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BIODIESEL PRODUCTION FROM SESAME OIL AND TUNG OIL AND DETERMINATION OF ITS EFFECTS ON PERFORMANCE AND EMISSIONS OF A CI ENGINE

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ABSTRACT

In today's world various source of energy are given importance because of gradual depletion of fossil fuels reserves vegetable oils can be used as an alternative to diesel in CI engines. The utilization of vegetable oils in CI engine results in low CO and HC emissions compared to conventional diesel fuel. This study covers the various aspects of biodiesels fuel derived from sesame & tung oil. Sesame & Tung oil is converted to Sesame & Tung oil methyl esters by transesterification process. An experimental investigation was carried out on C.I.engine with Bio Diesel blends of sesame oil methyl Esters and tung oil methyl Esters. The engine used for the experiments was single cylinder Four Stroke water cooled, constant speed diesel engine. Sesame oil methyl ester (SOME) and Tung oil methyl ester (TOME) are derived through transesterification process and parameters of transesterification were optimized. The blends of various proportions of the SOME &TOME with diesel were prepared, analyzed and compared with diesel fuel, and comparison was created to suggest the better choice among the bio diesel. Various tests have been carried out to examine properties, performance of various blends (S20, S40, S60, and S80) of SOME and TOME as compared to diesel. From the experimental results it is indicated that S20 have closer performance to diesel. However, its diesel blends showed affordable efficiencies. From the experimental results it is observed that sesame oil methyl ester gives better performance compared to oil methyl esters and also the emissions and smoke for these diesel blends are less as compare to the pure diesel.

Keywords— Bio-diesel, Properties, Transesterification, Optimization, Sesame Oil Methyl Ester (SOME), Tung Oil Methyl Ester (TOME)

I. INTRODUCTION

Energy is prime mover for technological and economic development of a nation. Five generations (125 years) past, wood supplied up to 90th of our energy needs. Because of the convenience and low costs of fossil fuels wood use has fallen worldwide. The current energy scenario now could be heavily biased towards the traditional energy sources corresponding to petroleum products, coal, nuclear energy etc. which are finite in nature besides

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causing environmental pollution. Of the available energy, the current energy utilization pattern is heavily biased for meeting the high energy demand in urban and cosmopolitan cities. There are different types of Biodiesels are available corresponding to sunflower, Soyabean, Cottonseed, Linseed, Mahua, Jatropha, Pongamia, Sesame, Tung etc .[3]. The vegetable oils are often utilized in diesel engines by various techniques corresponding to fuel modifications by Transesterification , Diesel Vegetable blends and vegetable oil heating etc.[4]. The current work has to research the evolution of Sesame and Tung oils with Diesel. Experiments were carried out at constant speed 1500 rpm and at completely different loads with different blends.

1.1 Fuel Modification

1.1.1 Transesterification

Transesterification process is the reaction of vegetable oil or animal fat with a presence of alcohol, in most cases methanol, to form esters and glycerol. The transesterification reaction is affected by alcohol type, molar ratio of glycerides to alcohol, type and amount of catalyst, reaction temperature, reaction time and free fatty acids and water content of vegetable oils or animal fats. The transesterification reaction proceeds with or without a catalyst by using primary or secondary monohydric aliphatic alcohols having 1–8 carbon atoms as follows: Triglycerides + Alcohol Glycerin + Mono-alkyl esters.

Generally, the reaction temperature near the boiling point of the alcohol is recommended. Nevertheless, the reaction may be carried out at room temperature. The reactions take place at low temperatures (~65°C) and at modest pressures (2 atm, 1 atm = 101.325 kPa). Bio-diesel is further purified by washing and evaporation to remove any remaining methanol. The oil (87%), alcohol (9%), and catalyst (1%) are the inputs in the production of bio-diesel (86%), the main output. Pre-treatment is not necessary if the reaction is carried out under high pressure (9000 kPa) and high temperature (~240°C), where simultaneous esterification and transesterification take place with maximum yield obtained at temperatures ranging from 60 to 80°C at a molar ratio of 6:1. The alcohols utilized in the transesterification are usually short chain alcohols such as methanol, ethanol, propanol, and butanol. It was reported that when transesterification of soybean oil using methanol, ethanol and butanol was performed, 96–98% of ester could be obtained after 1 h of reaction.

Table 1. Properties of Diesel and Crude Oils

S.No.	PROPERTY	DIESEL	SESAME OIL	TUNG OIL
1	Calorific Value (kJ/kg)	43,000	39480	35810
2	Flash Point (°C)	44	345	322
3	Fire Point(°C)	49	360	345
4	Viscosity	0.278 poise	35.5 at 38°C	121.74 at 40°C
5	Density(kg/m^3)	835	913	902

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Table 1.1 Blending percentage of Sesame oil

NOTATION	FUEL QUANTITY (Litres)	BIO-DIESEL QUANTITY (ml)	DIESEL QUANTITY (ml)
SO20	1	200	800
SO40	1	400	600
SO60	1	600	400
SO80	1	800	200

Table 1.2 Blending percentage of Tung oil

NOTATION	FUEL QUANTITY (Litres)	BIO-DIESEL QUANTITY (ml)	DIESEL QUANTITY (ml)
TO20	1	200	800
TO40	1	400	600
TO60	1	600	400
TO80	1	800	200

Table 1.3 Properties of Pure Diesel, Sesame oil Methyl Ester with Tung Oil Methyl Ester

Property	Diesel	Sesame Oil Methyl Ester (SOME)	Tung Oil Methyl Ester (TOME)
Heating value (kJ/kg)	43000	38480	39000
Carbon residue (% by weight)	<0.35	0.25	0.0150%
Density (g/cc)	0.815	0.870	0.885
Kinematic Viscosity(cSt)	3.5	4.72	4.6

II. EXPERIMENTAL SET UP

The experimental set up used in this research work is shown in Fig. 1. It consists of a Kirloskar made single cylinder, four stroke, constant speed (1500 RPM), water cooled, variable compression ratio, direct injection compression ignition engine. The fuel injection system of the engine consists of of a plunger type pump with an injector having three spray holes, all 0.28 mm diameters. The specifications of the engine are shown in Table 2. A single cylinder four stroke water cooled diesel engine was combined to an eddy current dynamometer with a

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load cell. The eddy current dynamometer is used to feed load to the system. The In-cylinder pressure was measured by piezoelectric pressure transducer built-in on the engine cylinder head. A crank angle encoder be situated to sense the crank position. Exhaust gas analyser was executed using five gas exhaust analyzer (AVL make). AVL 437 smoke meter was attached to exhaust pipe to measure smoke levels.

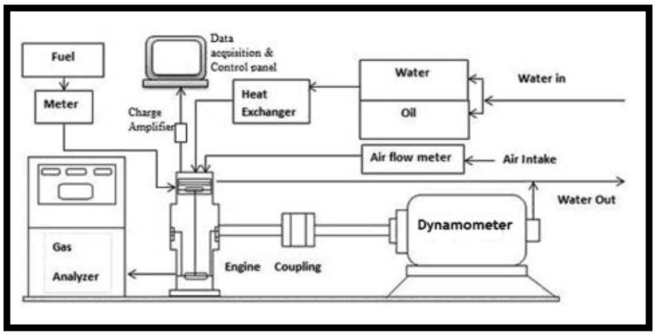

Fig.1 Experimental set-up of VCR Engine

Table 2: Engine specifications

Manufacturer	Kirloskar engines Ltd, Pune, India
Engine Type	Four stroke, single cylinder, constant speed, compression ignition engine
Rated power	3.7 kW at 1500 RPM
Bore	87.5 mm
Stroke	110 mm
Swept volume	661 cc
Compression Ratio	12 to 18
Mode of injection	Direct injection
Cooling system	Water
Dynamometer	Eddy current dynamometer

2.1 Fuel Property Measurement

The development in the performance of the CI engines, over the past century, has resulted from the complimentary refinement of the engine design and fuel properties. Calculating the fuel properties such as flash point, fire point, specific gravity, calorific value for different oils for different blends using the suitable equipment. Several of the fuels properties consist of are Flash point Fire point Specific gravity Calorific value Viscosity Carbon residue.

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Table 3: Properties of diesel fuel

Cetane number	53
Density at 30 °C	836 kg/m^3
Viscosity at 40°C	2.68 mm^2/ s
Calorific value	42500 KJ/ Kg

(a)

(b)

Fig: 2 (a) 4- Stroke diesel engine (b) Dynamometer

III. PERFORMANCE

The performance test was conducted on Single cylinder 4-stroke diesel engine with water cooling, constant speed that is coupled to break dynamometer. Initially the engine was tested with Pure Diesel and later on with

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different blends of the SOME and TOME with Diesel were prepared, analyzed and compared with diesel fuel, and comparison was made to recommend the better possibility among Bio Diesel blend, but its Diesel blends showed affordable efficiencies. different engine performance parameters like Brake Power, Brake Thermal efficiency, BSFC, IP, CV, Mechanical efficiency etc. were determined and results were plotted with respect to load.

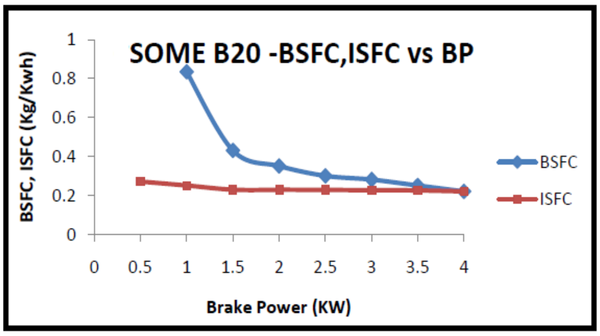

Fig. 3: Variations of SOME C20-BSFC, ISFC v/s BP

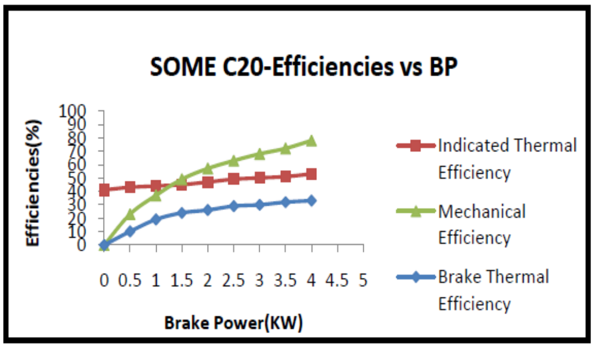

Fig 4: Variations of SOME B20-EFFICIENCIES v/s BP

IV. RESULTS AND DISCUSSION

From the results obtained from experiments of Diesel and its blends the graphs were plotted with respect to load.

5.1 Fuel Consumption

The fuel consumption characteristics of an engine are generally expressed in terms of specific fuel consumption in kilograms of fuel per kilowatt-hour. It is an important parameter that reflects how good the engine performance is. It is inversely proportional to the thermal efficiency of the engine.

- Sfc = Specific fuel consumption per unit time/power

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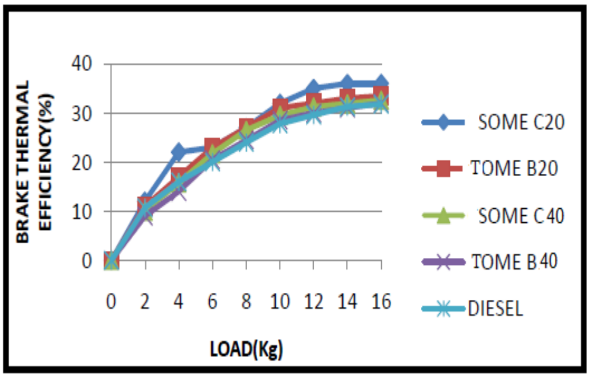

Fig 5: Variations of BSFC v/s Load of SOME & TOME blends with Diesel

From the above plot, it is observed that the brake specific fuel consumption (BSFC) for SOME and TOME with Diesel are decreasing and these blends were giving better values as compared to the diesel fuel.

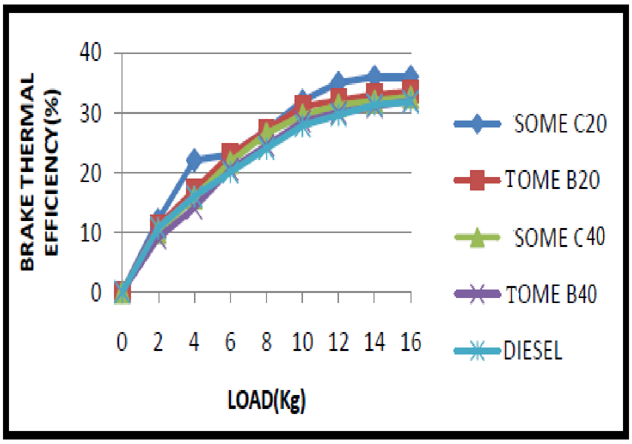

Fig 5: Variations of Brake Thermal Efficiency v/s Load of SOME & TOME with Diesel

From the plot, it is indicated that the Brake Thermal efficiencies of SOME and TOME are slightly higher values as compared the Diesel because of complete combustion.

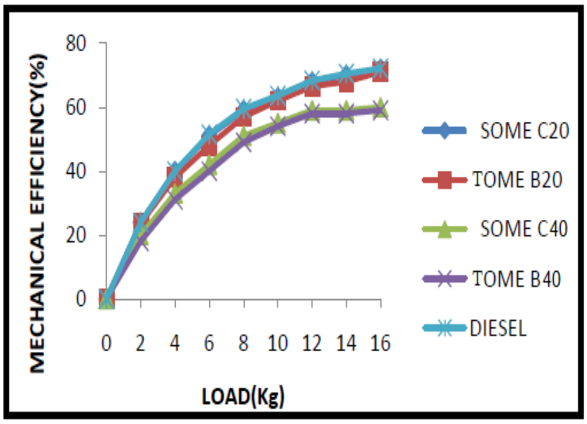

Fig 6: Variations of Mechanical Efficiency v/s Load of SOME & TOME with Diesel

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From the plot it is observed that Mechanical efficiency in case of Diesel with SOME & TOME blends has been found that the mechanical efficiency is on par when compared to Diesel but a slight drop of efficiency was found with methyl esters (bio-diesel) when compared with diesel. This drop in thermal efficiency must be attributed to the poor combustion characteristics of methyl esters due to high viscosity. It was observed that the brake thermal efficiency of SO20 and SO40 are very close to brake thermal efficiency of diesel. SO20 methyl ester had equal efficiency with diesel. Hence SO20 can be suggested as best blend for bio-diesel preparation.

V. CONCLUSION

In the current investigation, it has confirmed that SESAME and TUNG oil may be used as resource to obtain the bio diesel. The methyl esters of Sesame and Tung oil along with diesel may reduce the environmental impacts of transportation and also reduce the dependency on crude oil imports, and also provide employments in agricultural field. The conclusions are summarized as follows.

- There was increase in Brake Thermal Efficiency of SOME –S020 as compared to Pure Diesel because of complete combustion.
- It was observed that the smoke and emissions for the blends of SOME and TOME are less as compared to Pure Diesel.
- Properties of the 20% blend of SOME are nearer to the Diesel Fuel.
- Thus the above investigations suggest that blend of SOME – S020 is the optimum blend which can produce better values with Pure Diesel for Diesel engines as far as performance and emissions were considered.

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(COP), Clean Development Mechanism (CD M), Prototype Carbon Fund (PCF), Sustainable Development.

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