Cottonseed Oil and Esterifies Cottonseed Oil as Lubricant in IC

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ABSTRACT

Due to growing environmental concerns and the depletion of the world's crude oil, vegetable oils are finding their way into lubricants for industrial and transportation applications. Emphasis on the development of renewable, biodegradable, and environmentally friendly lubricants has resulted in the widespread use of natural oils and fats. The substitution of mineral oil with vegetable oil as a base stock for an environment friendly lubricant in a CI engine is explored in this study without adding any additives. The experiments have been conducted with cotton seed oil, and compared with SAE20W40 mineral oil. The viscosity and engine oil temperature. The engine performance and emission tests were carried out on a single cylinder, water cooled, 4-stroke CI engine. Bio based lubricant gave give good result and their viscosity was within range, the test were carried out for 96 hours it is observed that bio based lubricant start deteriorating after 96 hours of working. To improve life performance of cottonseed oil esterfication is done and then it is tested on single cylinder SI engine with blend of which shoes improved result.

Keywords: *bio degradable;, lubricant;, cotton seed oil; esterification; I.C. Engine*

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1. INTRODUCTION

Vegetable oils are promising candidates as base fluid for eco-friendly lubricants because of their excellent lubricity, biodegradability, viscosity-temperature characteristics and low volatility. Vegetable oil lubricants provide a renewable source of environmentally friendly lubricants, relating to the lubricant's ability to biodegrade into harmless products. Recently there has been an increased concern in enhancing the use of biodegradable vegetable oils in lubricants, mostly by environmental as well as health and safety issues, emerging due to changes in economic and supply factors. From the viewpoint of emissions, biodegradable lubricants are expected to behave differently from conventional lubricants, mainly with respect to emissions soluble organic fraction of particulate emissions (SOF). Polycyclic aromatic hydrocarbons, which are absent in vegetable oils, pose a great contingency to human health. Vegetable oils are also low in potential pollutants like sulphur-containing compounds which can damage both environment and catalytic converter. The advantages of vegetable oils as base oil in lubricants as compared to mineral oils are non toxicity, biodegradability, resource renewability, affordable application cost, high viscosity index, and so forth. Vegetable oils are usually much cheaper than ester based oils and therefore provide more potential for the successful implementation as lubricants in base oil. Pure cottonseed oil shows less life if used as lubricant so esterification is done to improve it

2 LITERATURE REVIEW.

Researchers have worked on these methods, many got positive results.

Schramm [1] carried out emission measurements on a chassis dynamometer to compare the emissions of CO, CO, NO_x, THC, PM, and lubricant-SOF from diesel vehicle, lubricant and fuel consumption were also carried out. They operated the vehicle on conventional crude oil-based fuels and alternative fuels. Lubricant samples were taken from the engine crankcase after driving 7500 km on the road and were analyzed in order to evaluate biodegradability of the used lubricant and engine wear. Masjukietal.foremost[2] have demonstrated the benefits for particulate reduction provided by vegetable oil

lubricants, which were derived from renewable resource materials. They carried out the experiment on single cylinder engine with and without thermal barrier coated components, with petroleum based lubricants and a vegetable oil lubricant for comparison purpose. Also their four-ball wear test data on this vegetable oil formulation showed similar or improved wear friction characteristics when compared with commercial petroleum and synthetic lubricants.K. Cheenkachorn and B. Fungtammasan[3] carried out a comparative study of wear, friction, viscosity, lubricant degradation, and exhaust emissions with palm oil and commercial lubricating oil. Their results revealed that the palm oil-based lubricating oil exhibited better performance in terms of wear and that the commercial oil exhibited better performance in terms of friction. However, the palm oil-based lubricant was more effective in reducing the emission levels of CO andhydrocarbon.

Boehmanetal.Cheenkachorn and Fungtammasan [4] investigated the use of palm oil as base oil for an environmentally friendly lubricant for small four-stroke motorcycle engines. Their study showed that, compared to mineral-based commercial oil, the palm oil-based lubricant showed superior tribological properties but offers no significant advantage on engine and emission performance

Durak [5] carried out experiment on using vegetable oil as alternative lubricating oil candidate, using Turkish originated rapeseed oil in different concentrations by volume percent with base oil. The author studied the effect of rapeseed oil as additive to mineral oil on specially designed experimental system and compared the lubricating oil in journal bearings. His experiments revealed that addition of rapeseed oil to mineral-based lubricant reduces the friction coefficient in journal even at high temperature.

Bekal and Bhat [6] investigated the substitution of mineral oil with vegetable oil as a lubricant in a CI engine. Their

experiments were conducted with neat pongamia oil and blend of pongamia oil and mineral oil (50%V/V) in different proportions. For various combinations of fuel and lubricant, NO_x, smoke, CO, HC, BSEC, EGT, and FP were compared. They recorded best results for the fuel-lubricant combination.

Hassan et al [7] had done research work on the possibility of producing lubricating oil from vegetable oil with palm oil. Physical and chemical properties such as viscosity, flash/fire point, pour point, and specific gravity were analysed.Bleached sample was tested to determine the above mentioned properties. Finally, it was revealed that the crude palm oil and the bleached sample exhibit a good base as a lubricant.

Navindgi et al. [8] carried the performance parameters and emissions of a CI engine fuelled with straight vegetable oils of neem, mahua, linseed, and castor oil. They found out that the process of transesterification is found to be effective way of decreasing viscosity and eliminating operational and durability problems of vegetable oils. The performance parameters evaluated include thermal efficiency, BSFC, BSEC,and exhaust gas temperature and emissions smoke. Significant Improvements have been observed in the performance parameters of the engine as well as exhaust emissions with use of neem, mahua, and castor oil as compared to baseline data of diesel.

The objective was to investigate the usability of Cotton seed oil as complete lubricant 4-stroke diesel engines and to study the variation in the viscosity , engine oil temperature and flash and fire point of cotton seed oil as lubricant.

3 EXPERIMETAL STUDY METHODS

3.1 Experimentation with pure cottonseed oil as lubricant

The Kirloskar engine is mounted on the ground. The test engine was directly coupled to an Eddy current dynamometer with control facility for loading the engine. The specifications of the engine are shown in Table 1.

Table 1 Engine specification

Make	Kirloskar
Model	AVI
Cycle	4 strokes
Rated power	3.75kW (5HP)
Speed	1500 rpm
Bore diameter	80 mm
Stroke length	110mm
Cooling system	Water cooled
Cubic capacity	0.661 litres
Ignition system	Compression ignition
Compression ratio	17.5 : 1
Lubricating oil specification	SAE 20W40
Lubricating oil capacity	3.7 liters

The experimental setup is shown in Figure 1.

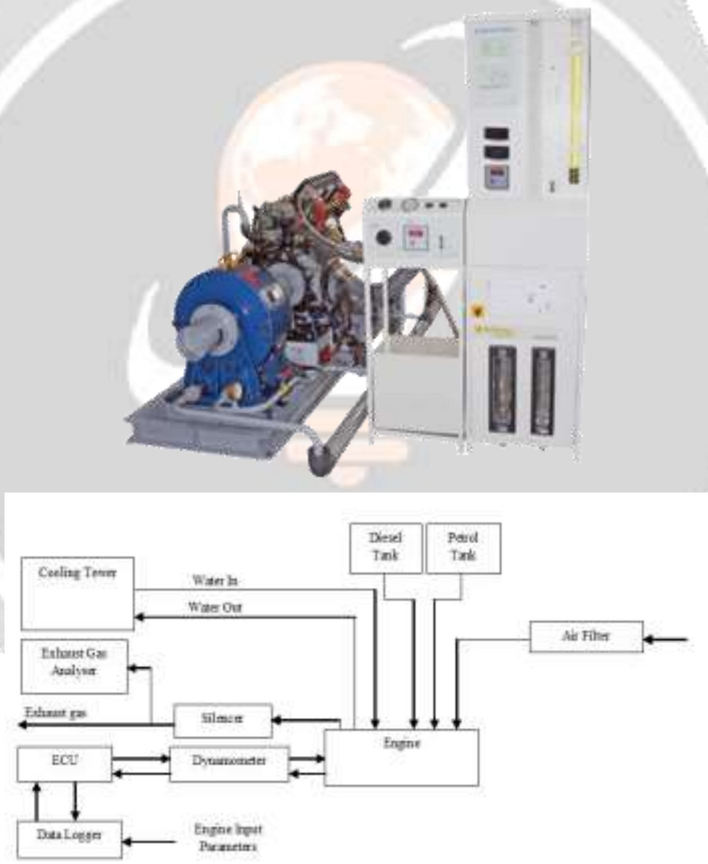

Figure. 1 Engine setup

2.1. Experimental Methodology.

The aim of this experimental study was to investigate an effect of cotton seed oil as lubricant instead of petroleum based lubricant oil and its effect of engine oil temperature and viscosity of oil for 4-stroke CI engines. The lubricant oil is completely replaced by pure cottonseed oil and engine is run , the engine oil temperature is recorded by thermocouple and periodically after each 10 hours some oil is taken out from engine and its viscosity is recorded with redwood viscometer.

Table 2 physical characteristics of SAE 20 W 40 and cottonseed oil

Typical properties	Cotton seed oil	SAE 20W40
Kinematic viscosity cSt @ 40°C	31.93	120
Kinematic viscosity cSt @ 90°C	6.8	14-16
Pour point	-15	9
Flash point	300	280
Specific gravity	0.91	0.855

3.2 Experimentation with esterifies cottonseed oil as lubricant

Esterifies cottonseed oil process:

Esterification of cottonseed oil is done, the process as explained

Step 1: Preparation of methyl ester of Cottonseed oil

The cottonseed oil (1500 ml) was filtered to remove solid precipitate in the oil and then was subjected to drying by heating at 100 ^{0}C for 30 min to obtain very minimal amounts of water in the oil. As any water in the system will consume some of the catalyst and slow the transesterification reaction. Then wait until the oil returns to room temperature.

NaOH (1% by W/W of oil) was added to 400 milliliters of methanol and was dissolved by vigorous stirring. Then the prepared mixture was poured into 1500 milliliters of the cottonseed oil. The reaction mixture was allowed to stir for 90 min at 60 ^{0}C. Then, the heater was turned off. The reaction was quenched by adding ice and was allowed to settle and separate into phases The top ester layer was poured into another beaker and was washed from the remaining ester and residual catalyst with 400 ml of water three times. After some time, the water phase containing the remaining alcohol and catalyst settled, leaving a clear ester phase on top which was separated and used for the next reaction.

Figure 2. Esterification of cottonseed oil

Step 2: Transesterification to form TMP ester

Methyl ester of Cottonseed oil (1200 ml) and TMP (300g) were added to the glass reactor. After the mixture reached the desired temperature (150 ^{0}C), the catalyst, sodium methoxide (NaOMe) (1% by W/W of methyl ester) was added. Next, the mixture was stirred, and the vacuum pump was turned on in order to remove the methanol the reversible reaction. At the end of the reaction, the mixture was cooled, washed with water, dried with anhydrous sodium sulfate and filtered.

After esterification product is verified by FTIR.
Fourier-transform infrared spectroscopy (FTIR) is done to verify the result, as shown in fig 3 shows required pick.

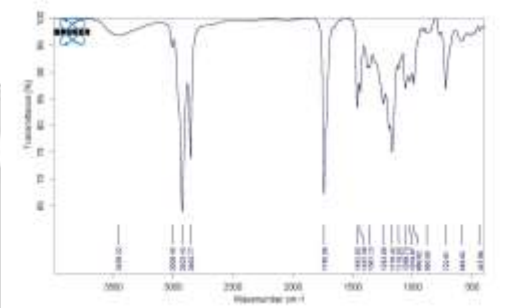

Fig 3. FTIR after esterification of cottonseed oil

After esterification viscosity of esterifies cottonseed oil is checked with redwood viscometer and compared with pure cottonseed oil as shown in following table.

Figure 4: redwood viscometer

Table 3 : cottonseed oil and esterifies cotton seed oil viscosity

Temperature °C	Viscosity in centistokes pure cottonseed oil	Viscosity in centistokes pure esterifies cottonseed oil
40	31.85	27.85
90	7.53	4.97

Fire point of esterified cottonseed oil is measured by fire point setup, results are shown in table

Table 4: cottonseed oil and esterifies cotton seed fire point

	cottonseed oil in °C	esterifies cottonseed oil in °C
Flash point	305	210
Fire point	310	220

4. RSULTS AND DISCUSSION

4.1 Experimentation of Pure Cottonseed oil

The experiments were conducted with cotton seed oil as lubricant in I.C. engine and their change in viscosity and engine oil temperature were recorded for 96 hours.

4.1 a. Viscosity of cottonseed oil.

Figure 5 shows variation in Viscosity on periodic basis for the cotton seed oil used as lubricant in C.I. Engine, it can be seen we can use cotton seed oil as a lubricant for the small period of time like 96 hours but if we want to use it for long period modification are required.

Table 5 viscosity of oil after used in engine

Time in hours	**Viscosity centistokes**
0	6.824762
1	7.530909
10	8.22087
20	8.22087
30	8.22087
40	11.80246
50	14.25385
60	17.78623
70	20.07647
80	29.76667
90	64.83746
100	111.9219

Figure 5: viscosity of lubricating oil

4.1.b. Lubrication oil temperature while engine running.

Figure 6 shows variation of lubrication oil temperature for the period of 96 hours and it is will show not much increase in temperature of engine oil when cottonseed oil is used as lubricant oil.

Table 6 Engine oil temperature while using cotton seed oil as lubricant

Time in hours	Engine oil temperature
0	30
1	50
10	55
20	56
30	57
40	56
50	55
60	58
70	60
80	61
90	60
100	70

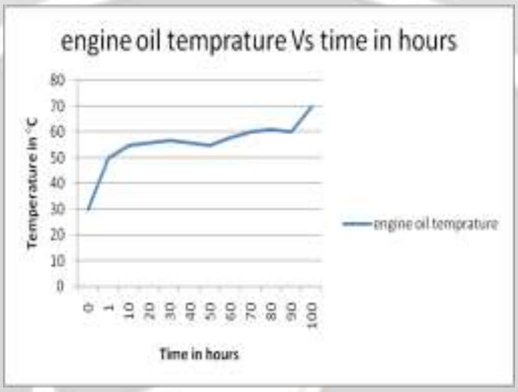

Figure 6: engine oil temperature

4.2 . Experimentation on esterifies cotton seed oil

Table 7 Engine specification for esterified cottonseed oil

Make	Honda
Cycle	4 strokes
Rated power	6.15 kW (8 HP)
Speed	8000 rpm
Bore diameter	88 mm
Stroke length	110mm
Cooling system	Air cooled

Esterifies cotton seed oil in SI engine: Esterifies cotton seed oil with 50 % blend with SAE 20W40 is used in four stroke SI engine for 100 hours and it is observer that it can be used as lubricant and without much reduction in efficiency , for longer period additives need to be added to avoid oxidation and improvement of lubricant properties.

5. CONCLUSION

The cotton seed oil show similar properties compared to commercial SAE 20W40 oil in terms of, viscosity and engine oil temperature. It is observed that cotton seed oil shows similar to characteristics to commercial SAE 20W40 oil for the short duration of 96 hours. After that it has been observed cotton seed oil get degraded and gum like structure is formed when trial was extended and efficiency of engine decreases due in proper lubrication. Engine oil temperature is increased in first hours and then it almost remain constant till the cottonseed oil get degraded (oxidized). So pure cottonseed oil can be used as lubricant for the short duration but for long period modifications are required in cotton seed oil. Esterifies cotton seed oil show little lesser values of viscosity and flash and fire point as compared to pure cottonseed oil, when esterifies cottonseed oil with blend SAE 20W40 is used in four stroke SI engine for 100 hours and it is observer that it can be used as lubricant and without much reduction in efficiency , for longer period additives need to be added to avoid oxidation and improvement of lubricant properties.

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