

Tribological investigation of cashew nut shell oil as lubricant additive

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Abstract. The ecological and harmfulness issues of conservative lubricants as well as their increasing cost lead to converted interest in the growth of environmentally friendly oils as lubricants and manufacturing fluids. This investigation examines friction and wear behaviour of cashew nut shell methyl ester contaminated bio-lubricant using four-ball tribometer. The cashew nut shell methyl ester (CSME) was assorted with conservative lubricant in dissimilar fractions of 15% and 30% by volume. The investigation results shown that 30% addition of cashew nut shell methyl ester shows less coefficient of friction and wear scar diameter also reduced. the results show 30% addition of cashew nut shell methyl ester in bio-lubricant produces better presentation and antiwear features.

1. Introduction

Ecological oils are flattering a vital alternative to conservative oils as an outcome of the improved responsiveness of eco-friendly pollution. Vegetal oil, including animal fat, was used as a lubricant thousands of years ago vegetal oils were used in the structure of tributes. Therefore, the use of vegetal oils as a lubricant in the manufacturing sector is not a new idea. For the last three decades, the lubrication industry has been trying to formulate environmentally friendly lubricants with practical features equal to those of mineral oil. [1-2]. The benefits of choosing vegetal oil rather than oils from other sources are that they are ecological, less toxic compared to petroleum-based oils, easily produced, and renewable. Vegetable oils have lubricating abilities that are better than those of currently used mineral or synthetic oils because of a large amount of unsaturated and polar ester groups composition resulting in the development of thick films among the metal to metal interactions. [3-5] There are certain limitations to bio-based lubricants which include greater corrosion due to the lower thermal stability that donates to the sticking effect. Oxidation stability and low pour point can be adapted by partial use of additives. To make bio-based lubricants maintainable, there is a need to improve the available range of viscosity. do so, viscosity transformers can also be used which are ecologically friendly. the friction and wear behaviour of Pongamia biodiesel-based bio-lubricant were investigated under varying dissimilar load to determine their potential as an alternative to mineral oil. This example was selected as it is comparable to edible oils that are also used in food applications, and also because it can be planted on marginal or semi-desiccated lands. There are some misinterpretations in the comparison of the fuels' lubrication properties and viscosity.[6-10] The lubrication of the fuel is not directly provided by the viscosity of the fuel but by other components in the fuel that prevent wear on contacting metal surfaces to make vegetable oil-based lubricants sustainable, there is a need to improve their narrow range of viscosities Viscosity is one of the significant factors in defining coefficient of friction between the sliding surfaces, as it acts as a protective film between the surfaces in contact to protect them from wear. To do so, viscosity Carried to your modifiers can also be used which are globally friendly. [11-15]There are some negatives of vegetable oil-based lubricants that they have lower thermal/oxidative stability, higher flash point and high-temperature operability important to the higher coefficient of friction to overcome these boundaries, several investigators have



been carried out Oxidation stability and low pour point can be adapted by partially adding additives and using N-Phenyl-alpha-naphthylamine (Am2) as an antioxidant to improve oxidation stability. Moreover, transesterification or epoxidation.

2. Experimental development:

2.1 Lubricant preparations

The different percentages of the cashew nut shell methyl ester (CSME) are with lubricant oil SAE 20W40. It was varied from 15% and 30% by volume mixed with cashew nut shell methyl ester. And the lubricant was considered as SAE 20W40 with comparison of above two samples. The blending percentages is assorted with conservative bio lubricant by a standardized mixture equipment.

2.2 Apparatus

A four-ball Tribometer TR-30L-IAS, a versatile apparatus supplied by Ducom Instruments Bangalore, used to conduct the experiments. The use of a four-ball wear machine is a reputable method for examining lubricant characteristics. This device uses four balls: three on the bottom and one on top. The upper ball is seized in a collet at the lower end of the vertical spindle, which is driven by the motor. The bottom three balls are held definitely in a ball pot containing the lubricant being tested and are pressed against the upper rotating ball. The important components are the oil cup assembly, collet, locknut adaptor, and standard steel ball bearings. The components' surfaces were cleaned with acetone before the tests. The balls are made up of AISI E-52100 chrome alloy steel with a diameter of 12.7 mm, extra polished to grade 25 and hardness of 64 HRC. In each test, the new balls are used. The ball pot is supported above the loading lever on a thrust bearing and plunger with a load cell which is fixed to a loading lever to measure the normal load. The frictional torque exerted on the three balls is measured by a frictional load cell. A RTD type temperature sensor is mounted at the bottom part of ball pot between the two heaters. The test lubricant is heated to 75 °C by a heater fixed in a four ball tribometer with a speed of about 1200 rpm and normal load of 148 N. The specific CCD microscope is used for capturing the images the wear scar of three fixed balls in the ball pot. The specific image capture software is used for measuring the wear scar diameter and wear scar image on the ball surface. The test was conducted in accordance with ASTM D 4172.



Figure 1 Four ball wear tester

3.Results and Discussion

The coefficient of friction of various concentrations of cashew nut shell oil with biolubricants and SAE20W40 are shown in Fig.2. The values of cashew nut shell methyl ester (CSME) are 0.065010 and 0.8992 respectively. Whereas for the SAE20W40 is 0.10152. The coefficient of friction is lowered by about 11% and 35% as compared with SAE20W40.the values wear scare diameter of cashew nut shell methyl ester (CSME) are 0.55mm and 0.508 mm and SAE20W40 is 0.932mm shown in fig: 3.the wear scare diameter is lowered by about 38.2% and 42.4% as compared with SAE20W40.The lubrication properties shows better results in CSME 30% compared to SAE 20W40 and CSME 15%. shown in table1

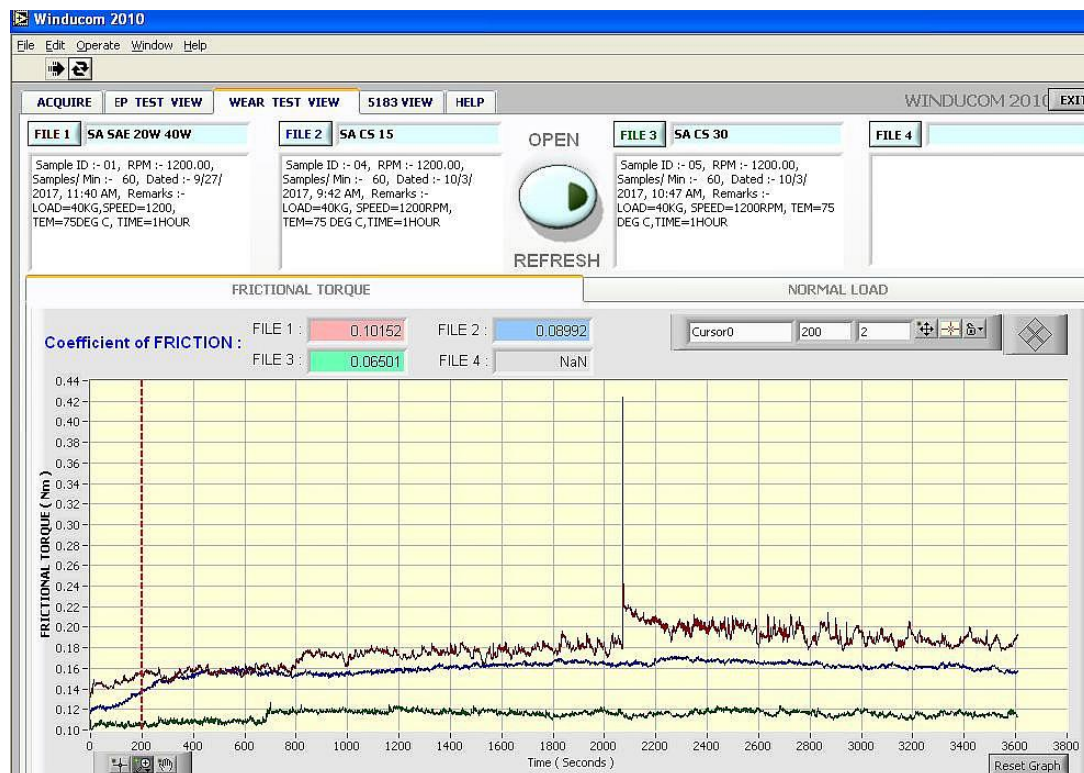


Figure 2 Time vs COF

Table 1: Properties of Lubricants

Properties	SAE20W40	CSME 15% WITH SAE20W40	CSME30% WITH SAE20W40
Flash point (°C) [ASTM D92]	200	214.27	190.2
Viscosity @100°C (cSt) [ASTM D445]	121	74.79	42.61
Viscosity @100°C (cSt) [ASTM D445]	15.2	15.48	12.56
Viscosity index [ASTM D2270]	120	126	158

The wear scar morphology was recorded using confocal microscope. The most important capability of confocal microscopy is the ability to acquire high quality metallographic images with the capability to reconstruct the sectional plane information into three-dimensional model. SEM images have taken in mag500x. from the SEM images observed minimum wear occurred in cashew nut shell methyl ester CSME 30% compared to other two lubricants. From the EDAX results the carbon and silicon present are lesser in the CSME30% compared two other two lubricants. Chromium and iron values are higher in the CSME30% compared two other two lubricants. Are shown in fig.4

Table 2. Elemental Analysis of SAE20W40 and its Blends

Lubricants			
Elements	SAE20W40	CSME 15% WITH SAE20W40	CSME 30% WITH SAE20W40
Carbon	2.46	3.39	1.32
Silicon	0.12	0.17	0.09
Chromium	1.42	1.31	1.46
Iron	96	95.14	97.13

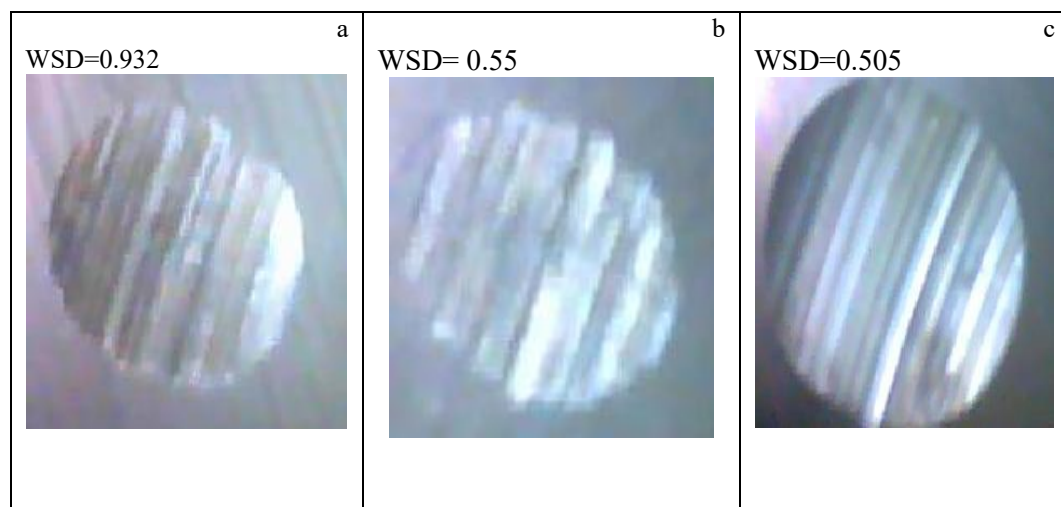


Figure 3 wear scar diameter images a) SAE20W40, b) CSME 15% WITH SAE20W40 c) CSME 30% WITH SAE20W40

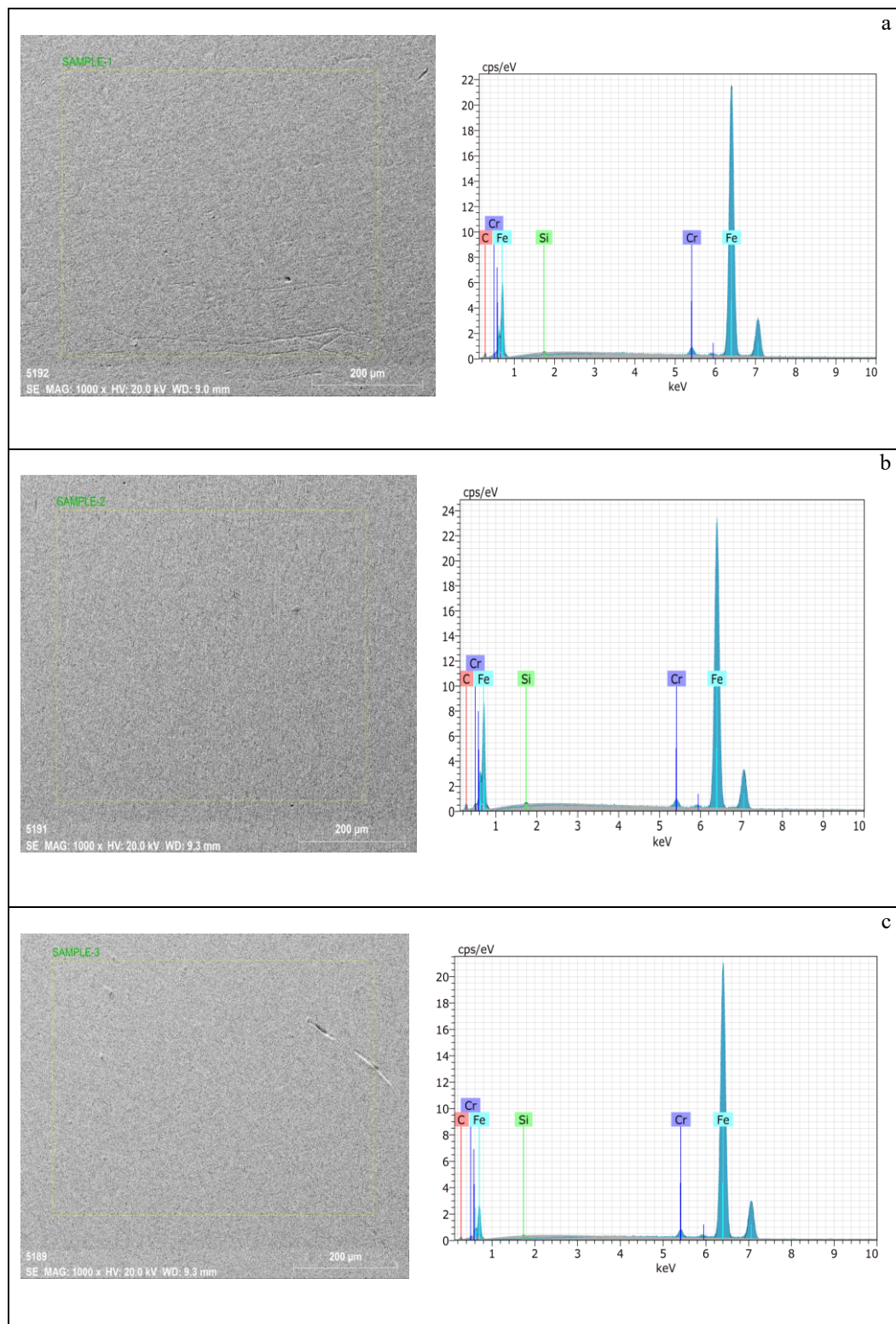


Figure 4 SEM And Edax images a) SAE20W40, b) CSME 15% WITH SAE20W40 c) CSME 30% WITH SAE20W40

Conclusions

The tribological investigation of different Lubricants was tested using Pin on Disc Tribometer under various conditions and the results were compared with the SAE20W40 Lubricant. The following conclusions were made from the experimental study:

- The properties of the viscosity and viscosity index of the three samples shows better results in the CSME 30% compared two other two lubricants.
- The coefficient friction wear also shows better in the CSME 30%with SAE20W40 compared two other two lubricants
- SEM and EDAX results also concluded that better results shows in CSME 30%with SAE 20W40

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