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STUDIES ON *SIMAROUBA GLAUCA* BIODIESEL AS AN ALTERNATIVE FUEL FOR DIESEL ENGINE

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ABSTRACT

Biodiesel is a non–toxic, biodegradable and renewable alternative fuel that can be used with little or no engine modifications. Biodiesel is currently expensive but would be more cost effective if it could be produced from low–cost non edible oils. The objective of this study was to investigate the effect of the biodiesel produced from non edible oils on engine performance and emissions. In this work, biodiesel was produced from *Simarouba glauca* oil using base catalyzed transesterification. The properties of the biodiesel was determined as per ASTM standards and compared with the diesel. From the property analysis, it is observed that the properties of the biodiesel are better than the raw oil and close to the diesel. From the engine tests, it is observed that the engine performance is close to the Diesel.

KEY WORDS : Vegetable oils, Simarouba glauca biodiesel, Properties, Engine performance

INTRODUCTION

The growth of national economy and energy consumption are closely related. It is clear that a growing economy will demand much higher levels of energy consumption. India is spending about U$ 53.37,108 per annum in foreign exchange on importing petroleum fuels due to the increasing gap between demand and supply of the petroleum products (Ganla and Chinchankar, 1989). Vegetable oils present a very promising alternative fuel to diesel oil due to their better properties compared to other alternative fuels such as ethanol and methanol (Sinhai and Rehman, 1994). Moreover, production of vegetable oils is very simple and economical in all agricultural countries like India.

Several studies (Barsic and Humke, 1981; Bandel and Heinrich) have shown that chemically unaltered vegetable oils are not suitable as a fuel for diesel engine. Investigations have been carried out on a variety of vegetable oils like Jatropha oil, Rice bran oil, Rape seed oil etc on diesel engines (Swami, 1997). Vegetable oils have cetane number of about 35 to 40 due to poor volality, which is lower than the minimum requirements in a diesel engine. As the oxygen content is higher in vegetable oil compared to diesel oil, the heating value of vegetable oil is about 10% lower than the diesel oil. Viscosity of vegetable oil derivatives is more comparable with those of diesel oil. Various techniques exist for the use of vegetable oil in CI engines such as vegetable oil – diesel blending, transesterfication to form methyl, ethyl or butyl ester etc. (Bandel and Heinrich; Akor *et al.,* 1983). The most commonly used ester is the methyl ester derived by the reaction between vegetable oils and methanol (Scholl and Sorenson, 1993).

Senthil *et al.* (2001) investigated the use of Methyl Ester of *Jatropha* oil as sole fuel for diesel engine. They concluded that Methyl esters of *Jatropha* oil could be used as sole fuel for diesel engine. Bari *et al.* (2002) used preheated crude palm oil as a fuel in a diesel engine. They demonstrated that preheating is essential for the smooth floe of fuel through the injection system studied the effect of injection pressure on the engine performance with rice bran oil as bio diesel.

Present Work

The Simarouba tree is indigenous to India, grow

1. Assistant Professor

even in draught prone area and found abundantly over several parts of India. These trees oils are non edible oils. Use of this oil as renewable alternative fuel will be a suitable substitute for diesel oil. Viscosity of these oils is high hence in the present work their methyl ester (biodiesel) was used.

Biodiesel of *Simarouba glauca* oil was prepared by transesterfication process. The important fuel properties of these biodiesels were determined experimentally in the fuel laboratory. This biodiesel was used as sole fuel in a four stroke direct injection diesel engine.

Preparation of biodiesel

The biodiesel was produced from the *Simarouba glauca* oil using base catalyzed transesterification. The molar ratio of oil to methanol used in this work was 6:1 and reaction time and reaction temperatures are 60 min and 60 °C, respectively. The mixture of reactants was then refluxed in a water bath at 65 °C using water cooled condenser and for another half an hour without water cooled condenser to remove excess methanol. Once the reaction was completed two major products, glycerol and methyl ester were obtained. The separated esters were than washed 3 – 4 times with warm water to wash of impurities like soap and other residues. Finally the methyl esters i.e., biodiesel was dried off using 10 grams of anhydrous sodium sulphates (Na_2SO_4).

Fig.1 shows the schematic of the experimental setup. The engine speed was kept constant at 1500 rpm. At steady state condition, load, fuel flow rate, air flow rate, speed and exhaust emissions such as UBHC, CO, CO_2, O_2, smoke and NOx were recorded. Then the load was varied from low load to full load.

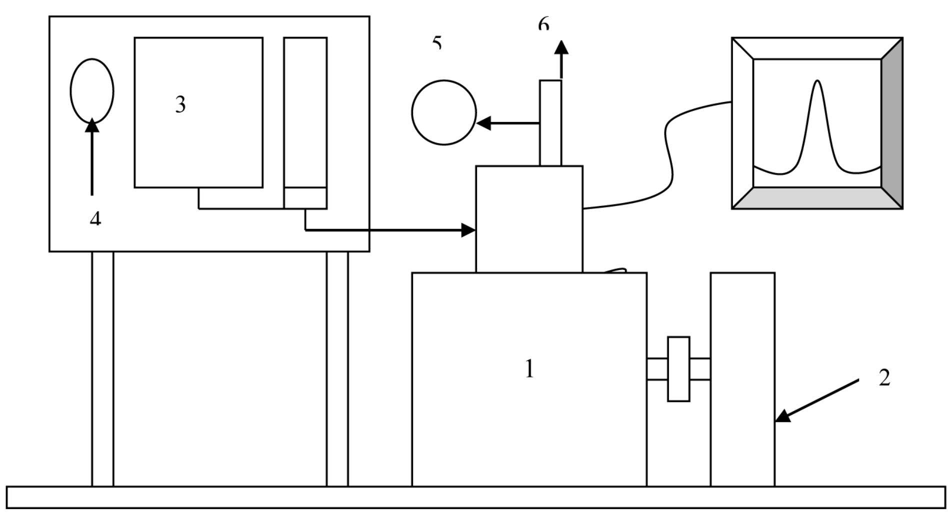
Table 1 shows the properties of *Simarouba glauca* oil biodiesel and diesel oil. The flash and fire points of *Simarouba glauca* oil biodiesel is lower than their vegetable oils. This lower flash and fire points result in better vaporization of the oil. The calorific value of the *Simarouba glauca* oil biodiesel is higher than their vegetable oils. This higher calorific value will result in higher heat release of the oil. The kinematic viscosity of the *Simarouba glauca* oil biodiesel is lower than their vegetable oil. This will result in better atomization of the oil. Hence vegetable oil biodiesel is having better fuel properties than their raw vegetable oil.

Table 1. Comparison of properties of biodiesel and diesel.

Sl. No .	Property	*Simarouba glauca* oil biodiesel	diesel
1.	Flash point (°C)	140	56
2.	Fire point (°C)	148	58
3.	Calorific value (kJ/kg)	41,300	42,500
4.	Kinematic viscosity at 40 °C (mm^2/s)	4.2	1.83
5.	Specific gravity at 40 °C	0.912	0.82
6.	Density at 40 °C (kg/m^3)	912	820

Engine testing for performance and emission characteristics

A single cylinder 4 stroke water cooled naturally aspirated direct injection diesel engine was used for



1. Engine 2. Eddy Current Dynamometer 3. Fuel Tank
4.Thermperature Indicator 5. Exhaust Gas Analyzer 6. Exhaust Gases

Fig. 1. Experimental Setup

the research work. Engine details are given in Table 2.

Engine performance

Biodiesels prepared from vegetable oil was successfully used as a sole fuel for diesel engine without any modification in the fuel injection system. Brake thermal efficiency is defined as the ratio of brake power to the heat supplied. This term is used to indicate the conversion of heat energy into useful mechanical power.

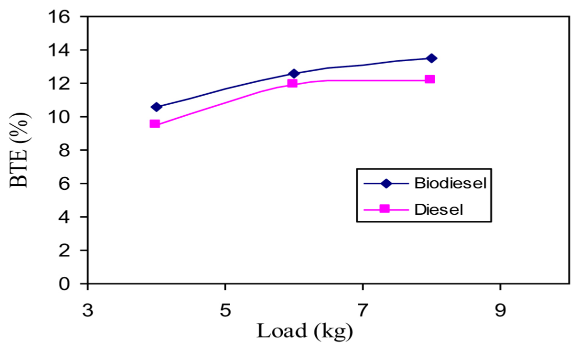


Fig. 2. BTE Vs Load

Table 2. Engine Details

Engine	4 – S, Single cylinder, water cooled engine
Make / Model	Kirloskar
Rated Power	5.2 kW at 1500 RPM
Bore X Stroke	80 mm × 110 mm
Compression Ratio	16.5: 1
Injection Timing	27^{o} before TDC

The variation of brake thermal efficiency with load is shown in Fig.2. From this figure, it is observed that the brake thermal efficiency of vegetable oil biodiesel is comparable to diesel oil.

Engine emission

The variation of smoke opacity for various loads is shown in Fig. 3. The biodiesel results in higher smoke emission as compared to neat diesel

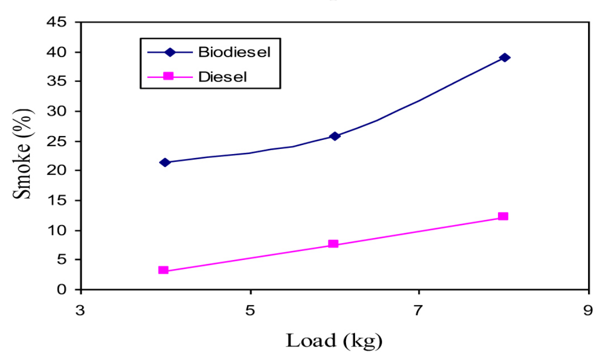


Fig. 3. Smoke Vs Load

operation. This may be due to higher kinematic viscosity of biodiesel.

Figure 4 shows the variation of Un-burnt hydrocarbon (UBHC) emission with load. It shows that the biodiesel results in higher UBHC emission as compared to diesel oil. The variation of CO emission with load is shown in Fig. 5. It also shows that the vegetable oil biodiesel results in lower CO emission as compared to diesel oil.

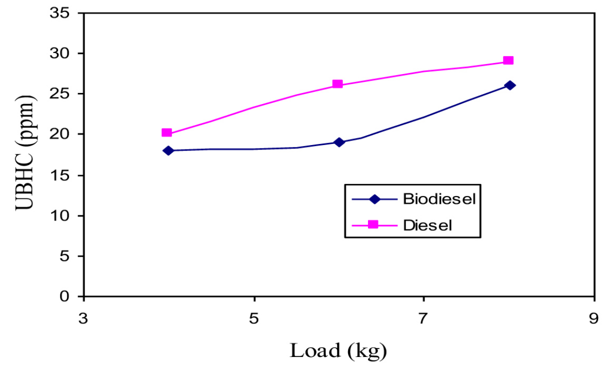


Fig. 4. UBHC Vs Load

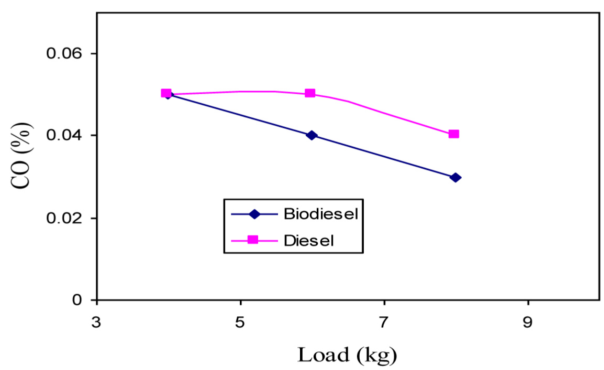


Fig. 5. CO Vs Load

CONCLUSION

Biodiesel was prepared from vegetable oil by transesterfication process. The biodiesel was used as sole fuel for 4 stroke diesel engine. The following conclusions are made based on the experimental results.

- The properties of vegetable oil biodiesels are better than raw oils.
- The properties of vegetable oil biodiesels are close to the properties of diesel oil.
- Engine works smoothly on *Simarouba glauca* oil with performance comparable to diesel operation.
- *Simarouba glauca* biodiesel result in lower smoke, UBHC and CO emissions as compared to diesel operation.

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