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SYNTHESIS AND TRIBOLOGICAL CHARACTERIZATION OF RAPESEED OIL BASED 2T OIL

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ABSTRACT

Smoky emissions and wear from mineral based two- stroke gasoline engine (2T) are the problem for the environment. Use of vegetable oil is one solution. Vegetable oil based products are sustainable, renewable and biodegradable that can replace petroleum derived products in numerous industrial applications. Rapeseed oil is the highest producing oil seed crop. In the present investigation, biodegradable 2T oil was developed from rapeseed oil via some chemical processes like trans-esterification to remove glycerol and aryl-alkylation process for the formation of toluene ring is to strengthen the oil, finally tolylmonoester is formed. To improve the characteristics of the base oil, performance additives were added. Then the tribological characterization of formulated 2T oil was carried out as per ASTM Standard. Furthermore the field emissions studies were carried out using formulated 2T oil with TVS XL Super 2-stroke vehicle. Same test is also compared with commercial mineral based 2T oil. Emission results showed that, rapeseed oil based 2T oil reduces carbon monoxide and hydrocarbon emissions. The four-ball wear test method can be used to determine the relative wear preventing properties of rapeseed oil based 2T oil under the test conditions.

Keywords: *Rapeseed oil, 2T oil, four ball wear test*

1. INTRODUCTION

Two-stroke gasoline engine (2T) driven vehicles are major source of air pollution by their smoky emissions particularly in Asia. An immediate ban on gasoline-powered two-stroke engine vehicles would be extremely difficult and costly because 2T vehicles are numerous and popular. Two immediate simple solutions include use of less smoke generating lubricant and regular vehicle maintenance, which ultimately will improve air quality. The 2T engine is a well-known power source for outboard motors, snow mobiles, motor boats, motorcycles, scooters, mopeds, gen-sets and a variety of landscaping equipment. The 2Tengine is still in demand due to its simple design, lightweight construction, and ability to provide high power output with quick starts at low temperature and relatively low cost. As estimated, at least 60 million two-stroke automobile engines are on the road of Asia. In Asian countries.

2. LUBRICATION

Lubrication completely or partially separates the surface of the friction bodies by selectively introducing an interfacial medium (lubricant) that minimize friction and wear. Most lubricants are fluids (mineral oils, synthetic oils, etc.,) yet they can also be solid e.g., for using in dry sliding bearing [poly tetra fluro ethylene PTFE] graphite, molybdenum disulfide (Mos_2) etc., oils are also applied, e.g., in ball bearing and sliding bearing and occasionally in gears too.

Gases (air) are also employed e.g., in gas lubricated bearings, powders, lubricating varnishes and pastes can be classified as solid lubricants. Similar to friction states, different lubrication states can also be defined to be precise fluid film lubrication, mixed lubrication, boundary lubrication and solid lubrication.

3. RAPESEED OIL

Rapeseed oil is of vegetable origin and is obtained from crushed rapeseed by pressing or extraction. It is a light yellow to brownish yellow oil. Rapeseed oil is one of the most important vegetable oils. Rape oil is obtained from the seeds of several species of Brassica, and the oil from different species is not distinguished on the market, since all have similar properties. Rapeseed oil is similar to mustard seed oil. Oil is extracted by rolling the seed to fracture the seed coat and rupture the oil cells. For centuries, humans and animals could not consume rapeseed oil, as it had high erotic acid content. However, rapeseed varieties are now available for cultivation which has lower erotic acid content. Rapeseed oil have many good natural properties including good lubricity, good resistance to shear a high flash point and a high viscosity index. Vegetable oils vary in price but, in general are about twice as expensive as petroleum-based oils. They have some undesirable characteristics.

4. FORMULATION OF RAPESEED OIL BASED 2T OIL

In the trans-esterification of vegetable oils, a triglyceride reacts with an alcohol in the presence of a strong acid or base, producing a mixture of fatty acids alkyl esters and glycerol. The overall process is a sequence of three consecutive and reversible reactions, in which diandmonoglycerides are formed as intermediates26. The stanchion metric reaction requires 1 mole of a triglyceride and 3 mole of the alcohol. However, an excess of the alcohol is used to increase the yields of the alkyl esters and to allow its phase separation from the glycerol formed. Several aspects, including the type of catalyst (alkaline or acid), alcohol/vegetable oil molar ratio, temperature, purity of the reactants (mainly water content) and free fatty acid content have an influence on the course of the trans-esterification and will be discussed below, based on the type of catalyst used. In the present work, 200g of 2-ethyl-1-hexanol was heated with 3g of sodium (catalyst) at 120c until all sodium dissolved to give a clear solution. This sodium ethyl hexatone solution was added to 200g of acetylated rapeseed oil and the reaction mixture was refluxed at 180c for 30hours.Excess ethyl-hexanol was removed by distillation under vacuum at 10mm.Steam was passed through the contents heated at 120c till sodium ethyl hexanoate hydrolyzed. The lower layer was acidified to pH7 with dilute hydrochloric acid and removed. This layer contains glycerol.

The upper layer, containing traces of water, was dissolved in toluene and traces of water was removed by “Dean and Stark” trap and the toluene was distilled off. The ester was dried under vacuum at 130c to remove the remaining 2-ethyl-1-hexanol and toluene.

5. FOUR BALL WEAR TEST

Four Ball Wear Test determines a lubricant's antiwear properties under boundary lubrication (metal to metal contact). Three steel balls are clamped together to form a cradle upon which a fourth ball rotates on a vertical axis. The balls are immersed in the oil sample at a specified speed, temperature and load. At the end of a specified test time, the average diameter of the wear scars on the three lower balls is measured. During the test, the load is increased every 10 minutes up to the point where the frictional trace indicates incipient seizure. The coefficient of friction is measured at the end of each 10 min interval.

6. EXPERIMENTAL RESULTS

6.1. Viscosity

Viscosity is defined as the resistance of a liquid to flow. There are several units for measuring viscosity. Formally the unit commonly used in America was Say bolt Universal Second (SSU) measured at100° for 210°F. Oil with higher viscosity can stand greater pressure without being squeezed out of the lubricating surfaces. However, the high internal friction of the oil may offer greater resistance to the movement of the lubricating parts. Viscosity changes with temperature. Hence, the measuring temperature must be specified whenever the viscosity of a liquid is stated. When temperature must be specified whenever the viscosity of a liquid is stated. When temperature rises, a liquid becomes less viscous. Similarly a liquid becomes thicker when temperature drops.

6.2. Viscosity Index

Viscosity index (VI) is an arbitrary measure for the changes of viscosity with temperature. It is used to characterize lubricating oil in the automotive industry. The viscosity of liquids decreases as temperature increases. The viscosity of a lubricant is closely related to its ability to reduce friction. Generally the least viscous lubricant which still forces the two moving surfaces apart is desired. If the lubricant is too viscous it will require a large amount of energy to move if it’s too thin, the surfaces will come in contact and friction will increase. Viscosity index is an indication of how the viscosity of a liquid varies with temperature. A high viscosity index means the liquid does not thin out so much when temperature rises. Viscosity index improver additives that are usually high molecular weight polymers can increase the viscosity index of lubricating oil. Increase in oil viscosity achieved by addition of polymers can be partially lost again through degradation of the polymer molecules by shear such as heavily loaded gears. Oil that can resist viscosity change due to shear are said to have shear stability.

6.3. Properties of Rapeseed Based 2t Oil

For characterization of the base oil standard methods were used which are given in the table below:

TABLE: 1 properties of rapeseed based 2T oil

6.4. Emission Test

During the emissions test, hydrocarbons (HC), carbon

S.No	Properties	Rapeseed oil based 2T oil	2TOil
1	Kinematic viscosity (40°C)	38 mm^2/S	50. 0 to 60. 0
2	Viscosity index	37.0	27.10
3	Density	0.88 g/cc	0.86 g/cc
4	Flash point (° c)	246	200
5	Pour point (° c)	-33.7	- 12
6	Oxidation stability	5.0 h	4.0h

monoxide (CO), are measured. HC (hydrocarbons) are mostly composed of unburned fuel. A misfiring cylinder will cause the HC levels to be high. CO is produced as a normal by-product of combustion but high levels can be controlled with careful fuel management and the use of a catalytic converter. If the fuel mixture going into the engine is on the rich side (too much fuel) then the CO levels will be high. Something as simple as a dirty air filter can also cause CO levels to be too high.

TABLE: 2 Comparisons between mineral based 2Toil and rapeseed oil based 2T oil

The smoke emitted by the engine is passed through the emission tester. The HC analyzer and CO analyzer analyses the presence of HC and CO in the smoke and separates it and gets collected in different regions. The amount of HC and CO present is compared to the total amount of smoke collected for the testing and the percentage of HC and CO present were found. The test results for the analyzed smoke and the emission details are tabulated below.

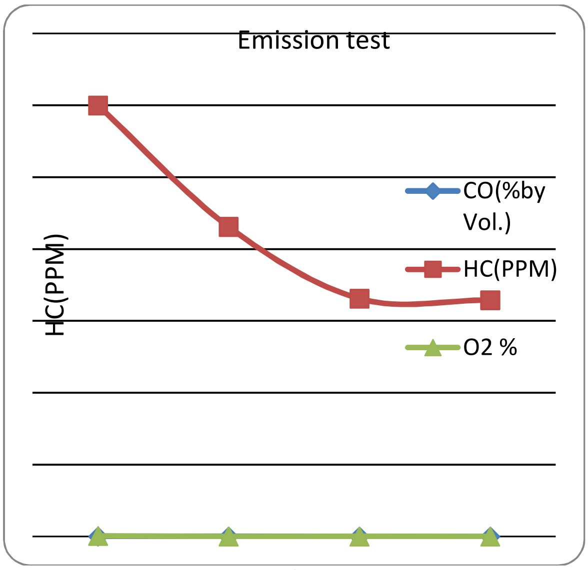

Fig : Compression of Emission test report

6.5. Four Ball Wear Test Analysis

Preparation of Apparatus

- Set up the drive of the test machine to obtain a spindle speed of 1200 ± 60 rpm.
- Set the temperature controller to maintain a test temperature of 75±2°C [167 ±4°F].
- When an automatic timer is used to terminate a test, it should be checked for the required ±1 min. accuracy at 90 sec. elapsed time.
- The loading mechanism must be balanced to a zero reading with all parts and test oil in place. To demonstrate proper precision, an addition or subtraction of 0.2 kg should be detectable in imbalance. Determination of accuracy of loading at 80 kg) is difficult and generally is limited to careful measurement of lever-arm ratios and weights with dead-weight loading apparatus or piston diameter and calibration of pressure gage with pneumatic loading systems.

6.6. Test Conditions

The test shall be conducted under the following conditions:

- Temperature 75 ± 2°C (167 ± 4°F)
- Speed 1200 ±60 rpm
- Duration 60 ±1 min
- Load 80 kg

6.6.Four Ball Wear Test Report

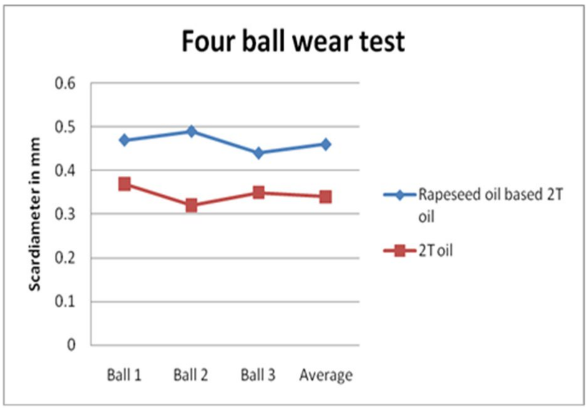

Table: 2 Four ball wear test report

Parameter	Regulation limit	2t oil	Rapeseed oil based 2t oil	Running condition with rapeseed oil after 50km
CO(% by Vol.)	3.5	3.27	2.59	2.40
HC(PPM)	6000	4310	3310	3290
CO_2 %	nHexane	nHexane	nHexane	nHexane
O_2 %	10	2.378	3.155	2.2

The temperature is brought from 18.3ºC to 35ºC, and the ball is rotated at 1200 RPM. A series of tests of 90 seconds duration are made at increasing loads until welding occurs. Values of each sample were obtained for the Weld Point, the load in kilograms when the rotating ball welds to the stationary balls, and the Load Wear Index, the load-carrying property of a lubricant.

7. CONCLUSION

Burning any fuel for our vehicle creates emissions that pollute the environment. Using rapeseed oil based 2T oil instead of petroleum based fuels such as diesel or gasoline reduces the total amount of harmful emissions we release into the atmosphere. The benefits in using rapeseed oil based 2T lubricant are as follows:

- Vegetable oil emissions are virtually sulphur-free. Burning either fuel releases less sulphur.
- Vegetable oil release fewer hydrocarbons than mineral oil based lubricant
- Vegetable oil releases less carbon dioxide and carbon monoxide than regular mineral oil based lubricant.

By comparing the characterization of rapeseed oil based 2T lubricant with that of existing mineral oil based lubricant we conclude that the CO and HC emission is comparatively low. By using mineral oil based lubricant black smoke will be obtained. On the other hand when petrol is mixed with rapeseed oil white smoke is obtained. Thus vegetable oil based 2T lubricant is better than that of commercially available oil.

REFERENCES

1. **Arnsek A., Vizintin J.,** 2000, “Lubrication properties of rapeseed-based oils”, *Lubr. Sc.*,Vol.16(4), pp. 281-296.
2. **Arnsek A., Vizintin J.,** 2000, “Pitting Resistance of rapeseed-based oils”, *Proc. of the 12th Int. Coll. Tribology*, TAE, pp. 143-148.
3. Basic Analytical Ferrography, 1999, Concepts of Ferrography. Predict DLI.
4. **Boschert T., McCombs T.,** 2002, “Outstanding in their field”, *Lubes’n’Oiloils*,Vol.8(5), pp. 44-49.
5. **Gapinski R. E., Joseph I.E., Layzell B. D.,** 1994, “A vegetable oil based tractor lubricant”, *Int. off-highway & power plant congress & exposition*, Milwaukee, Wisconsin.
6. **Gapinski R. E., Kernizan C. F., Joseph I. E.,** 2000, “Improved gear performance through new tractor hydraulic fluid technology”, *Proc. 12th Int. Coll. Tribology*, TAE, pp. 2269-2276.
7. **Hubmann A.,** 1994, “ChemiepflanzlicherÖle”,*Proc. of the9th Int. Coll. Ecological and Economic Aspects of Tribology*, TAE.
8. **O’Connor B. M., Winter H.,** 1992, “Use of low speed FZG test methods to evaluate tractor hydraulic fluids”, *Engine Oils and Automotive Lubrication, Expert* Verlag, pp. 661-686.
9. **Ravasio N., Zaccheria F., Gargano M., Recchia S., Fusi, A., Poli N., Psaro R.,** 2001, “Environmental friendly lubricants through selective hydrogenation of rapeseed oil over supported copper catalysts”, Applied Catalysis A: General 233:1-6.