RESEARCH ARTICLE OPEN ACCESS

Anti-Wear Properties of Benzoic Acid in Karanja Oil

Anand H*, K M Peethambaran** Mr. Mahipal D ***
*(M Tech Scholar (AMD), Dept. of Mechanical Engg, Government College of Engineering Kannur, Kerala-670563, India)
** (Professor, Dept. of Mechanical Engg. Government College of Engineering Kannur, Kerala-670563, India)
***Associate Professor in Mechanical Engg., Govt. Engineering College - Thrissur, Kerala

ABSTRACT
Increased concerns about environmental impact caused by mineral oil based lubricants, has created a growing worldwide trend of promoting vegetable oil as base oil for lubricants. . This paper deals with the study of anti-wear and anti-friction properties of Karanja (Pongamia Pinnatta) oil and its blends containing numerous amounts of benzoic acid at variable temperatures. The experimental results indicate that Karanja oil and its blends containing benzoic acid, exhibits good anti-wear and anti-friction properties.
***Keywords* -** coefficient of friction, four-ball tester, Karanja oil, viscosity index, wear scar diameter

I. INTRODUCTION

There has been growing concern for the use of mineral oils as lubricants because of the world wide environmental issues. This has promoted research into developing and using vegetable oils as alternative base oils for environmentally benign lubricants. Vegetable oils in general have excellent properties such as high viscosity index, high lubricity, high flash point, low evaporative loss, high bio-degradability and low toxicity with regard to their use as base oils for lubricants. On the negative side they are known to possess low thermal, oxidative and hydrolytic stabilities and poor low-temperature characteristics. The properties of vegetable oils are determined by their fatty acid composition. A high content of linoleic/ linolenic acid decreases thermal-oxidative stability, whereas a higher proportion of long chain saturated fatty acids leads to inferior cold flow behavior [1].

In this article we have investigated the anti-wear properties of benzoic acid in Karanja oil. Karanja oil is non-edible oil extracted from the seeds of Karanja (Pongamia Pinnatta) tree. Karanja oil is widely used in rural India for lighting lamps, as fuel for cooking and as medicine for skin diseases. The oil's non-edible nature and wide availability makes it a suitable candidate as alternative base oil for lubricants. The physico-chemical, viscometric and other technological properties of Karanja oil which have a bearing on its use as lubricant base oil is scarcely reported in literature. Investigation of anti-wear properties predominantly includes the determination of coefficient of friction (COF), wear scar diameter (WSD), and viscosity index (VI). For finding the COF and WSD, tests were conducted on Four Ball tester TR-30L-PNU-IAS DUCOM material characterization system with international standard

ASTM D4172B. For the Viscosity test BROOKFIELD DV2T extra viscometer is used with international standard ASTM D 2983-03 and VI is calculated by international standard ASTM Standard D2270-04. Low COF and WSD shows better anti-wear property of oils and high VI shows the better thermal stability of the oils.

II. EXPERIMENTAL DETAILS

The equipment used for the friction and viscosity tests are Four Ball tester TR-30L-PNU-IAS DUCOM material characterization system, Germany and BROOKFIELD DV2T extra viscometer, USA, respectively.

Friction and viscosity tests were conducted for Karanja oil and its blends containing different percentage of benzoic acid in it. The weight concentrations selected are 1%, 1.5%, 2%, 2.5% and 3% respectively. In four ball tester, tests are conducted under the test conditions of 392N load, 75 ^{0}C, 1200 RPM and 3600 seconds. For this test, four spherical balls used are made of chromium alloy steel and as per specifications laid down in (ASTM D 2783, 2596, IP 239) and with ANSI standard steel no. E5100, diameter of 12.7 mm, 64 HN (Hardness Number), Grade EP (extra polish) etc. Of the four balls, three are fixed in a ball port and the fourth in motor spindle as shown in Fig.1 [2]

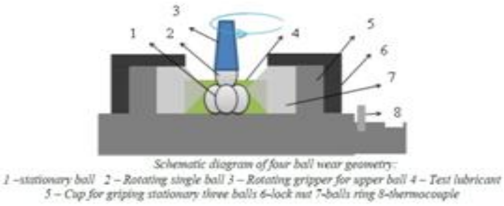

Fig.1: Schematic diagram of four ball geometry

For calculation of viscosity index, the kinematic viscosity of oils at 40 ^{0}C and 100 ^{0}C is determined as per ASTM D445 method. The oil is taken in a container and is heated with the help of silicon oil bath as per the experimental set up in BROOKFIELD DV2T extra viscometer and the corresponding viscosities are found out.

III. RESULTS AND DISCUSSION

The results of COF/ WSD and viscosity analysis are given below. The wear scar in the balls is obtained with the help of Transmission Electron Microscope (TEM) and the images for each ball in individual tests indicate the wear scar diameter. Fig. 2 shows wear scar diameter obtained for a ball in one of the tests.

The Table 1 shows coefficient of friction and wear scar values of different blends of Karanja oil with various concentrations of benzoic acid. Viscosity index is calculated as follows. First find the kinematic viscosity of oil at 40 ^{0}C and 100 ^{0}C in centipoises and divide the value with corresponding density value to determine dynamic viscosity at that particular temperature. Then find the values o*f* L and H from table ASTM D 2270-04, corresponding Kinematic Viscosity (at 100 °C) in mm^2 /s (centistokes) and calculated the viscosity index with the following formula,

$$VI = \frac{(L-U)}{(L-H)} * 100$$

Where, *U*= kinematic viscosity at 40 °C of the oil, whose viscosity index is to be calculated in mm^2/s (centistokes). *L* = kinematic viscosity at 40 °C of an oil of 0 viscosity index having the same kinematic viscosity at 100 °C as the oil whose viscosity index is to be calculated, mm^2/s (centistokes), and *H*= kinematic viscosity at 40 °C of an oil of 100 viscosity index having the same kinematic viscosity at 100 °C as the oil whose viscosity index is to be calculated, mm^2/s (centistokes) [3].

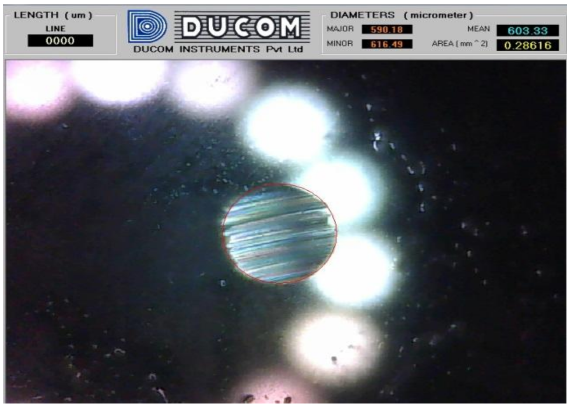

Fig. 2: Wear scar view photograph

Table 1 given below shows the COF and WSD values obtained and Table 2 given below shows the values of dynamic viscosity at 40 ^{0}C and 100 ^{0}C and also viscosity index of pure Karanja oil and its different blends with benzoic acid, in different weight percentage.

Table 1: Coefficient of friction and wear scar values

Sl No	**Weight % Benzoic acid**	**COF**	**WSD**
1	0	0.0551	438.48
2	1	0.675	433.43
3	1.5	0.0585	428.39
4	2	0.0428	420.45
5	2.5	0.0653	513.44
6	3	0.0656	525.03

Table 2: Viscosity of oils at different temperature and viscosity index of various blends of Karanja oil with benzoic acid added in different proportion.

% Concentration	**Dynamic Viscosity at 40^{0}c**	**Dynamic Viscosity at 100^{0}c**	**Viscosity index**
0	41.77	8.01	147
1	43.56	10.75	162
1.5	53.33	10.53	150
2	51.64	10.54	152
2.5	49.13	10.5	134
3	38.19	8.31	131

The Fig.3 given illustrates the comparison of coefficient of friction graph for different blends of benzoic acid in Karanja oil. This is the wear test view obtained in software WINDCOM, used with four ball tester.

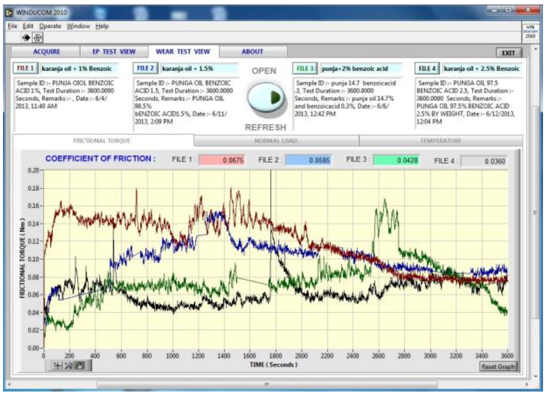

Fig. 3: Comparison of COF graph for different blends of benzoic acid in Karanja oil.

IV. CONCLUSION

Anti-wear properties of Karanja oil were studied for both in the absence and the presence of benzoic acid. Karanja oil provides good anti-wear properties. Four ball tester experimentation is found to a better and easy method for identifying the oil tribological properties like coefficient of friction (COF) and wear scar diameter (WSD). Viscosities obtained in Brookfield viscometer is found to be more accurate than in traditional viscometers. The acquired results indicate that benzoic acid is an effective anti-wear additive for Karanja oil. The friction coefficient and wear scar diameter is significantly reduced by the addition of benzoic acid. The viscosity index is enhanced by the addition of benzoic acid to some extent. The best results are obtained for the oil blend with 2% by weight of benzoic acid.

V. ACKNOWLEDGEMENTS

The authors would like to thank Prof. D. Mahipal and Post Graduate student Krishnanunni P, Department of Mechanical Engineering, Govt. Engineering College - Thrissur, Kerala, India, for their support given for the conduct of experiments. The four ball test analysis, viscosity measurement and the recording of the wear scar view were performed at the thermal engineering laboratory of this department.

REFERENCES

[1] S A Lawal, et al, “Application of vegetable oil based metalworking fluids”, *International Journal of Machine Tools & Manufacture 52*, 2012, 1-12.

[2] Iman Golsukhnath, et al, “Investigation of Physical Properties for Jatropha Oil in Different Temperature as Lubricant Oil”, *Life Science Journal, Vol: 10*, 2013, 110-119.

[3] ASTM INTERNATIONAL - D2270-04 “Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100°C**”.**

[4] Amir SadaKhan, et al, “Antiwear properties of Benzoic acid in bitter rapseed oil and sesame oil at high and low temperature,” *International Journal of Mechanical & Mechatronics Engineering IJMME-IJENS Vol:12 No:06*, 2012, 7-12.

[5] Jayadas, N. H., and Nair, K. P., “Coconut Oil as Base Oil for Industrial Lubricants-Evaluation and Modification of Thermal, Oxidative and Low Temperature Properties,” *Tribology International, 39*, 2006, 873-878.