PRESSURE DISTRIBUTION AND LOAD CARRYING CAPACITY OF JOURNAL BEARING BY USING BIO OIL

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Abstract -Rapid decrease in petroleum resources, we are in search of alternative sources for power generation and environmental hazards alarms to use eco-friendly alternative. Jatropha is a non-edible sourced Bio-lubricant shows excellent coefficient of friction, noble anti-wear capability, low environmental emission. Recent research states Jatropha have higher viscosity and improves the load carrying capacity. Comparative study of popular synthetic lubricant (i.e. 20W40, Turbinol XT46 oil) with Jatropha oil has been carried out. The friction forces and the hydrodynamic friction coefficients are calculated and compared. Rapid depletion of petroleum resources and environmental hazards alarms to use eco-friendly alternative. Jatropha is a non-edible sourced Bio-lubricant shows low coefficient of friction, anti-wear capability, low environmental hazardous. The research states that Jatropha have high in viscosity and improves the load carrying capacity.

Key Words*:*Bio-lubricant, Jatropha, journal bearing, load carrying capacity, pressure distribution and viscosity.

1.INTRODUCTION

Lubricant is a substance that reduces wear and friction by formation of thin oil film in between the contacting areas of two mating bodies. Removal of heat, prevention against corrosion, transmission of power is the basic functions of lubricating oil. Lubricant roles as seal between the two moving boundaries layers and hence trap and remove the wear particles forms in between them. To perform this role lubricating oil must possess some specific chemical and physical characteristics. The viscosity of the lubricant is the principal characteristic of the lubricating oil which greatly influences the friction and wear reduction and thus increases the overall efficiency of power transmission. [1]
At present the world is dealing with increasing crude oil price, depletion of crude oil reserves and global environmental concern about preventing the environment from pollution, have generated awareness in the society for developing and using the environment friendly alternative lubricant from derived sources. Non-edible vegetable oil based bio-lubricants. are environment friendly as they are bio-degradable, non-toxic and having zero contribution in greenhouse effect. Overall vegetable oil based lubricants exhibits several excellent properties compared to the mineral oils. Potential of these non-edible sourced bio-lubricants for automotive application is discussed. Non-edible sourced lubricants lave enhanced lubricity, good antiwear property, higher viscosity and viscosity index, low evaporation and emission, increased equipment life and high load carrying capacity. [2]

Vegetable oil can be used as lubricants in their natural form. Advantages of vegetable oil are that they show higher viscosity index and flash point compared with the mineral oil. Limiting side is that they are susceptible to oxidation hence low oxidation stability, low temperature limitation and unpleasant smell, filter clogging tendency at lower temperature. [3]

Properties of Jatropha oil contaminated biolubricant are determined by using Cygnus wear setup and four-ball tribo testing machines setup. Jatropha oil (JO) by volume fraction of 15-55% has been blended with the base lubricant SAE-40 oil to formulate the bi*o-lubricants. Results showed that the lubrication regime occurred during the test was boundary lubricated while the main wear mechanisms are abrasive and adhesive wear. Lowest wear was found with the addition of 12% Jatropha oil in SAE 40 oil and above 22% concentration of JO in SAE 40 oil, the wear rate get increased considerably. The result of tribotest shows an addition of Jatropha oil in the base lubricant shows excellent lubricant additive characteristics, which reduce the friction and wear scar diameter by maximum 35% and 30% respectively during the tribo test. The application of 11% bio- lubricants in the automotive engines will enhance the mechanical efficiency and take part to reduce the dependency on petroleum oil as well. [4]

2JATROPHA BIO-LUBRICANTS

Jatropha Bio-lubricant is a non-edible sourced vegetable oil which shows potential characteristics to be used as bio lubricant as it have high viscosity and viscosity index compared to other vegetable oils which are close to the commercially used synthetic oils. Analysis showed that the viscosity, density, thermal conductivity and pour point of Jatropha were higher than the values of SAE 20W40 oil engine oil while specific heat, flash point and refractive index values of Jatropha were less than the values of SAE20W40 oil engine oil. [5] The performance of Jatropha oil under journal bearing lubrication is investigated in this study.

- It's an oil seed tree.
- It produces very high quality bio fuel.
- It flourishes best on land that is unsuitable for food production.
- Propagates rapidly.
- It is highly resistant to drought and poor soil condition.

Fig 1. Jatropha seed

2.1 Problem statement

The mineral oil used are non-degradable and it causes oil pollution .So Bio oils are been used as an alternative for mineral oils .These are pollution free ,it can last longer, it has better properties like flash point ,pour point ,fire point, viscosity, viscosity index, foaming ,acidity alkalinity etc. Bio Oils are used for pressure distribution and load carrying capacity of Journal Bearings. It gives minimum oil film thickness.

2.2 Objective

The main aim is to find the equivalent oils like bio lubricants such as jatropha instead of mineral oil which helps to determine the followings:

- Minimum oil thickness
- Viscosity of oil
- Load carrying capacity of journal bearing
- Pressure distribution
- Environmental impact

3. HYDRODYNAMIC JOURNAL BEARING

Hydrodynamic journal bearing is the very important component or part of any rotating machine. The working performance of hydrodynamic journal bearing depends upon the working performance of its lubricant during the lubrication. The Journal Speed and eccentricity ratio plays an important part in the working performance of journal bearing. A finite length short journal with L/D ratio 0.5 is used throughout the study. All dimension of hydrodynamic journal bearing used in this extensive study are as shown in table.

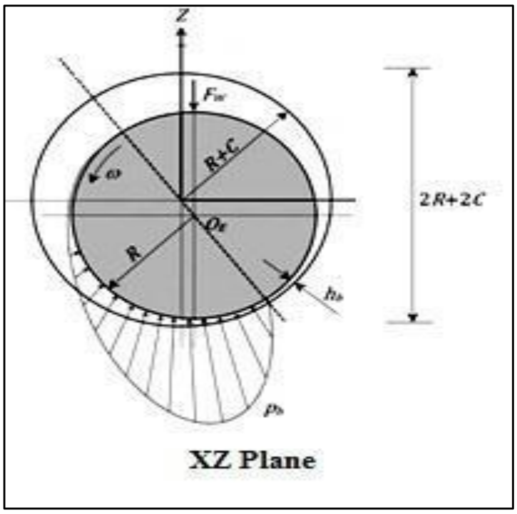


Fig 2: Schematics diagram of journal bearing with its pressure distribution

4.JOURNAL BEARING SETUP

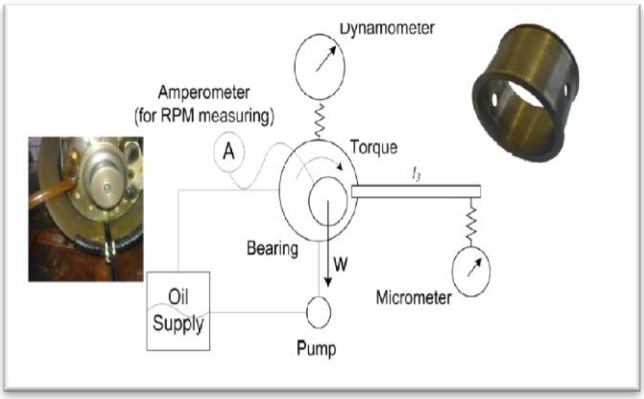


Fig 3. journal bearing setup

A journal bearing working system , with rotor and bearing diameter *D* = 52.8 mm and *D* = 53.2 mm respectively and radial clearance *C* = 150.1 μm was used in order to test the prepared mixture. The bearing length was 30 mm. The rotor could be rotated from 0 to 2591 rounds per minute (rpm) driven by a 5 hp AC electric motor with mechanically variable belt transmission. The lubricants are pumped to the journal bearing by a exrernal source gear oil pump. The bearing is made of bronze and is loaded with a static load (*W*) using the mechanism shown in Fig. For the purposes of the experiments three different lubricants were used. One Jatropha biolubricant, an

20W40 synthetic oil and an turbinol XT 46 lubricant. The temperatures of operation in all cases were between 32 °C and 22 °C.

4.1 Journal bearing tester

Fig 4. Journal bearing tester TR-60

4.2 Specifications

1. Journal Diameter : 39.90mm
2. L/D ratio : 1
3. Radial load :750N max
4. Speed range : 150 to 2000 rpm
5. Test bearing : 40.120 mm(inner diameter)
6. Journal Material : EN 31
7. Bearing material : Brass
8. Radial Clearance : 0.075mm
9. Oil tank capacity : 3 Lit
10. AC Induction motor : 1HP,1415 rpm,50Hz, 5A

5. TRIALS ON JOURNAL BEARING TESTER

First of all we take the reading of 20W40 oil on journal bearing tester to determine the pressure distribution and load carrying capacity for that we consider following parameters

Table 1. Readings of 20W40

Load	Viscosity	Initial temp	Final temp	Rpm	Max Pr
450	40	26	35	1500	1600

After testing the 20W40 oil for practical application we know that journal bearing is used in steam turbines due to that we test the Turbinol XT 46 oil which is used in many cogeneration plants . After testing the oil we get following readings

Table 2. Readings of Turbinol XT 46

Load	Viscosity	Initial Temp	Final Temp	Rpm	Max Pressure
450	42	26	36	1500	1400

After testing the bio-oil we got the following readings:

Table 3. Readings of bio oil (1)

Load	Viscosity	Initial temp	Final temp	Rpm	Max Pressure
600	52	26	38	1500	1420

Table 4. Readings of bio oil (2)

Load	Viscosity	Initial temp	Final temp	Rpm	Max press
600	52	26	40	2000	1369

6. MAXIMUM PRESSURE RESULTS

1. File -20W40

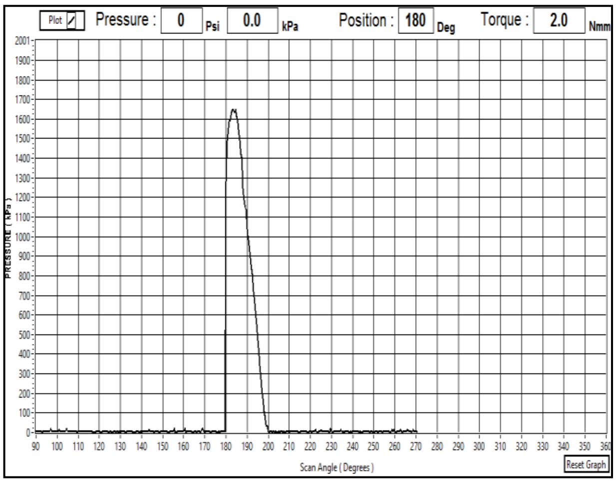


Fig 5. 20W40

2. File – Turbinol XT 46

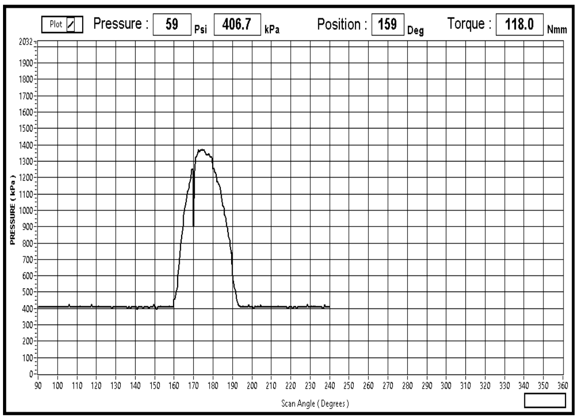


Fig 6.Turbinol XT 46(1)

3. File –Bio oil (1)

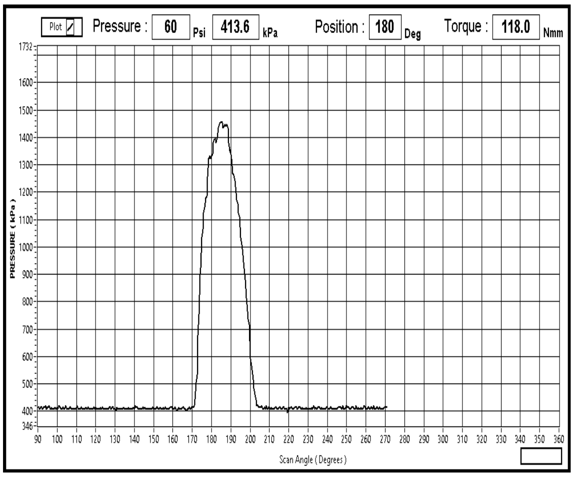


Fig 7.Bio oil (1)

4. File –Bio oil (2)

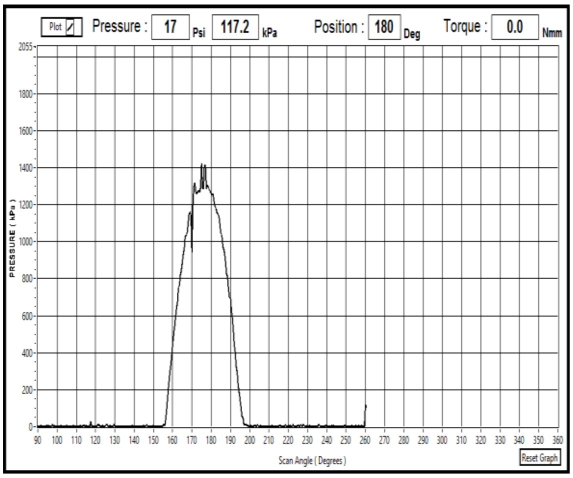


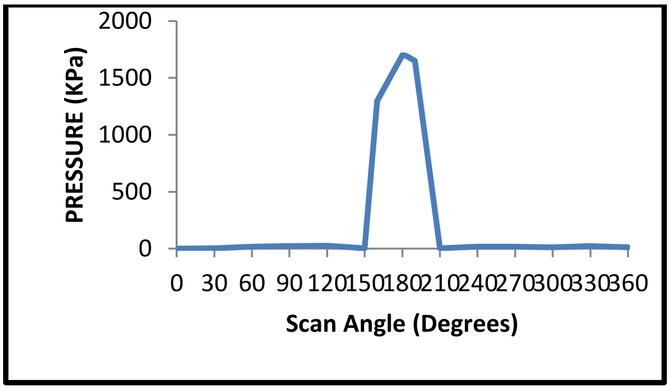
Fig 8.Bio oil (2)

7. MATLAB TRIALS FOR MAXIMUM PRESSURE

1. File -20W40

Load	Viscosity	Initial temp	Final temp	Rpm	Max pressure
450	40	26	35	1500	1695

Table 5. Readings of 20w40

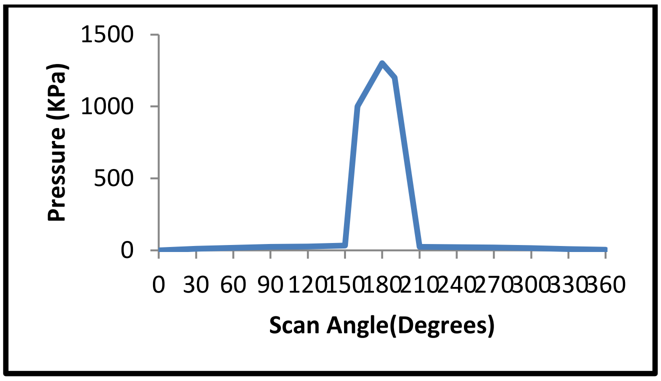


Graph 1: 20W40

2. File –Turbinol XT 46

Load	Viscosity	Initial Temp	Final Temp	Rpm	Max Pressure
450	42	26	36	1500	1400

Table 6. Readings of Turbinol XT 46

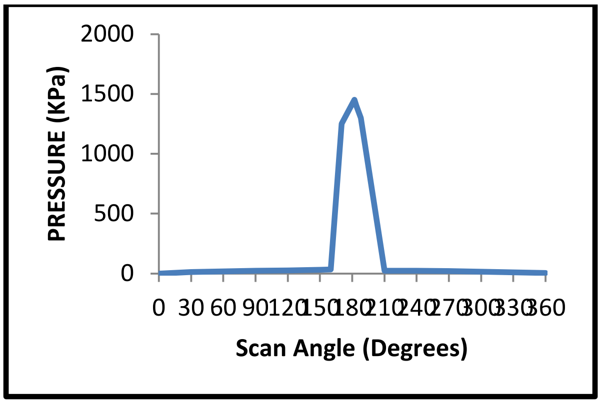


Graph 2: Turbinol XT 46

3. File –Bio Oil (1)

Load	Viscosity	Initial temp	Final temp	Rpm	Max Pressure
450	52	26	38	1500	1495

Table 7. Readings of bio oil (1)



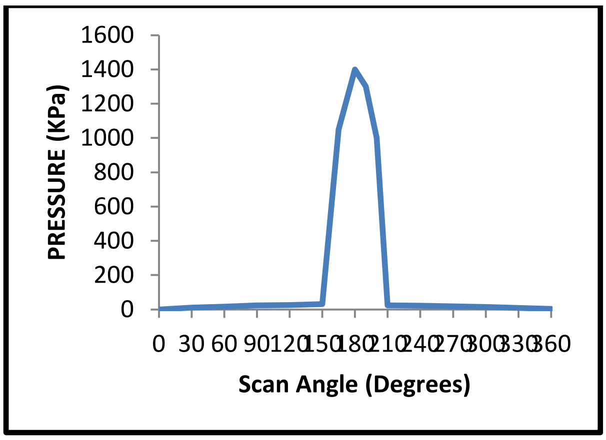
Graph 3: Bio Oil

4. File Bio Oil (2)

Load	Viscosity	Initial temp	Final temp	Rpm	Max pressure
600	52	26	40	2000	1390

Table 8. Readings of bio oil (1)

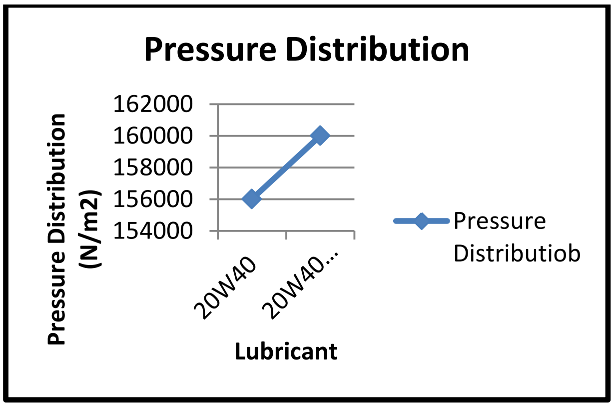
Graph 4: Bio Oil



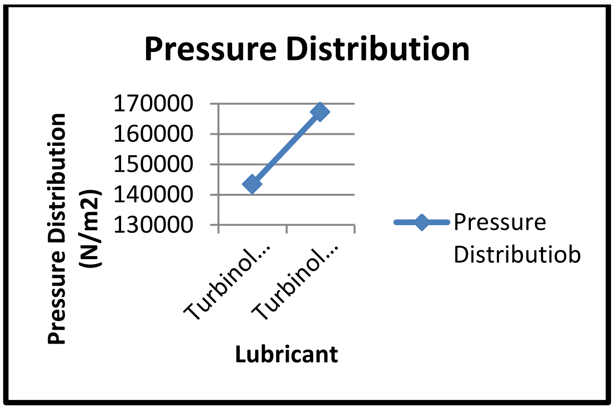
8. PRESSURE DISTRIBUTION READINGS BY ANALYTICAL AND MATLAB

Lubricants	Pressure Distribution (Analytical Method)	Pressure Distribution (Matlab)
20W40	156.016×10³ N/m²	160 × 10³ N/m²
Turbinol XT 46	143.429×10³ N/m²	167.22×10³ N/m²
Jatropha	416.477× 10³ N/m²	423 × 10³ N/m²

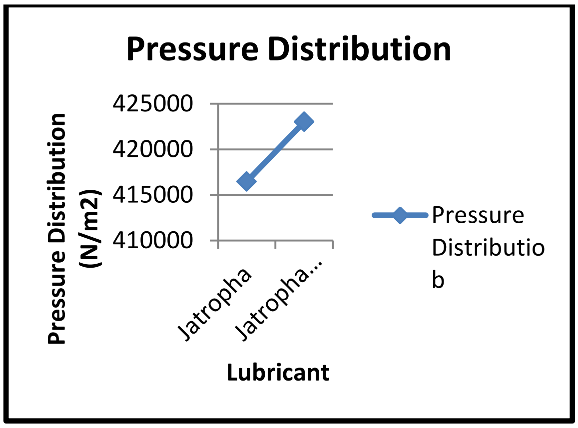
Table 9. Readings of Pressure distribution



Graph 5 : 20W40



Graph 6 : Turbinol XT 46

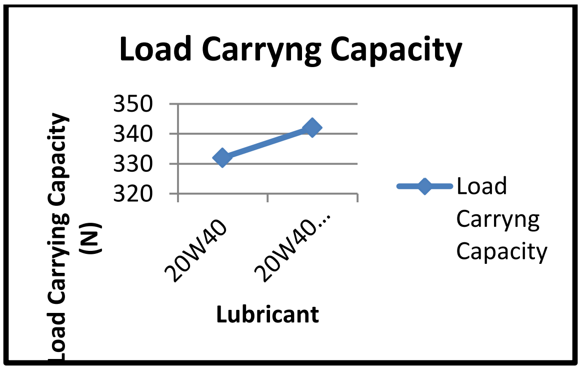


Graph 7 : Jatropha

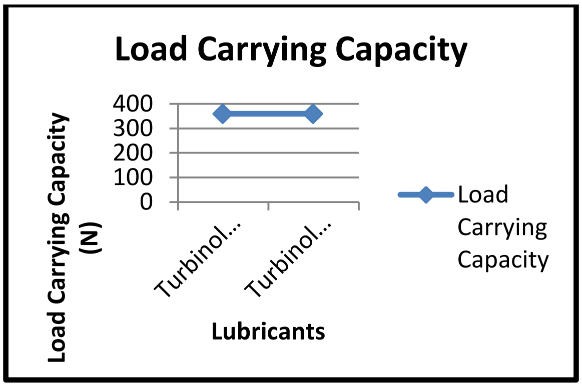
9. LOAD CARRYING CAPACITY READINGS BY ANALYTICAL AND MATLAB

Lubricants	Load Carrying Capacity (Analytical Method)	Load Carrying Capacity (Matlab)
20W40	332 N	342 N
Turbinol XT 46	359 N	359 N
Jatropha	131.25×10^3 N	132×10^3 N

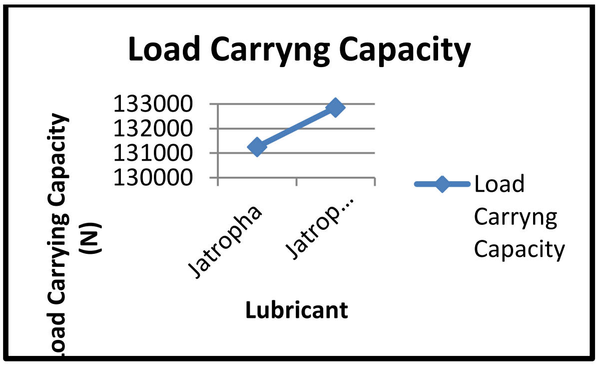
Table 10. Readings of Load Carrying Capacity



Graph 8 : 20W40



Graph 9 : Turbinol XT 46



Graph 10 : Jatropha

10. CONCLUSION

After testing of three oils that is SAE20W40 ,Turbinol XT 46 and Jatropha bio lubricant. we conclude that we got maximum pressure distribution for Jatropha bio-oil as compared to XT 46 and 20W40, So it is benifical to use. The main point where bio lubricants are ahead is their biodegradability with acts as non pollutant for environment. Jatropha works on low operating temperature generates high torque but power loss is high, this is because of high viscosity. The viscosity of the Jatropha reduces very rapidly as L/D ratio increases, so Jatropha can be used for high L/D ratio journal bearings. Jatropha Biolubricant shows the intermediate hydrodynamic behavior for pressure and load carrying capacity as that of the 20W40 and Turbinol XT 46. Both theoretical and analytical results shows enhancement in maximum Pressure and load carrying capacity of the Jatropha bio-lubricant rises with increase in journal speed and eccentricity ratio. Jatropha oil shows several good characteristics high viscosity and increased load carrying capacity hence can be used as alternative bio-lubricant for journal bearing application.

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