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PERFORMANCE TEST FOR LEMON GRASS OIL IN SINGLE CYLINDER DIESEL ENGINES

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ABSTRACT

Due to the concern on the availability of recoverable fossil fuel reserves and the environmental problems caused by the use of those fossil fuels, considerable attention has been given to biodiesel production as an alternative to petrodiesel. The two most common types of biofuels are ethanol and biodiesel. However, as the biodiesel is produced from vegetable oils and animal fats, there are concerns that biodiesel feedstock may compete with food supply in the long-term. Hence, the recent focus is to find oil bearing plants that produce non-edible oils as the feedstock for biodiesel production. In this project, plant species, Lemon grass (*Cymbopogan flexuosus*) is discussed as newer sources of oil for biodiesel production. Lemongrass is native to India and tropical Asia. In India, it is cultivated along Western Ghats (Maharashtra, Kerala), Karnataka and Tamil Nadu states besides foot-hills of Arunachal Pradesh and Sikkim i.e., it can be cultivated on wide range throughout India and may favor easy availability. This study investigates the performance of Lemongrass oil and its blends as fuel for a CI engine. The data thus generated were compared with the data obtained using diesel. The engine exhibited a very good performance without any problem of combustion. It is suggested that, Lemongrass oil and its blends can be used as an alternate fuel for diesel engine.

Keywords: lemon grass, petrodiesel, biodiesel.

INTRODUCTION

With petroleum prices soaring, people are looking for cheaper, renewable sources of fuel for their vehicles. India imported about 2/3rd of its petroleum requirements which involved a cost of approximately Rs. 80, 000 crores in foreign exchange. Even 5% replacement of petroleum fuel by bio-fuel can help India save Rs. 4000 crore per year in foreign exchange. The country has been hit hard by the increased cost and uncertainty and so is exploring other energy sources occurring bio-diesel extracted from trees is one such alternative under consideration. Bio-diesel burns cleaner than traditional petroleum diesel fuel and is biodegradable, making it an interesting alternative fuel option in terms of both environmental protection and energy independence. Bio-diesel would be cheap to produce as it can be extracted from certain species of tree that are common in many parts of India.

However, as the biodiesel is produced from vegetable oils and animal fats, there are concerns that biodiesel feedstock may compete with food supply in the long-term. Hence, the recent focus is to find oil bearing plants that produce non-edible oils as the feedstock for biodiesel production. Hence, the contribution of non-edible oils will be significant as a non-edible plant oil source for biodiesel production.

Bio-diesel fuels commonly available are really blends of bio-diesel and petroleum diesel. An important distinction needs to be made between bio-diesel and bio-diesel blends. Pure bio-diesel, also known as neat bio-diesel, is commonly noted as B100, indicating that the fuel has 100 percent biodiesel and 0 percent diesel. The most common bio-diesel blend is B20, which contains 20 percent biodiesel and 80 percent diesel.

In this project we produce bio-diesel from lemon grass oil and to compare the performance and characteristics of diesel engine using diesel and bio-diesel blends. Lemongrass (*Cymbopogan flexuosus*) is a native aromatic tall sedge (family: Poaceae) which grows in many parts of tropical and sub-tropical South East Asia and Africa. In India, it is cultivated along Western Ghats (Maharashtra, Kerala), Karnataka and Tamil Nadu states besides foot-hills of Arunachal Pradesh and Sikkim. Lemongrass is native to India and tropical Asia. Citronella grass (*Cymbopogon nardus* and *Cymbopogon winterianus*) grows to about 2 meters (about 6.5 feet) and has red base stems. These species are used for the production of citronella oil, which is used in soaps, as an insect repellent in insect sprays and candles.

The lemongrass essential oil is extracted from *Cymbopogon citrates*. The main chemical components of lemongrass oil are myrcene, citronellal, geranyl acetate, nerol, geraniol, neral and traces of limonene and citral.

EXPERIMENTAL APPARATUS AND METHODS

Transesterification of vegetable oil

In general, vegetable oil contains 97% of triglycerides and 3% di- and monoglycerides and fatty acids. The process of removal of all glycerol and the fatty acids from the vegetable oil in the presence of a catalyst is called transesterification. The vegetable oil reacts with methanol and forms esterified vegetable oil in the presence of sodium/potassium hydroxide as catalyst.

Transesterification is crucial for producing biodiesel from oils. The transesterification process is the reaction of a triglyceride (fat/oil) with a bioalcohol to form esters and glycerol. However; consecutive and reversible reactions are believed to occur.

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These reactions are represented in equations below:

Triglycerides + ROH= diglycerides + R1COOR (1)
Diglycerides + ROH = monoglycerides + R2COOR (2)
Monoglycerides + ROH = glycerol + R3COOR (3)

Catalyst is usually a strong alkaline (NaOH, KOH or sodium silicate) medium.
Alcohol + Ester → different alcohol + different ester

The first step is the conversion of triglycerides to diglycerides followed by the conversion of diglycerides to monoglycerides and of monoglycerides to glycerol yielding one methyl ester molecule from each glycerides at each step. Meher *et al*. reported that the experimental study revealed that the optimum reaction condition for methanolysis of karanja oil was 1% KOH as catalyst. MeOH/oil of molar ratio 6:1, reaction temperature 65°C, at the rate of mixing 360 rpm for a period of 3 h. The yield of methyl ester was >85% in 15 min and reaction was almost complete in 2 h with a yield of 97- 98% with 12:1 molar ratio of MeOH oil or higher, the reaction was completed within 1 h. The reaction was incomplete with a low rate of stirring, i.e., 180 rpm; whereas, stirring at high rpm was a time-efficient process.

Engine specification

Engine manufacturer	Kirloskar oil engines ltd
Bore and stroke	87.5 x 110 (mm)
Number of cylinders	1
Compression ratio	17.5: 1
Speed	1800 rpm
Cubic capacity	0.661 litres
Method of cooling	water cooled
Fuel timing	27º by spill (btdc)
Clearance volume	37.8 cc
Rated power	8 hp
Nozzle opening pressure	200 bars

Experimental test setup

The experimental setup consists of diesel engine, gas analyzer, brake drum, and Plenum chamber. The engine used in the investigation is a constant speed kirlosker engine, four stroke single cylinder, direct injection, vertical diesel engine.

The engine is mounted on concrete bed with suitable connection for water-cooling and lubrication. The outlet temperature of water from engine is maintained at 50°c by adjusting the flow of the coolant. The schematic arrangement of experimental test setup is shown in Figure-1.

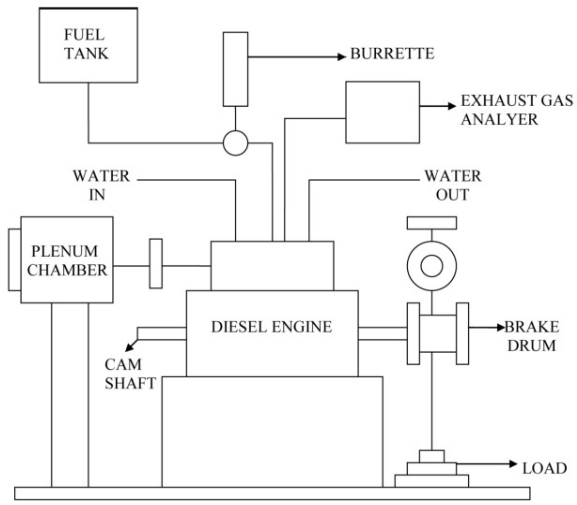

Figure-1. Experimental test setup.

RESULTS AND DISCUSSIONS

The comparison of performance characteristics of CI engine using diesel and blends of Lemongrass oil is charted. The graphs are plotted for the following characteristics:

- Load vs MFC
- Load vs SFC
- Load vs Brake thermal efficiency

Load vs MFC

The Mass Fuel Consumption is higher for biodiesel blends than diesel is shown in Figure-2. Diesel gives a better fuel efficiency. The graph shows that B20 values are closer to that of diesel.

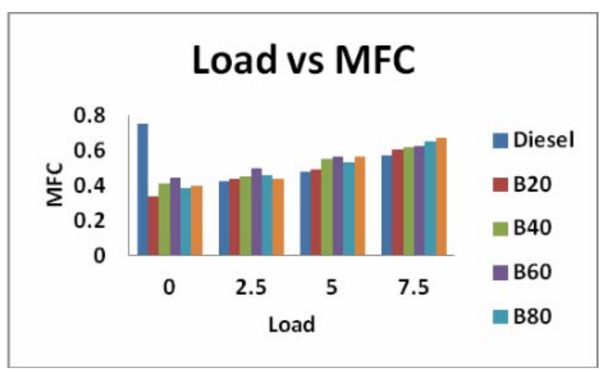

Figure-2. Load vs MFC.

Load vs SFC

The Specific Fuel Consumption for diesel is lower than all other biodiesel blends; hence the fuel efficiency of diesel is better is shown in Figure-3. Still B20 shows a closer range to diesel.

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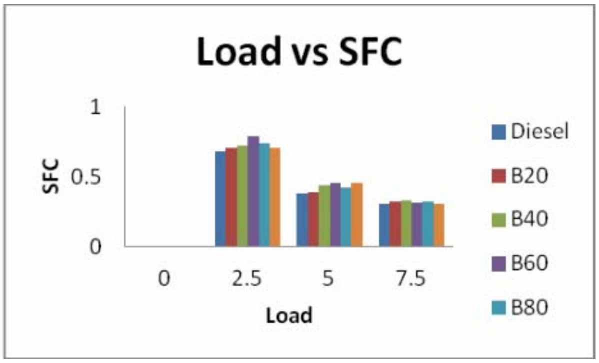

Figure-3. Load vs SFC.

Load vs brake thermal efficiency

Diesel shows a better brake thermal efficiency with load even though the biodiesel B100 shows closer values to diesel is shown in Figure-4.

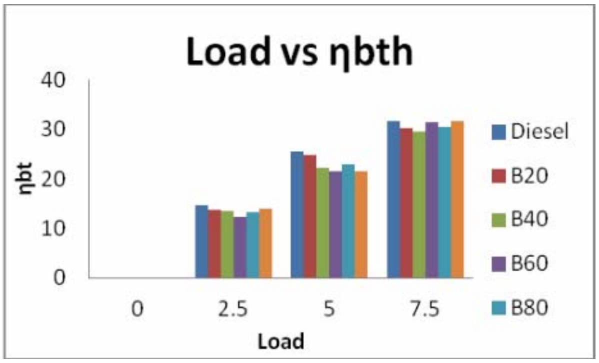

Figure-4. Load vs brake thermal efficiency.

CONCLUSIONS

Thus with the performance characteristics and results obtained,

- Production of Lemongrass oil is done successfully.
- The properties of Lemongrass obtained are closer to the diesel.
- The viscosity seems to be little higher than diesel.

Blends of Lemongrass oil was tested successfully in a single cylinder unmodified diesel engine. Test runs were also made with diesel in order to make comparative assessments.

Tabulations and calculations were done. Graphs were plotted for various efficiencies and performance parameters.

- The thermal efficiencies of the biodiesel are closer to that of diesel, even though diesel gives the better efficiency.
- B20 shows an indicated efficiency closer to diesel than any other blends of diesel used.
- Mechanical efficiency is almost same for all the biodiesel blends but is lesser than that of diesel.
- With the increase in load the fuel consumed by the engine while using diesel is lesser than when the biodiesel is used. And B20 shows better fuel efficiency than any other blends.

Thus with the performance characteristics and results obtained, it may be specified that Lemongrass oil, which is obtained from a wild grass scientifically called *Cymbopogan flexuosus* can be used as a fuel in diesel engine.

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