iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: VI Month of publication: June 2021

DOI: https://doi.org/10.22214/ijraset.2021.35162

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

A Review on Improvement of Hydrodynamic Journal Bearing by using Bio-Lubricant

Sandesh Magar[1], Tirupati Narhare[2], Atul Gaikwad[3], Nikhil Kapade[4]
"G H Raisoni College of Engineering and Management, Wagholi, Pune. – 412207"

Abstract: Journal bearings typically consists of metal sleeve that fits around a shaft. The sleeve is held in place within a housing. The journal is simply place on the shaft that is surrounded and supported by the bearing. Journal bearings can be made out of metallic or non-metallic materials such as bronze, aluminium etc. Bearings are generally made out of material that is softer than the metal of the shaft. Journal bearings typically consists of metal sleeve that fits around a shaft. The sleeve is held in place within a housing. The journal is simply place on the shaft that is surrounded and supported by the bearing. Journal bearings can be made out of metallic or non-metallic materials such as bronze, aluminium etc. Bearings are generally made out of material that is softer than the metal of the shaft. Typically, journal bearings are used in various applications such as turbines, compressors, centrifugal pumps etc. The performance of hydrodynamic journal bearing is depend upon the lubrication. Lubrication provides a thin film between internal sliding surfaces of the bearing components to reduce friction. Nowadays crude oil uses increases day by day. Due to depletion of petroleum resources, increasing its price and environmental pollution interest is developed towards the use of economical, environment-friendly lubricants. Bio-lubricants are made from vegetable oils. They are environment-friendly, non-toxic and also having performance benefits such as high viscosity index, high lubricity, high load carrying capacities, rapid biodegradability etc. In this review paper, to improve performance of hydrodynamic journal bearing and also to replace petroleum oil different types of bio-lubricants were examined.
Keywords: Bio-lubricant, Journal bearing, Hydrodynamic bearing, load carrying capacity

I. INTRODUCTION

Basically, bearings are used to provide supports to the shaft. The term journal refers to the shaft itself. There is a relative motion between shaft and bearing. There is a clearance between shaft and bearing, and it was filled with lubricant. Lubricant is used to reduce friction between two mating surfaces by providing a thin film between them. Provide protection against oxidization, corrosion and also remove the heat from surfaces these are the functions of lubricating oil. To perform this function the lubricating oil must have some chemical properties. Viscosity is the most essential property of a lubricating oil which has a significant impact on friction and wear reduction. Nowadays crude oil demand, pollution increases day by day and also there is a depletion of crude oil reserves. That causes awareness in the people for developing and using eco-friendly alternative lubricant. Bio-lubricants are eco-friendly because they are made from vegetable oils. Bio-lubricants are non-toxic, biodegradable, eco-friendly compared to mineral oil. Bio-lubricants have some disadvantages such as low oxidation stability, low temperature limitations etc. To overcome these nanoparticles are used. Nanoparticles are also increases the viscosity of the lubricant. Overall adding nanoparticles in lubricant, the performance of lubricant is increases. A nanoparticle is a small particle that ranges between 1 to 100 nanometres in size. Nanoparticles can be created from any solid or liquid material, including metals, dielectrics, and semiconductors. Nanoparticles have a wide variety of applications in industries such as textiles, pharmaceutical, cosmetics, electronics etc.

II. LITERATURE REVIEW

A brief review of some different researches and scientists are introduced here.

P. Zulhanafi [1] worked on the performance improvement of hydrodynamic journal bearing by using bio-based lubricant. In this study the advanced journal bearing test rig. was used. The main function of this machine is to measure the oil film temperature and pressure along the circumference of the bearing at different positions. They conducted some test at varying load 10kN, 20kN, 30kN at varying speed 200rpm, 400rpm, 600rpm. The time required for each test was 25 minutes. Two types of lubricants were tested in this experiment, namely, a mineral-based engine oil (SAE 40) and palm oil-based (palm mid olein –PMO) lubricant. By comparing the performance of the lubricants, it was concluded that PMO showed a higher maximum pressure at a lower load than SAE 40.

Surajkumar Khasbage [2] worked on performance of jatropha bio-lubricant for hydrodynamic journal bearing. Jatropha bio-lubricant have high viscosity and viscosity index compared to other vegetable oils. To perform theoretical calculation for hydrodynamic journal bearing they were using computational fluid dynamic (CFD) analysis. From this analysis they concluded that jatropha bio-lubricant shows the intermediate behaviour for pressure and load carrying capacity as that of the ISO VG 32 and ISO VG 46.

Baskar. S. [3] studied effect of vegetable oil-based nano lubricant on pressure distribution of a hydrodynamic journal bearing. They using chemically modified rapeseed oil (CMRO). To investigate pressure distribution of journal bearing they used journal bearing test rig machine. The bearing used is made of brass material. This study concludes that pressure variation in chemically modified rapeseed oil is maximum as compared to SAE 20W 40. This due to nano copper oxide additive. Nano additives have greatly effect on pressure distribution in the journal bearing system.

G. Sriram [4] studied G.Sairam studied Behaviour of Journal Bearing Material under Different Lubricants. They modified raw rapeseed oil using epoxidation, hydroxylation process to improve its thermo-oxidative stability and lower the pour point. Further using ultrasonic sonicator and rotary shaker for adding nano copper oxide having size of 40nm in it. A Pin on disc test machine was used to establish the wear and friction characteristics of a journal bearing material under different lubricated conditions. They conducted test on three different lubricants such as SAE20W40, chemically modified rapeseed oil [CMRO], chemically modified rapeseed oil with Nano CuO. They concluded that chemically modified rapeseed oil with Nano CuO has lowest coefficient of friction compared to others.

Ighor Caetano Silva Ferreira [5] worked on lubricity study of vegetable oils through a comparison of their physical properties. They compared physical properties of different vegetable oils to the properties of mineral oils. From the comparison of properties between vegetable and mineral oils it is observed that vegetable oils have better viscosity index and flash point compared to mineral oils. Between the different oil comparison Jatropha oil has lower pour point (-35 °C) with great adaptability for situations that require low operating temperatures, linseed oil has high flash point (334 °C) which is suitable in system with high heat dissipation.

S.R. Suryawanshi [6] studied the performance characteristics of Journal Bearing using Tio2 nanoparticle Additives and bearing geometry. Three grades of mobil lubricants they were used such as DTE 24, DTE 25 and DTE 26. From the experimental results they concluded that bearing geometry plays a very important role to analyze the performance of lubricated journal bearing.

J.T. Pattiwar [7] studied effect of TiO2 nanoparticles blended with lubricating oil on the tribological performance of the journal bearing. They considering some assumptions such as lubricant is incompressible, the flow is laminar, viscosity of the lubricant is constant, continuous supply of lubricant for the theoretical calculations. The lubricants used for testing were mobile grade(DTE 24,DTE 25,DTE 26).Because these lubricants have superior oxidation resistance property. To perform testing operations Four Ball Tester machine was used. It is used to study properties of the lubricant such as extreme pressure, wear and friction. From the experimental results they concluded that anti-wear and anti-friction properties are improved for the lubricants operating with TiO2 nanoparticle additives. Addition of Tio2 nanoparticles in lubricant viscosity is also increased. It tends to increases the load carrying capacity, the pressure distribution, frictional force, attitude angle

III. HYDRODYNAMIC JOURNAL BEARING

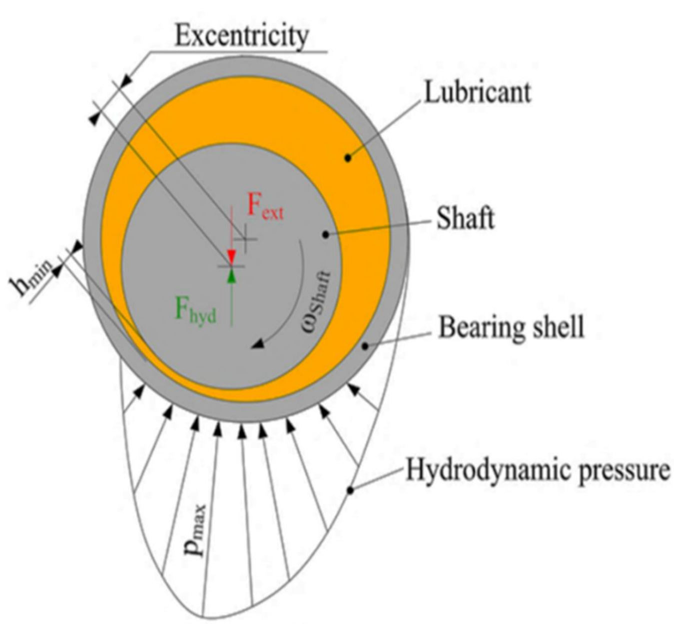

Fig 1 Hydrodynamic Journal Bearing

At initial position due to the self-weight the shaft and sleeve are in contact. When shaft start rotating the lubricant in between shaft and sleeve tends to get compressed and, in the end, forms a boundary lubrication between the shaft and the sleeve. When shaft rotates rapidly the lubricant is pumped by the shaft. The lubricant velocity near to the shaft surface and the lubricant velocity near to the sleeve surface both are different. Because of that pumping action in lubricant take place. To keep two mating surfaces out of the contact this pumping phenomenon of lubricant itself is called as hydrodynamic lubrication. The principle of hydrodynamic bearing ensures that during running shaft remains out of contact with sleeve. In the performance of journal bearing, journal speed and eccentricity always play an important role. Hydrodynamic journal bearing is used widely because of its high load carrying capacity and good damping properties. Hydrodynamic bearings are used in various applications such as crankshaft bearings in automobile engine, large turbines, gearbox in the power generation, generators, compressors etc.

IV. EXPERIMENTAL SETUP

Fig 2 Journal Bearing Tester

Journal bearing tester machine is used to investigate pressure distribution of journal bearing in a lubricant under different load condition. For performing operations 3 litres oil must require. The maximum load applying capacity is 750 N and the maximum speed applying capacity is 2000rpm. The oil reservoir capacity of this machine is 500ml. It consists of a shaft which is mounted vertically and driven by variable speed motor. A metallic bellow connects brass bearing on the bottom and top is fixed to the frictional torque load cell. The bearing is made of brass material. A stepper motor moves the bearing in the direction of the rotation of the shaft onto 180 in steps of 9. A pressure sensor is fixed to the bearing, which measures the film pressure distributed in the oil film. The lever arm is used to apply radial load by dead weights. The assembly of the shaft and the bearing is immersed in oil, so as to provide continuous lubrication at all times. A controller is used to display the values of the angular position of pressure sensor with reference to the load line and the corresponding pressure values. The data obtained are transmitted to PC through data acquisition cable.

REFERENCES

[1] P. Zulhanafi , S. Syahrullail , M.A. Ahmad " worked on "The Tribological Performance of Hydrodynamic Journal Bearing Using Bio-based Lubricant ". Vol. 42, No. 2 (2020) 278-287, DOI: 10.24874/ti.843.02.20.05

[2] Surajkumar Khasbage, Vijay Patil, Dinesh Dhande worked on "Performance of Jatropha Biolubricant for Hydrodynamic Journal Bearing Lubrication. International Research Journal of Engineering and Technology (IRJET). Volume: 03 Issue: 07 | July-2016. e-ISSN: 2395 -0056

[3] Baskar.S. , Sriram.G. "Pressure distribution analysis of a hydrodynamic journal bearing using vegetable oil-based nano lubricant".

[4] S. Baskara, G. Srirama "Tribological Behaviour of Journal Bearing Material under Different Lubricants." Vol. 36, No. 2 (2014) 127-133

[5] Ighor Caetano Silva Ferreira worked on '' Lubricity Study of Vegetable Oils through a Comparison of Their Physical Properties .'' Int. J. Mech. Eng. Autom. Volume 3, Number 10, 2016, pp. 421-425 Published: October 25, 2016

[6] S.R. Suryawanshi, Experimental Study on an Influence of Bearing Geometry and TiO2 Nanoparticle Additives on the Performance Characteristics of Fluid Film Lubricated Journal Bearing, Vol. 41, No. 2 (2019) 220-236, DOI: 10.24874/ti.2019.41.02.08

[7] J.T. Pattiwar, Effect of TiO2 Nanoparticles Blended with Lubricating Oil on the Tribological Performance of the Journal Bearing, Vol. 40, No. 3 (2018) 370-391, DOI: 10.24874/ti.2018.40.03.04

[8] bompos, P.G. Nikolakpoulos and D.A. "Experimental Measurements of Journal Bearing Friction Using Mineral, Synthetic, and Bio-based Lubricants ." Lubricants , 2015.

[9] N. W. M. Zulkifi, M. A. Kalam ,"Experimental analysis of tribological properties of biolubricant with nanoparticle additive", Elsevier at Malaysia International Tribology Conference, Procedia Engineering 68, 2013, 152-157.

[10] M. Deligant, P. Podevin, G. Descombes, CFD model for turbocharger journal bearing performances, Applied Thermal Engineering, vol. 31, iss. 5, pp. 811-819, 2011, doi: 10.1016/j.applthermaleng.2010.10.030

[11] R. Sehgal, Experimental Measurement of Oil Film Temperatures of Elliptical Journal Bearing Profile Using Different Grade Oils, Tribology Online, vol. 5, iss. 6, pp. 291–299, 2010, doi: 10.2474/trol.5.291

[12] R. Nicoletti, The Importance of the Heat Capacity of Lubricants With Nanoparticles in the Static Behavior of Journal Bearings, Journal of Tribology, vol. 136, iss. 4, p. 5, 2014, doi: 10.1115/1.4027861

[13] H. Montazeri, Numerical analysis of hydrodynamic journal bearings lubricated with ferrofluid, Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology, vol. 222, iss. 1, pp. 51–60, 2007, doi: 10.1243%2F13506501JET314

[14] Y. Aiman, S. Syahrullail, Development of palm oil blended with semi synthetic oil as a lubricant using four-ball tester, Jurnal Tribologi, vol. 13, pp. 1-20, 2017.

[15] K. P. Gertzos, P. G. Nikolakopoulos, and C. A. Ã. Papadopoulos, "Tribology International CFD analysis of journal bearing hydrodynamic lubrication by Bingham lubricant," vol. 41, pp. 1190–1204, 2008.