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Study of Tribological Characteristics of Journal Bearing using Mixture of different Bio-Lubricants

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Abstract
Wear is the main reason for material losses & degradation of any machine component. If we reduce the magnitude of this wear can bring about enhanced performance. This can be possible by decreasing friction. Usage of Lubricant is a viable method for controlling the friction. This decreases wear and it has wide application in operation of machine component, for example, bearing. Nowadays different oils are used to diminish erosion and wear between mechanical contact surfaces however mineral oils are known for higher manufacturing expenses and low biodegradability. A few research works are going ahead keeping in mind the end goal to create bio-oil and to have tribological characteristic study between interacting mechanical surfaces.
In any case, our investigation mostly features the tribological-study about on Journal-bearing at various speeds and at various loads, so at long last we can choose best bio-mixture of Lubricant for journal bearing on the premise of low coefficient of friction and high load conveying capacity. From the present work we found that cotton seed and hippe oil and castor and honge oil (50:50) mixture will give the best operating performance of the journal bearing.

Keywords : *Tribology , Journal Bearing, Lubricants , Bio-Lubricants*

INTRODUCTION

Journal bearings are typical critical power transmission components that carry high loads in different machines. It is used to support radial loads under high speed operating conditions. Therefore, it is essential to know the true or expected operating conditions of the bearings. The operating conditions of hydrodynamic journal bearings can be described by a set of tribological variables called key operating parameters. The key operating parameters most directly related to the bearing-lubricant-shaft contact are the oil film temperature, oil film thickness, coefficient of friction and oil film pressure. In a hydrodynamic journal bearing pressure of hydrodynamic lift is generated in thin lubricant oil film that separates the shaft and bearing thus preventing metal-to-metal contact. So selection of best bio lubrication is essential.

Analysis is done on journal bearing using different bio-lubricants. The pressure distribution reading is taken for different bio-lubricants such as hippe, honge, cotton seed and castor oil at different loads and at different speeds. Viscosity is found out by using viscometer and coefficient of friction is calculated on different bio lubricants. The best lubricant is selected on low coefficient of friction value. After plotting pressure distribution diagram, best oil is selected on the basis of high load carrying capacity.

Finally on the basis of low coefficient of friction and high load carrying capacity best oil is recommended for journal bearing. Hence the performance of the journal bearing is enhanced.[1]

EXPERIMENTAL SETUP

For analysis we are using two apparatus

1. Redwood Viscometer
2. Journal bearing test rig

Red wood viscometer

In this we use red wood viscometer. The viscosity of various lubricants are measured at different temperature

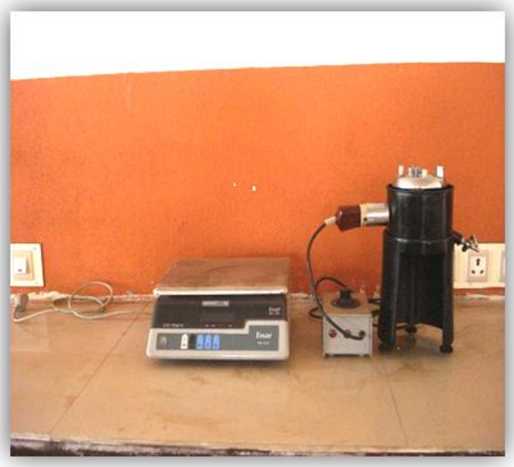

Fig. 1 *Redwood viscometer*

Description of red wood viscometer

The redwood viscometer consists of silver plated oil cup about 4.5cm diameters 9cm deep, mounted in a chrome plated water bath. The water bath is mounted on stand with levelling screw .the base of the cup has central hole into which the jet is fitted with its bore in the axis of cup. The level to which oil is to be filled into the oil cup is given by an index fixed to the inside wall of the oil cup.

The cylindrical water bath surrounds the oil cup and is provided with a tape for emptying. A ball valve for starting and stopping of the oil flow is also provided. A stiff wire spring clip arrangement is mounted to hold the thermometer.

Journal bearing test rig The pressure distribution reading for different oils are taken for different loads and speed Pressure distribution diagram is plotted for different oils and thus selecting oil having high load carrying capacity

Fig. 2 *Journal bearing test rig*

Specification

1. Diameter of journal d=50mm
2. Diameter of bearing D=55mm
3. Radial clearance, C=D-d/2 =55-50/2=2.5mm
4. Length of bearing=100mm
5. Motor DC=0.5Hp, 1500 rpm
6. Manometer board with 16 tubes of 300 cm height with suitable scales and adjustable oil tank
7. Supply required= AC, 1HP, 230V, stabilised

Description

Journal bearing test rig is an apparatus which is used to find the pressure distribution around the journal surface in the journal bearing. It consists of a 50mm journal which is connected to a motor shaft of 0.5HP with adjustable speed up to a max speed of 1500rpm. There is a clearance of 2.5mm between journal and bearing which helps for lubrication and thus prevents metal to metal contact. 12 holes at equal angles are made on the circumference of bearing and the pipes from each hole are connected to a manometer pipes with a height of 200cm. A load panel is located on the lower side of the bearing, where the radial loads are applied. A tank of 5 litre capacity is located at certain height so that oil flows to the clearance between journal and bearing

METHODOLOGY

The oil cup is cleaned using petrol and the viscometer is leveled using leveling feet then the bath is filled with water. The oil cup is filled up to the index mark with the oil whose viscosity is to be measured. The water in the bath and oil in cup are constantly stirred to equalize their temperatures a 50cc standard flask is kept below the jet. When the temperature of oil and water remain constant the ball valve is lifted and 50cc of oil is collected in the flask and the time required to run down the 50cc of oil from oil cup into receiver flask is noted. The standard flask with oil is weighed and the mass of oil at that temperature is found out. The experiment is repeated for different temperature and density for different temperature is measured later viscosity is calculated by using formula. The average viscosity is taken for particular lubricant. This is repeated for different bio lubricants, the viscosity is calculated for different bio lubricants.[2]

Selected oil is filled in the oil tank and position the tank at desired height. Air which is present in the manometer tubes are removed and check level balance with supply level oil leakage is checked the motor is switched on and the journal is set for required speed and made to run for about half an hour until the oil in the bearing is warmed up. The required loads are added and the balancing rod is kept in horizontal position. As the manometer levels are settle down the pressure reading on twelve manometer tubes are taken, the experiment is repeated for various speeds and loads. As the journal rotates the difference in pressure around the circumference is read on the manometer pipe. Based on these values a pressure distribution diagram is drawn.

The oil is drained and filled with different bio oil and the experiment is repeated. Then the speed indicator is set to zero position and main supply is switched off [3]

RESULTS AND DISCUSSION

Experiment is carried by using mixture of Hippe oil, castor oil &cottonseed oil (50:50)

Table.1 *Average viscosity of mixture of different bio lubricants*

Samples	**Avg. viscosity (centipoises)**
Cotton seed & Honge oil	3.326
Cotton seed oil& Hippe oil	3.27
Honge oil & Hippe oil	15.93
Castor oil& Hippe oil	27.94
Castor & Honge oil	31.12
Castor & Cotton seed oil	17.25
SAE30 oil	66

Table 2 *Coefficient of friction for sample oils*

SAMPLES	COEFFICENT OF FRICTION
COTTON SEED OIL&HIPPE OIL	6.69*10^-3
COTTON SEED OIL&HONGE OIL	6.8*10^-3
HONGE OIL&HIPPE OIL	0.0325
CASTOR OIL&HIPPE OIL	0.0573
CASTOR& HONGE OIL	0.0637
CASTOR OIL & COTTON SEED OIL	0.0352
SAE30	0.1353

Pressure distribution diagram

A suitable scale is selected and a circle equal to the size of journal is drawn. The circle is then cut into 12 equal divisions to represent the location of the pressure tapping on the bearing along the circumference. Using appropriate scale the lines are drawn from journal surface from the pressure distribution values. After that the radial lines are drawn and numbered sequentially in the clockwise direction then join them with a smooth curve to get pressure distribution diagram. The plot is drawn for different load and speed. Since the load applied is radial, if the oil has to resist the applied load, it should give higher area on lower surface of journal. So area is direct measure of load carrying capacity. From plot we select the oil which has larger area below the journal surface i.e. selecting the bio lubricant having high load carrying capacity.

Procedure for drawing Pressure distribution diagram

A suitable scale is selected and a circle equal to the size of journal is drawn. The circle is then cut into 12 equal divisions to represent the location of the pressure tapping on the bearing along the circumference. Using appropriate scale the lines are drawn from journal surface from the pressure distribution values. After that the radial lines are drawn and numbered sequentially in the clockwise direction then join them with a smooth curve to get pressure distribution diagram. The plot is drawn for different load and speed. Since the load applied is radial, if the oil has to resist the applied load, it should give higher area on lower surface of journal. So area is direct measure of load carrying capacity. From plot we select the oil which has larger area below the journal surface i.e. selecting the bio lubricant having high load carrying capacity.

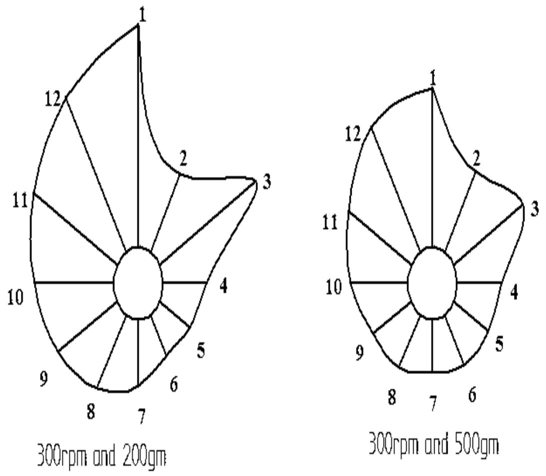

***Fig. 3** Pressure distribution diagram for mixture of cotton seed and Hippe oil.*

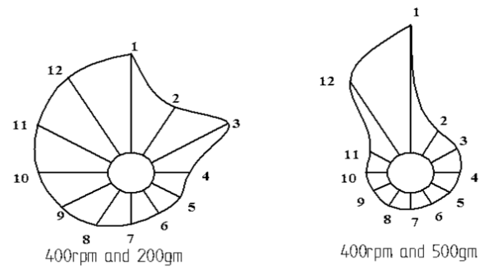

***Fig. 4** Pressure distribution diagram for mixture of Cottonseed and Hippe oil*

Average area below journal surface on P.D plot =4675.0975 mm^2

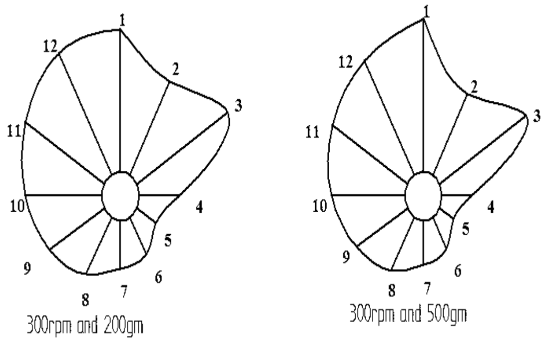

***Fig.5** Pressure distribution diagram for mixture of Castor and Honge oil*

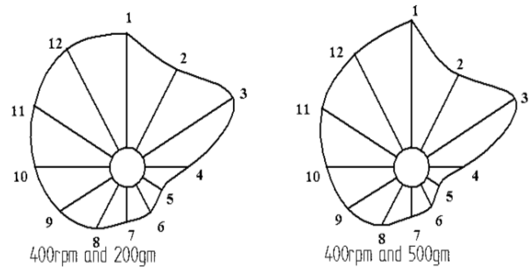

***Fig. 6** Pressure distribution diagram for mixture of Castor and Honge oil*

Average area below journal surface on P.D plot =5975.365 mm^2

Discussion

The obtained coefficient of friction values for different bio-lubricant and SAE30 as per calculation, and the same value indicated in the below table

***Table 3** Coefficient of friction for following samples*

SAMPLES	COEFFICENT OF FRICTION
COTTON SEED OIL&HIPPE OIL	6.69*10^-3
COTTON SEED OIL&HONGE OIL	6.8*10^-3
HONGE OIL&HIPPE OIL	0.0325
CASTOR OIL&HIPPE OIL	0.0573
CASTOR& HONGE OIL	0.0637
CASTOR OIL & COTTON SEED OIL	0.0352
SAE30	0.1353

From above table we see that cotton seed oil and hippe oil has low coefficient of friction followed by other mixed oils.

Area on P.D plot is directly measure of load carrying capacity. If the value of area is larger, then it has high load carrying capacity. Values are shown in decreasing order in table 1.4 for different bio lubricants

***Table 4** Areas on P.D plot for following samples*

SAMPLES	Area on P.D plot (mm^2)
Castor &Honge oil	5975.365
Cotton seed &Castor oil	5795.8075
Hippe & Honge oil	5419.665
Castor &Honge oil	4895.45
Hippe& Cotton seed oil	4675.0975
Hippe& Castor oil	4516.23
SAE30	42371.55

By observing the above two tables, we have decided that cotton seed and Hippe oil has got a minimum coefficient of friction and castor and Honge oil has got a max load carrying capacity.

From this we can expect that the mixture of cotton seed and Hippe oil and castor and Honge oil (in 50:50) will give the best mixture for the good performance of the bearing.

CONCLUSIONS

From analysis we conclude that

1. Mixture of Cotton seed and Hippe oil is having low coefficient of friction.
2. Mixture of Castor &Honge oil is having high load carrying capacity.
3. The mixture of cotton seed and honge oil and castor and Honge oil (in 50:50) will give the best mixture for the good operating performance of the journal bearing.

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