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Study Comparing the Tribological Behavior of Cottonseed and Castor Oil Biodiesel Blended Lubricant under varying Load Conditions

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Abstract: We have an increasing global need for bio lubricants that are safe for human and environmental use, easily biodegradable, and non-polluting. The friction and wear qualities of cotton seed blended lubricant as well as castor blended lubricant are compared and contrasted in this research using a Pin on disc wear testing Tribometer. In this research, we will look at the study's results and analyse their significance. Blended lubricants were created by combining cotton seed & castor based biodiesel with the basic lubricant SAE20W40 at volumetric ratios of 5, 10, 15, & 20%. Cotton seed and castor blended bio lubricants were tested for friction and wear at sliding velocities of 2.5 metres per second while subjected to weights of 50 N, 100 N, and 150 N. Wear might be slowed by as much as 15 percent by mixing in cotton seed biodiesel with the base oil, as has been shown. When this threshold is passed, wear increases at an ever-increasing pace. Castor oil blended lubricant performed best in wear tests when coupled with a base lubricant at a 5 and 10 percent castor oil blended lubricant concentration. The wear rate was accelerated when 15 percent castor oil was added to the basic lubricant. It has been discovered that at lowest and maximum load, CBL 5 and CBL 10 may serve as an alternative lubricant to increase mechanical efficiency at a sliding velocity of 2.5 metres per second. Because of their efforts, less need has been seen to lessen dependence on petroleum-based goods.

Keywords: Cotton seed, Castor, Wear, Coefficient of Friction, Blending Ratio

I. INTRODUCTION

A lubricant is applied to sliding components so that the rate of wear and friction may be reduced.

Lubrication is essential for reducing friction between moving engine parts like the piston ring as well as the cylinder liner. Recognizing the global threat presented by depleting non-renewable resources, the role of renewable resources becomes crucial [1]. Because items based on petroleum have contributed to global problems such as pollution, we now utilise products that are not based on petroleum.

Large amounts of lubricant are needed as a result of the rise in the global population and the expansion of the number of industries [2]. In order to fulfil this criterion, lubricants derived from vegetable and plant seed oils, as well as other key renewable sources, are used. Vegetable oil, unlike mineral oil, decomposes spontaneously and doesn't add to pollution. Additionally, vegetable oil has several drawbacks, including a reduced thermo-oxidative, poor cold flow characteristics, as well as hydrolytic stability [6]. Therefore, the structure of the plant's oil seed may need some modification in order to satisfy the demand for lubricant. Cotton seed blended lubricant and castor blended lubricant were both used in this research to investigate and evaluate the wear rate and frictional force characteristics at varying sliding velocities and loads [5].

II. PREPARATION OF BIODIESEL SAMPLES

A. Materials used

1) Oil – Cotton seed Oil, Castrol Oil
2) Fuel - Diesel
3) Strong Base - Methanol
4) Catalyst - Potassium Hydroxide

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B. Methodology

1) Blending Process

Fig.1. Blending Process

a) Blending is done at two ways which are a regular authentic one & other one is addition of chemical Additives which is shown in Fig 1.

b) Biodiesel is blended in following ratio and the ratio is standard.

c) BD20 - DIESEL 800ml, Oil 200ml.

2) Transesterification

Fig.2. Transesterification Process

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a) The transesterification process is shown in Fig 2. The working oil of 1200ml is heated up to 40˚C on a Magnetic Stirrer or Mixer.
b) After obtaining of required temperature, a mixture of Methanol &KOH is added to it and heated up to 56˚C -58˚C.
c) Let the oil to settle down with its fatty acids and glycerol.
d) Now separate the glycerol from the oil with the help of a separating funnel.
e) Later separation rinses the oil with distilled water or Hot water thoroughly.
f) And reheat the obtained oil for one more time up to 90˚C on Magnetic Stirrer to evaporate the water bubbles which may present in it.
g) Collect the oil into container bottles and process to Blending

III. EXPERIMENTATION PROCEDURE

A. Biodiesel Preparation Process

1) Pre-Heating

Fig.3.Pre-Heating

Get a beaker that can hold at least 500 ml of liquid. Start by heating 400 ml of oil in a magnetic stirrer [7]. Make sure the beaker's turning at less than 500 revolutions per minute before adding the magnetic pellet. Maintain a regular schedule of checking the oil temperature using a thermometer. When the oil reaches 40 degrees Celsius, you may add the methanol that you put up earlier. You should let the solution heat up. Fig. 3 depicts the beginning of the preheating phase [8].

2) Adding of Methanol Mixture

Then, combine 3.5 grammes of sodium hydroxide (KOH) pellets with 125 millilitres of methanol. Turn down the heat as soon as the oil reaches a temperature of 56 to 58 degrees Celsius. Let the oil an hour to settle [9].

3) Separation of Layers

Clearly visible in fig 4 are the two distinct layers of methyl ester and glycerol that need to be extracted.

Fig.4. Separation of Layers

4) Separating the Glycerol with the Methyl Ester

Pour the mixture into the separating funnel after the oil has settled. As seen in Fig. 5, the glycerine will evaporate from the oil as you wait for it to be poured into the Separator. Get a Beaker for the oil and another for the glycerine.

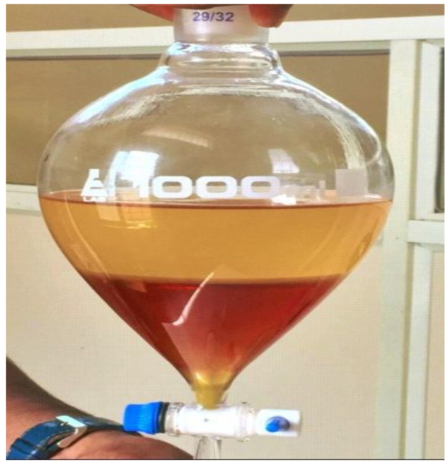

Fig.5. separation of Layers by using collecting flask

5) Water Wash

The recovered oil is then poured back into the washing funnel. Soap vapours may be eliminated by adding hot water (at a temperature of 60 degrees Celsius) to the oil in the separator funnel which is shown in Fig.6. This is done twice or thrice till the accumulated water is clear.

Fig.6. Water wash

6) Final Heating Stage

Now drain the beaker of the residual oil. Then, bring the oil up to a temperature of around 90 degrees Celsius, at which point any leftover water will have evaporated. Fig. 7 depicts the necessary Bio Diesel solution as the remaining oil.

Fig.7. Final Heating Stage

7) *Final Bio diesel Produced*

Fig.8. Final Product

Fig 8 depicts the end result. When making more oil, just repeat the procedures outlined above. Fig 9 and 10 show examples of prepared cotton seed oil and castor oil.

Fig 9: Cotton seed oil biodiesel

Fig 10: Castor oil Biodiesel

B. *Base Lubricant*

Fig 11 shows the base lubricant (SAE20W40 4T)

Fig 11: Base Lubricant

IV. EXPERIMENTAL PROCEDURE

Pin and disc equipment measures both the wear rate and the force generated by friction of the materials. A calibrated deadweight-laden pin and a horizontally decaying disc make up the pin on disc device [3]. Fig.12 shows the experimental setup for the pin disc experiments.

Fig.12. Experimental setup of Pin on disc wear testing Equipment

The disc is rotated by an integrated motor. The linear variable differential transformer (LVDT) sensor is where it excels. When the pin of the LVDT sensor touches the disc while it is spinning, wear occurs [3,4]. The lever arm serves as a load bearing surface for the pin.

Instrument Type	Pin on Disc
Normal Load	10-200N Dad Weights
Sliding Speed	0.26-10 m/s
Disc Speed	50 – 2000 RPM
Wear Measurement Range	± 2mm
Specimen Pin Diameter	3 – 12 mm
Specimen Standards	ASTM G99 & DIN50324

The blending ratios of biodiesel to base oil are shown in Figs.13 and 14. The lubricant (SAE20W40) is mixed with cotton seed oil based biodiesel (CSBL) at 5%, 10%, 15%, and 20% concentrations, under loads of 50N, 100N, as well as 150N, respectively [4]. Similar testing conditions with the aforementioned loads and the same lubricant at concentrations of 5%, 10%, 15%, and 20% Castrol-based biodiesel (CBL) are employed. In order to ensure complete mixing, a magnetic stirrer is used [10].Initial preparation for the experiment included sanding the disc. The experiment was repeated with a variety of loads and ratios, and the outcomes were recorded [11].From this data, graphs of the friction coefficient, wear rate, and load were generated.

Fig 13: Cottonseed oil with base lubricant Fig 14: Castor oil sample with base lubricant

V. RESULTS AND DISCUSSIONS

A. Impact of Load on Wear Rate

Fig 15 depicts the impact of load on the rate of wear. In general, wear increases with increasing load variation, however CSBL 5 and CSBL 15 exhibit less wear than CSBL 10 and CSBL 20 [12]. CBL 5 and CBL 10 have a lower wear rate than CBL 15 and CBL 20 [13] (fig. 16).

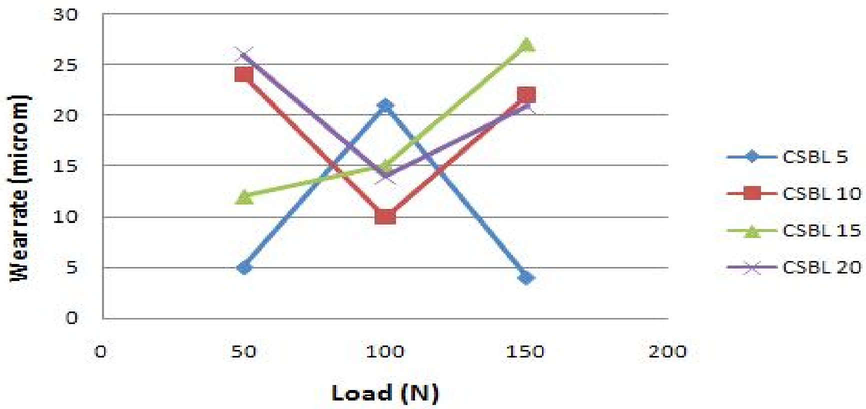

Fig 15: Load Vs Wear Rate for cotton seed blended lubricant

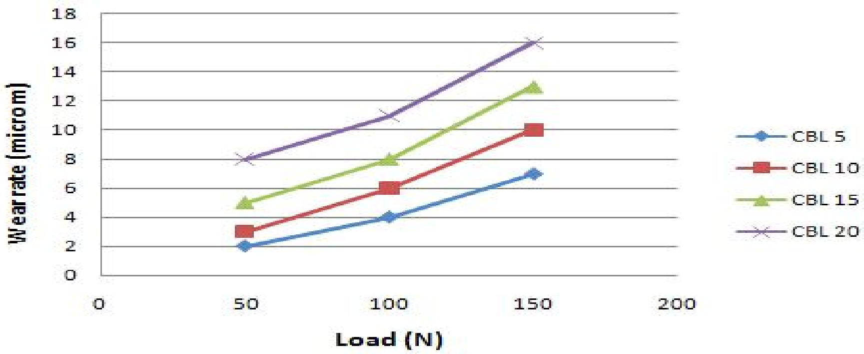

Fig 16: Load Vs Wear Rate for Castor blended lubricant

B. Effect of Load on coefficient of Friction:

The relationship between friction coefficient and load is seen in Fig. 17.If we examine Fig.17 shows that the lowest coefficient of friction belongs to CSBL5 and CSBL10 [14]. The coefficient of friction is shown to be minimal for CBL5 and CBL10 in Fig. 18, whereas it is maximal for CBL15 and CBL20 [15].

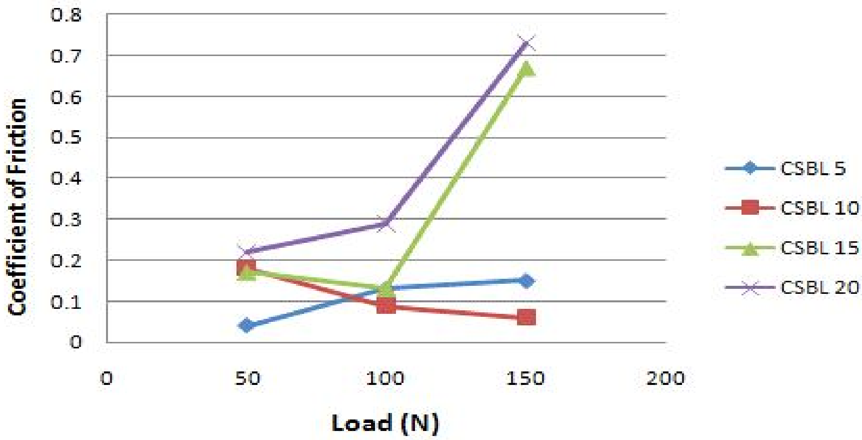

Fig 17: Load Vs Coefficient of Friction for cotton seed blended lubricant

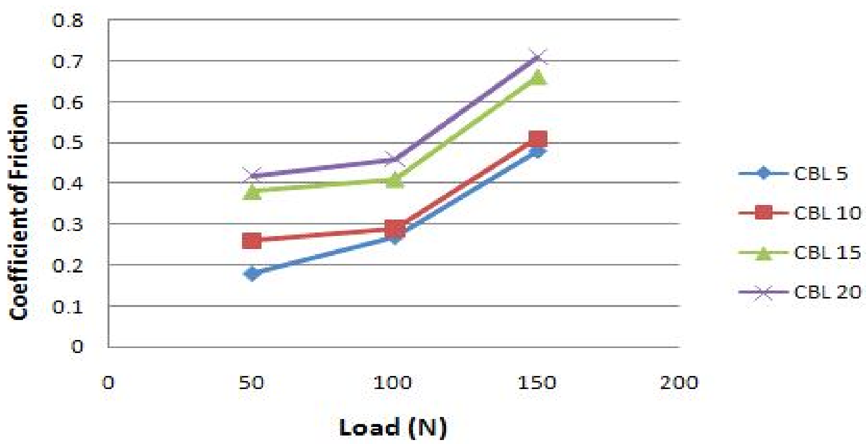

Fig 18: Load Vs Coefficient of Friction for castor blended lubricant

VI. CONCLUSIONS

1) Blends of cotton seed and castor oil biodiesel are created first, and their characteristics are analysed.
2) Cotton Seed as well as Castor oil biodiesel blends are then mixed with base lubricant in proportions of 5%, 10%, 15% and 20%
3) The wear rate was minimum when cotton seed oil biodiesel was mixed with 5% and 15% of base lubricant oil
4) The minimum wear rate was observed when castor oil biodiesel is mixed with 5% and 10% of base lubricant oil
5) Cotton seed oil biodiesel blended with 5 and 10 percent of base lubricating oil was shown to have the lowest friction coefficient.
6) Mixtures of castor oil biodiesel with basic lubrication oil at 5% and 10% have the lowest frictional coefficient.

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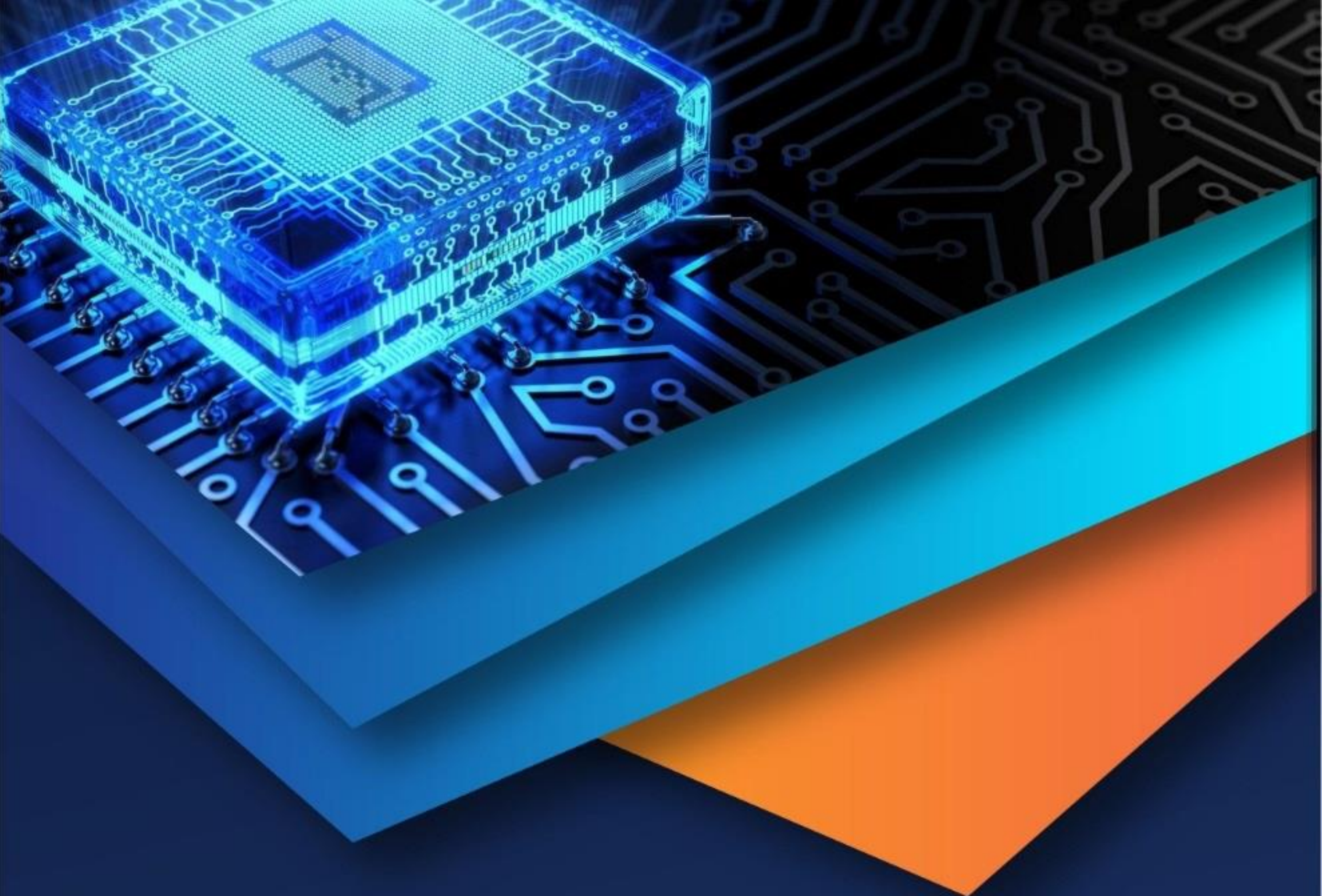

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