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TRIBOLOGICAL CHARACTERISTICS OF FATTY ACID METHYL ESTER AS AN ADDITIVE

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Abstract: In the research work carried out, fatty Acid Methyl Ester (FAME) is used as an additive for the preparation of a Lubricant. Rapeseed oil is used as base oil for the preparation of the lubricant. Four samples were prepared by adding FAME in to rape seed oil in different concentration. These samples were gone for two different tests. First Test was for load carrying capacity for which Timken OK Load Test were carried out. Second test was for service life for which Rotatory Bomb Oxidation Test was conducted. These two tests were also conducted on a commercially available lubricant for comparison. The results shows that the Laboratory prepared lubricant may have better properties than the commercially available lubricant.
Key Words: Lubrication, FAME, Rapeseed Oil, Additive and Timken OK Load

1. INTRODUCTION

Tribology is the science of friction, lubrication and wears [1]. Lubricants generally contain 90% base oil and less than 10% additives. Vegetable oils or synthetic liquids such as hydrogenated polyolefin's, silicone, esters, fluorocarbons and many others are used as base oils [2]. In view of this, there is a need to understand the different performance characteristics of lubricants which plays important role in wear and friction problems.

The aim of the present work is to study of the role of Fatty Acid Methyl Ester (FAME) as an additive in Rape seed oil and to evaluate its performance with respect to its load carrying capacity and corrosion for external meshing machine component and to comparing its performance with an standard lubricant of similar nature.

Friction is the natural resistance to motion caused by surfaces that are in contact with each other. The purpose of lubrication is to reduce the harmful effects of friction by changing sliding friction to fluid friction. Before discussing the characteristics of sliding and fluid friction, we must first define the two main categories of friction: static and kinetic. The friction that exists between a body at rest and the surface upon which it is resting is called Static friction. The friction that exists between the surfaces of moving bodies (or between one moving body and a fixed body) is called Kinetic friction. Static friction is greater than kinetic friction. To put a body in motion, you must overcome static friction and inertia. To keep a body in motion, you must overcome kinetic friction.

There are three types of kinetic friction: sliding, rolling, and fluid. Sliding friction occurs when the surface of one solid body slides across the surface of another solid body. Rolling friction occurs when the surface of a curved body, such as a cylinder or a sphere, rolls across another surface. Fluid friction is the internal resistance to motion exhibited by a fluid. Fluid friction occurs because of two proper-ties of a lubricant: cohesion and adhesion.

Cohesion is the attraction between the molecules of a substance that tends to hold the substance together.

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Adhesion is the attraction between molecules that tends to cause unlike surfaces to stick together. Additives are used to impart performance characteristics to the lubricants. The main families of additives are:

- Antioxidants
- Detergents
- Anti-wear
- Metal deactivators
- Corrosion inhibitors, Rust inhibitors
- Friction modifiers
- Extreme Pressure
- Anti-foaming agents

1.1 Materials & Methods

Fatty Acid Methyl Esters (FAME) is esters of fatty acids. FAME may impart good anti friction and anti wear properties to the base oil even at elevated temperature. it has been already investigated that the presence of fatty acid as additives for bio diesel improves their lubricating properties at elevated temperature conditions [3]. FAME of vegetable origin is more stable for oxidation on comparing with methyl esters of animal origin. Mixtures of methyl esters of animal and vegetable origin with antioxidants were more stable when compared with pure products [4]. FAME contains no hazardous materials and is generally regarded as safe to use.

Sperm oil was a popular lubricant. It worked well for fine, light machinery such as sewing machines and watches because it is thin, doesn't congeal or dry out and doesn't corrode metals [5][6]. It was also used in heavy machinery such as locomotives and steam-powered looms because it can withstand high temperatures[7].

The wear and extreme pressure characteristics typically associated with sulfurized natural sperm oil. Sulfurized sperm whale oil serves as an extreme-pressure additive for motor oils, gear lubricants, and automotive transmission fluids [8]. It also has excellent corrosion protection and heat stability properties. Sperm oil is a waxy liquid obtained from sperm whales. Sperm oil was used to protect metals from rust. Sulfurized sperm oil is a well-known EP agent and oxidation inhibitor which is widely used in the formation of gear lubricants [9].

The properties of the rapeseed oil methyl esters and comparing them with the diesel oil properties. The essential differences in the physic-chemical properties have been emphasised, such as Cetane number, viscosity, density, fraction content, calorific value and temperature properties of the rapeseed oil methyl esters in respect to the diesel oil. these properties are improved [10].

Rapeseed oil is used as a base oil. Rapeseed is an annual flowing plant belonging to the mustard family. Rape, rapeseed, oilseed rape, rappi, rapa & canola happen to be the their names with which the rape plant is often associated with. Rapeseed oil had a distinctive taste & a greenish colour due to the presence of chlorophyll. It also contained a high concentration of erucic acid. It is cultivated mainly for its extremely nutritious, oil-rich seeds, third largest source of vegetable oil in the world.

Base Oil Classification System, The American Petroleum Institute (API) has developed a classification system for base oils in order to smooth the progress of engine oil interchange guidelines. The base oils are divided in to five groups as follows [11]:

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Group I base stocks contain less than 90 percent saturates and/or greater than 0.03 percent sulfur and have viscosity index greater than or equal to 80 and less than 120.
Group II base stocks contain greater than or equal to 90 percent saturates and less than or equal to 0.03 percent sulfur and have viscosity index greater than or equal to 80 and less than 120.
Group III base stocks contain greater than or equal to 90 percent saturates and less than or equal to 0.03 percent sulfur and have viscosity index greater than or equal to 120.
Group IV base stocks are polyalphaolefins (PAO).
Group V base stocks include all other base stocks not included in groups I, II, III or IV. Naphthenic oils are considered Group V.

1.2 SAMPLE PREPARATION

Four Lubricant samples have been prepared by adding different proportion of FAME in Rapeseed oil and reacted with powdered sulphur. The sample preparation is tabulated in the given Table-1

Table -1: Sample Preparation

S. No.	Ratio of FAME & Rapeseed Oil	Reacted Sulphur	Sample
1	50-50	10%	A
2	40-60	10%	B
3	35-65	10%	C
4	70-30	10%	D

1.3 ROTATING BOMB OXIDATION TEST

To determine lubricant's resistance to oxidation and sludge formation using accelerated test conditions that involve high temperature, high pressure, oxygen the presence of water and active metal catalysts. RPVOT D-2272 ,previously known as RBOT (Rotating Bomb Oxidation Test) RPVOT (Rotating Pressure Vessel Oxidation Test) The oxidative stability is the estimation of remaining oxidative test life of in-service oil (or remaining useful life of the in-service oil).
Result of RPVOT is reported in minutes and are compared and trended against RPVOT of the new oil –base line.
The estimate of oxidation stability is useful in controlling the continuity of this property for batch acceptance of production lots having the same operation.

This test method is also used to assess the remaining oxidation test life of in- service oils. The values stated in acceptable SI units are to be regarded as the standard.

RBOT test is performed in accordance with ASTM standard test method D-2272-67.
The most common of these tests is the rotating pressure vessel oxidation test (RPVOT) - ASTM D2272, formerly called the rotating bomb oxidation test (RBOT). In essence, the test involves placing a sample of oil into a pressure vessel along with a ration of water and a copper coil.
ASTM D 2272 Rotating Bomb Oxidation Test (RBOT) [12], have traditionally been used to

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assess the oxidative stability of lubricating oils.

1.4 TIMKEN OK LOAD TESTER

Wear Test were conducted on the prepared samples using Timken Ok Load Tester as per ASTM-D-2509-69 T standards shown in figure- under following conditions:

Test Method:	ASTM-D-2782-T
Rotation (RPM):	405.88 ± 2.45 rpm
Load Run Time:	Interval of 10 Seconds
Arm Load Factor:	1 Load = 40 Pound

The Timken OK Load test is one of a number of bench tests that have been designed to stimulate extreme pressure conditions and to evaluate the load carrying capacity of lubricants.

The Timken tester has a steel cup attached to a lever arm to which graduate loads can be applied. The steel test wheel rotates against a test bullet immersed in the test oil mounted on it for loading. The rotating speed is 405.88 ± 2.45. Load is increased at an interval of 10 seconds, until scoring of the steel block occurs. The maximum load that can be applied without scoring or seizing is reported as the Timken OK load. The Timken OK load is a measure of the ability of oil to protect under extreme pressure and boundary lubrication conditions. Three readings of each sample have been taken and the average value has been reported.

2. RESULTS & DISCUSSION

2.1 Load Test

In the present investigation, artificially prepared lubricant samples were divided into four groups namely A, B, C & D depending upon the composition as already shown in Table-1.These samples have been tested for their load carrying capacity on Timken Ok Load Tester at Mukund Tribologies, Ghaziabad. The commercially available lubricant (Sperm Oil) is also tested on Timken Ok Load Tester under similar conditions. The results of both the prepared and commercially available Lubricant is tabulated in the given table-2.

Table -2: Tabulation of Results for Load Test

S. No.	Sample	Seizure Load	Load (Pound)	Load (kN)	Final Status of Sample Surface after Test
1	A (50/50)	4	160	711.95	Seizure
2	B (40/60)	**5**	200	889.94	Ok
3	C (35/65)	3	120	533.96	Seizure

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4	D (70/30)	3	120	533.96	Seizure
5	Sperm Oil	3	120	533.96	Seizure

2.2 Life Test (RBOT)

Along with the load carrying test another test which is known as Rotatory Bomb Oxidation Test (RBOT) is also carried out to check the service life of the oil. RBOT is performed accordance with ASTM standard method D-2272-67. The results are summarized in the table-2.1 given below:

Table -2: Tabulation of Results for RBOT

S.No.	Sample	RBOT life (min)
1	A (50/50)	270
2	B (40/60)	**310**
3	C (35/65)	260
4	D (70/30)	251
5	Sperm Oil	253

3. CONCLUSIONS

The results show that it is possible to prepare a lubricant for external meshing component with the use of FAME as an additive in laboratory which is better than the commercially available well renowned lubricant of similar in nature. FAME can be used as additives for improving load carrying capacity in preparation of a lubricant along with rapeseed oil as base oil.

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