of lubricants in between them, is called lubrication. Lubricants used to eliminate the wear and tear of the moving machine components. In such a case, the lubricant should have some properties to encounter the wear and tear without losing the mechanical energy. Those lubricants are extracted from petroleum based mineral oil.

At present, the increasing prices of crude oil, the depletion of crude oil reserves in the world, and as a global concern the environment should be protected from pollution have renewed interest in developing

and using environment-friendly lubricants derived from alternative sources [3]. A bio lubricant is renewable lubricants that is biodegradable, non-toxic, and emits net zero greenhouse gas. This study presents the

potential of a bio lubricant based on vegetable oil as an alternative lubricant [4]. Bio lubricants are potential alternative lubricants because of their low toxicity, good lubricating properties, high viscosity index, high ignition temperature, increased service life, high load-carrying abilities, good anti-wear characteristic, good coefficient of friction, natural multi-grade properties, low evaporation rates and low emissions into the atmosphere [5]. Bio lubricants have to replace the properties of usually used petroleum based mineral oil.

II. PROPERTIES OF LUBRICANTS

The main purposes of lubrication is to reduce wear and heat loss that result from the contact of surfaces in motion, that is to reduce the coefficient of friction between two contacting surfaces; to prevent rust and reduce oxidation; to act as an insulator in transformer applications; and to act as a seal against dirt, dust, and water. A lubricant is a substance that reduces friction and wear by providing a protective layer between two moving surfaces. Lubrication occurs when two surfaces are separated by a lubricant film. Lubricants are available in liquid, solid, and semisolid forms. A good lubricant exhibits the following characteristics: high viscosity index, high boiling point, thermal stability, low freezing point (pour point), corrosion prevention capability, and high resistance to oxidation. [3]. These lubricants are in different states.

A. Classification of Lubricants

I. Solid

The film of a solid material is composed of inorganic or organic compounds, such as graphite, molybdenum disulphide and cadmium disulphide.

II. Semisolid

Liquid is suspended in a solid matrix of thickener and additives, such as grease.

III. Liquid

Examples are oils such as petroleum, vegetable, animal and synthetic oils.

B. Properties of Lubricants

Lubricating oils should have some specific quality for performing the operation. The lubricants should possess the limit of following properties to achieve smooth operation.

I. Viscosity

Viscosity is the most important property of oil. It indicates resistance to flow, and is directly related to temperature, pressure, and film formation. High viscosity indicates high resistance to flow and low viscosity implies low resistance to flow.

II. Viscosity Index (VI)

The VI indicates changes in viscosity with changes in temperature. A high VI indicates small changes in temperature, whereas a low VI indicates high changes in temperature. Vegetable oil-based bio lubricants have higher VI than mineral oils, which ensures that bio lubricants remain effective even at high temperatures by maintaining the thickness of the oil film. Hence, bio lubricants are suitable for a wide temperature range.

III. Pour Point

Pour point is the lowest temperature at which oil flows or pours. Pour point is an important factor in which Vegetable oil-based bio lubricants have lower pour points than mineral oils, thus providing excellent lubrication for cold starts.

IV. Flash Point and Fire Point

Flash point is the lowest temperature at which a lubricant must be heated before it vaporizes. When mixed with air, a lubricant will ignite but will not burn. By contrast, fire point is the temperature at which the combustion of a lubricant continues [1]. Flash and fire points identifies the lubricant's volatility and fire-resistance properties. Both factors are important for transportation and storage requirements. Vegetable oil-based bio lubricants have higher flashpoint than mineral oils, thus considerably reducing the risks of fire in case of a lubricant leak, and providing safety on shop floors.

V. Cloud Point

Cloud point is the temperature at which solids dissolve in oil. Wax crystallizes and becomes visible when temperature drops. To prevent clogging of filters, temperature must be maintained above the cloud point.

VI. Corrosion Prevention

Rust is chemical reaction between water and ferrous metals; meanwhile, corrosion is a chemical reaction between chemicals and metals. Vegetable oil-based bio lubricants are nontoxic and react less with chemicals, water, and ferrous metals than mineral oils.

VII. Anti-wear Properties

Lubricants are satisfactory for low-speed and low-pressure applications. Boundary lubrication occurs when oil viscosity is insufficient to prevent surface contact. Anti-wear additives provide a defensive film at contact surfaces to reduce wear. Anti-wear property is identified by standard laboratory tests. Vegetable oil-based bio lubricants have better anti-wear properties than mineral oils.

These are the essential properties of bio lubricants which should possess to perform as good lubrication.

C. Benefits of Bio Lubricants

Bio based oils have excellent lubricity, which is far superior compared with that of mineral oils. Vegetable oils also have a high VI [6]. Another important property of vegetable oils is their high flash points. Typically, the flash point of vegetable oils is 326°C, whereas that of common mineral oils is 200°C. More importantly, vegetable oils are biodegradable, generally less toxic, renewable, and reduce dependency on imported petroleum oils.

III. EXPERIMENTAL PROCEDURE

A. Copper Corrosion Test

The copper strips were polished first with silicon carbide (SiC) paper, washed, and then polished again. Rubbing was performed in the direction of the long axis of the strip. Once the copper strips had been polished and cleaned of any metal dust, they were immersed in the sample oil and heated at 50°C-90°C for 2 hrs. [7] At the end of this time, the copper strip was washed and compared to the ASTM copper strip corrosion standards. The rating system of the ASTM D 130 test is described in table for easy interpretation of the results.

Classification	Designation	Description
1a	Slight tarnish	Light orange, almost the same as a freshly polished strip
1b		Dark orange
2a		Claret red
2b	Moderate tarnish	Lavender
2c		Multicolour with lavender blue or silver or both, overlaid on

		later red
2d		Silvery
2e		Brassy or gold
3a	Dark tarnish	Magenta overcast on brassy strip
3b		Multicolour with red and green showing (peacock) but no gray
4a	Corrosion	Transparent black, dry gray or brown with peacock green barely showing
4b		Graphite or lusterless black.
4c		Glossy or jet black

TABLE 1. Colour representation of copper strip corrosion test



Fig 1. Colour chart for copper strip corrosion test

B. Lower temperature Points

I. Cloud Point: Apparatus used in cloud point determination were test jar, cork carrying thermometer, water bath with heater, cloud point chamber and crushed ice. Experimental procedures are as enumerated below:

- Test jar was filled to the level mark, closed tightly by the cork carrying the thermometer and placed into a bath of crushed ice.
- Test jar was removed from the jacket quickly without disturbing the specimen. Inspection for cloud point was done and jacket replaced.
- Operation was done without exceeding time duration of three seconds. Since cloud point is the temperature of a liquid specimen when the smallest observable cluster of hydrocarbon crystals first occurs upon cooling under prescribed conditions, observation was done and cloud point was reported to the nearest 1°C.
- At this point, cloud is observed at the bottom of the test jar, which is confirmed by continued cooling.



Fig 2. Apparatus for finding the pour and cloud points

I. Pour Point: Same apparatus that we used in cloud point determination were used in pour point determination. Experimental procedures are enumerated below:

- A sample of oil was filled to the level mark. The test jar was tightly closed by the cork carrying the test thermometer and placed in a bath of crushed ice.
- The test jar was inspected at an interval of at three minutes by holding in a horizontal position.
- The pour point was reached when the oil surface stayed in the vertical position for a period of 5 seconds without sagging.
- At this point the thermometer was inserted to cool for 10 seconds and the temperature of the oil was taken.
- The pour point was 3°C higher than the thermometer reading. Oil sample at pour point is shown in Fig



Fig 3. Oil in state of pouring temperature

C. Viscosity

The redwood viscometer consists of vertical cylindrical oil cup with an orifice in the centre of its base. The orifice can be closed by a ball. A hook pointing upward serves as a guide mark for filling the oil. The cylindrical cup is surrounded by the water bath. The water bath maintains the temperature of the oil to be tested at constant temperature. The oil is heated by heating the water bath by means of an immersed electric heater in the water bath, The provisions is made for stirring the water, to maintain the uniform temperature in the water bath and to place the thermometer to record the temperature of oil and water bath[5]. The cylinder is 47mm in diameter and

88mm deep. The orifice is 1.70mm in diameter and 12mm in length. This viscometer is used to determine the kinematic viscosity of the oil.

D. Wear Test

The amount of wear in any system will, in general, depend upon the number of system factors such as the applied load, machine characteristics, sliding speed, sliding distance, the environment, and the material properties. The value of any wear test method lies in predicting the relative ranking of material combinations [7].

- a. First of all, the work piece is weighed and the value is noted. Then the test oil is filled up to the level of mark which indicates the volume of 2 liters. Then the work piece is tightly placed on the holder.
- b. After placing the work piece, the track length is adjusted to 70mm and is tightly fixed. Thermocouple is inserted to obtain the temperature of the work piece.
- c. Lubricant inlet and outlet is checked and the values on the setup are changed with respect to the test strategy. In this we are going to carry out the test for 60 minutes.
- d. Then the test is switched on and the lubricant will also continue to flow to the work piece.
- e. The base drum made of steel will rotate to the given RPM and the work piece is made to wear due to moving parts. After 60 minutes, the base drum rotation will automatically stop and the lubricant outlet is to be stopped.
- f. Finally the weight of the work piece is investigated and the weight loss will be due to the wear between initial and final stages.

IV. RESULTS AND DISCUSSION

Thus by conducting the test of wear, we found that the co-efficient of friction is better when comparing with the palm oils. Mineral oils now-a-days are widely used as a lubricants for many of the moving parts and is slightly nearer to the mineral oils. Hence by those values it is slightly proved to be as a lubricant. We used Steel EN-24 as a work piece on PIN ON DISC wear testing machine.

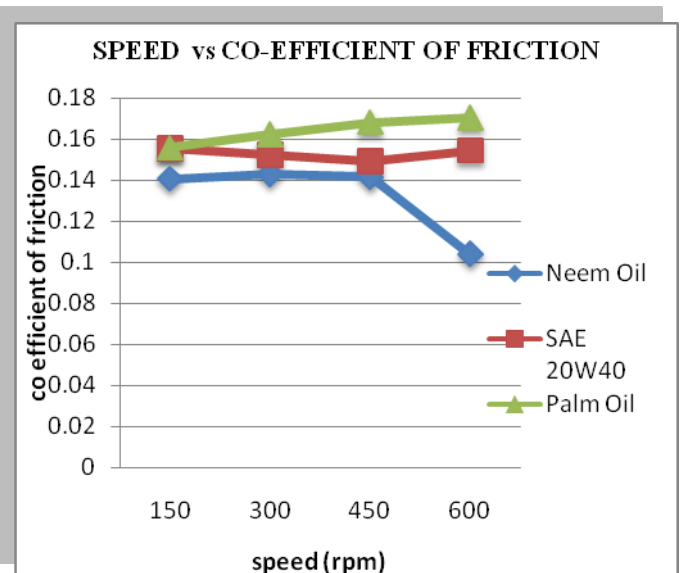


Fig 4. Graphical representation of the co-efficient of friction of Neem oil compared with Mineral oil and Palm oil.

V. CONCLUSION

We had concluded this by conducting the wear test experiment with the speed of 150r.p.m, 300r.p.m, 450r.p.m, 600r.p.m and at the load of 50N. Thus by the study and tests made with the Mineral, Neem and Palm oil, we found that the neem oil is providing less friction when compared with the Palm oil.

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