STUDY AND ANALYSIS OF DIFFERENT LUBRICANTS IN HYDRODYNAMIC BEARING

Thotada Kiran [1], Yeluri Sesha Sai[2], Guntuku Yeswanth Kumar[3], Sunkara Sai Kiran[4] , Laveti Nagitha Joshna[5]

[12345]Department of M E C H & ANITS

Abstract: Lubricants act as an antifriction medium, allowing for smoother operation, lowering the risk of unfavourable frequent failures, and ensuring reliable machine operations among various rotating parts of machines. vegetable oils are now being used in lubricants for industrial and transportation applications. potential advantages include resource renewability and biodegradability, as well as adequate performance. two-stroke engines, chain saws, hydraulics, mould releases, open gears, and farming, mining, and forestry equipment are among the applications where such oils are finding a home. these oils have also been shown to be excellent greases and fuels. sae oils are widely used in lubrication, but they are nondegradable and pollute the environment. vegetable oils have been identified as potential replacements for sae oils, particularly in lubrication applications. vegetable oils have better properties such as flash point, fire point, viscosity, and load carrying capacity. as a result, it is critical to investigate and analyse the pressure distribution in hydro dynamic journal bearing with mineral oils and vegetable oils.

Keywords: SAE, HYDRODYNAMIC ,RADIAL, AXIAL, SOMMERFELD NUMBER.

1.INTRODUCTION:

1.1 BEARINGS:

Bearings are mechanical elements that allow relative motion between two parts, such as the shaft and the housing, while minimizing friction.

The bearing allows the shaft or axle to rotate freely with minimal friction. The bearing holds the shaft or axle in place and supports it .The bearing absorbs the forces acting on the shaft or axle and transmits them to the frame or housing. Bearings are classified in various ways based on the direction of force acting on them. Bearings are classified based on the types of friction that exist between the shaft and the bearing surface.

Bearings with sliding contact and Bearings with rolling contact are the two types.

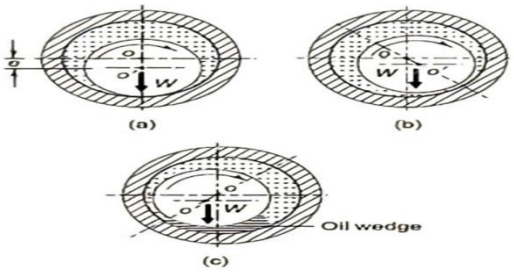
1.2 BASICS MODES OF LUBRICATION:

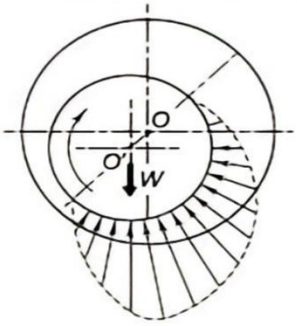
Lubrication is the science of reducing the friction by application of suitable substance called lubricant, between the rubbing surfaces of bodies having relative motion. the objectives of lubrication are: to reduce friction , to reduce or prevent wear , to carry away the heat generated due to friction and to prevent the journal and bearing from corrosion. the lubricants are classified into the following groups: liquid lubricants like mineral or vegetable oils, semi-solid lubricants like grease and solid lubricants like graphite

1.3 HYDRODYNAMIC LUBRICATION:

Hydrodynamic lubrication is defined as a lubrication system in which the load-supporting fluid film is created by the shape and relative motion of the lubricant, as shown in figure , where the shaft is initially at rest (a) and sinks to the bottom of the clearance space due to the action of load W. During rest,' the journal and bearing surfaces make contact. As the journal begins to rotate, it climbs the bearing surface (b), and as the speed increases, the fluid is forced into the wedge-shaped region (c). As more fluid is forced into the wedge-shaped clearance space, pressure builds up within the system. The Figure depicts the pressure distribution around the journal's periphery.It is not necessary in this case to supply the lubricant under pressure; the only requirement is a sufficient and continuous supply of the lubricant. This type of lubrication is found in engine bearings and centrifugal pumps. The term "journal bearing" is frequently used. A journal bearing is a sliding contact bearing that uses hydrodynamic lubrication to support loads in the radial direction. The journal is the portion of the shaft that is inside the bearing, hence the name "journal" bearing.There are two kinds of hydrodynamic journal bearings: full journal bearings and partial journal bearings. The angle of contact of the bushing with the journal in full

journal bearing is 360°. Loads can be applied to a full journal bearing in any radial direction.





pressure distribution

1.4 VISCOSITY:

Viscosity is defined as the internal frictional resistance offered by a fluid to change its shape or relative motion of its parts. The lower plate is stationary while the upper plate is moved with a velocity U by means of a force P.

1.5 PETROFF'S EQUATION:

The Petroff equation gives the coefficient of friction in journal bearings. It assumes that the shaft (journal) and the bushing are concentric. In reality, the shaft is not concentric with the bearing but the coefficient of friction predicted is quite good.

The Petroff's equation is given by

$f = (2\pi^2)(r/c)(\mu ns/p)$

2. EXPERIMENTAL METHODOLOGY

2.1 INTRODUCTION TO EXPERIMENTAL SETUP:

Journal Bearing Apparatus is based on real-world bearing action. It is a more difficult task to accurately formulate the bearing action in mathematical terms. However, using an experimental rig, one can visualise the pattern of bearing pressure distribution caused by hydrodynamic action. This aids in proper comprehension of the subject. A small journal bearing serves as the experimental rig. This apparatus aids in the demonstration and investigation of the effect of critical variables such as speed, viscosity, and load on the pressure distribution in a Journal Bearing.

2.2 DESCRIPTION OF APPARATUS:

It is made up of a Brass bearing that is freely mounted on a steel Journal shaft (A). This journal shaft is directly attached to a motor shaft (S). The speed of the DC motor is finely controlled by a dimmer stat. The journal bearing has twelve (No.1 to 12) equispaced 30° pressure tapings around its circumference, with two additional axial pressure tapings on the topside of the journal bearing. To prevent leakage, the two sides of the bearing are closed with two MS plates and sealed with gasket packing. Balancing weights are provided to keep the bearing horizontal while taking readings. Both weights are freely adjustable along the rod.

2.3 SPECIFICATIONS OF APPARTUS:

Diameter of Journal = 2r = 52.5 mm, Diameter of bearing = 2R=50mm (with 12 radial tapings and 2 axial tapings), Bearing width (L) = 90mm,Motor speed = 800 -1000rpm (variable speed – DC), Manometer frame with 14 tubes of 240cm, Height with scales and adjustable oil supply tank, Lubricating oil as per the test (SAE oil (OR) vegetable oil), Supply required AC single phase 230v.50Hz stabilized, r = Radius of Journal, Radial clearance (R-r) = 0.0275mm

2.4 EXPERIMENTAL PROCEDURE:

1. Fill the oil tank by using SAE 15W40/SAE 20W40 / SAE10W30 / Rice bran oil / Canola oil under test and position the tank at the desired height (up to 1.5-liter oil).
2. Drain out the air from the tubes on the manometer by removing the tubes from manometer.
3. Check that some oil sea page is there (See page of oil is necessary for cooling purpose).
4. Check the direction of rotation and increase the speed of the motor slowly.
5. Set the speed and let the journal run for about 2 minutes until the oil in the bearing is warmed up and check the steady oil levels at various tapings.

6. Add the required loads and adjust the balancing weights, on the rod to maintain the horizontal levels position.
7. When the manometer levels are settled down, take the pressure readings on 1-14 manometer tubes. For circumferential and axial pressure distribution.
8. Repeat the experiment for various speed and loads.
9. After the test is over set dimmer to zero position and switch off the main supply.
10. Keep the oil tank at lower most position so that there will be no leakage in the idle period.

Hydrodynamic bearing apparatus

bearing is a sliding contact bearing that uses hydrodynamic lubrication to support loads in the radial direction. The journal is the portion of the shaft that is inside the bearing, hence the name "journal" bearing.

There are two kinds of hydrodynamic journal bearings: full journal bearings and partial journal bearings. The angle of contact of the bushing with the journal in full journal bearing is 360°. Loads can be applied to a full journal bearing in any radial direction. It is not necessary in this case to supply the lubricant under pressure; the only requirement is a sufficient and continuous supply of the lubricant. This type of lubrication is found in engine bearings and centrifugal pumps. The term "journal bearing" is frequently used. A journal bearing is a sliding contact bearing that uses hydrodynamic lubrication to support loads in the radial direction. The journal is the portion of the shaft that is inside the bearing, hence the name "journal" bearing.

There are two kinds of hydrodynamic journal bearings: full journal bearings and partial journal bearings. The angle of contact of the bushing with the journal in full journal bearing is 360°. Loads can be applied to a full journal bearing in any radial direction.

Table 1: SUMMARY OF ANALYTICAL CALCULATIONS

S.NO	NAME OF OIL	SOMMERFELD NUMBER		
		500 RPM	700 RPM	900 RPM
1	SAE 15W40	8.624	12	15.5
2	SAE 20W40	6.664	9.328	12
3	SAE 10W30	9.44	13.21	17
4	RICE BRAN OIL	1.566	2.192	2.82
5	CANOLA OIL	2.221	3.109	4.44

After calculating the Sommerfeld number of mineral oils and vegetable oils at three different speeds using Petroff's equation, it is clear that the values of Sommerfeld number are very low for vegetable oils, making them much more favourable to use in hydrodynamic lubrication. Even at higher speeds, the values of Sommerfeld number are low when compared to mineral oils, and because Sommerfeld number is important for the design of

hydrodynamic bearings, these results conclude that vegetable oils can be useful for hydrodynamic bearings.

3.CONCLUSION:

A comparison study was conducted between mineral oils and vegetable oils in hydrodynamic lubrication to see if the selected vegetable oils, RICE BRAN AND CANOLA OIL, could be a perfect replacement for mineral oils such as SAE 15W40, SAE 20W40, and SAE10W30, which are commonly used in lubrication.

As we all know, everything has advantages and disadvantages, and we choose one over the other, for example, vegetable oil over mineral oil, based on these considerations.

ACKNOWLEDGEMENT:

We would like to thank Prof. Dr. B . Naga Raju (HOD, Department of MECH), MR. B S LAKSHMI PRASAD Asst.Professor, Dept. Of Mechanical Engineering (Project Guide) and management of ANITS for their support and encouragement towards completion of project work

REFERENCES :

1. W. Hughes and F. Osterle, “Temperature Effects in Journal Bearing Lubrication”.
2.S. Basri and D.T. Gethin, “A Comparative Study of The Thermal Behaviour of Profile Bore Bearings,” .
3. S. Cupillard, S. Glavatskih, M.J.Cervantes, “Computational Fluid Dynamics Analysis of A Journal Bearing with Surface Texturing,”.
4. K.P. Gertzos, P.G. Nikolakopoulos, C.A. Papadopoulos, “CFD Analysis of Journal Bearing Hydrodynamic Lubrication by Bingham Lubricant,”.
5. H. Liu, H. Xu , P. J. Ellison ,Z. Jin, “Application of Computational Fluid Dynamics And Fluid–Structure Interaction Method to The Lubrication Study of A Rotor–Bearing System,”.
6. J. Lin, C. Hwang and R. Yang, “Hydrodynamic Lubrication of Long, Flexible, Porous Journal Bearings Using The Brinkman Model,”.
7. M.B.W. Nabhan, G.A. Ibrahim and M.Z. Anabtawi, “Analysis of Hydrodynamic Journal Bearings Lubricated With A Binary Water-Based Lubricant,”.
8. H. E. Rasheed, “Effect of Surface Waviness on The Hydrodynamic Lubrication of A Plain Cylindrical Sliding Element Bearing,”.
9. S.K. Guha, “Analysis of Steady-State Characteristics of Misaligned Hydrodynamic Journal Bearings with Isotropic Roughness Effects,”.

10. Mr. Pramod, Akash.S. Patil, “Pressure distribution and friction coefficient of Hydrodynamic journal bearing.
11.A.Pratama, Jamari., “Hydrodynamic lubrication of textured journal bearing considering slippage”.
12.Arti Singh, “Performance of hydrodynamic journal bearing with various types of lubricant for pressure distribution and cavitation”.
13.S.A. Jagtap , M.J.Gitay ,“Performance of bio oil in journal bearing instead of synthetic oil”.