Characterization of Diesel Engine using Biodiesel (Calophyllum Inophyllum)

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Abstract—Influence of Calophyllum oil methyl ester blended with diesel as (B00, B10, B20, B30, B40, B50, B70 and B100). The quality parameters were determined as per standard procedure given by ASTM-6751. The characterization of fuel was carried out on single cylinder four stroke diesel engine. Parameter selected for study where compression ratio (in the range of 13 to 17) and load (in the range of 0 to 12 in kg). The engine performance parameters such as, brake specific fuel consumption, brake power, mechanical efficiency and exhaust emission (CO2 and HC) where evaluated. By observing B20 (20% Calophyllum oil + 80% diesel fuel) gives better performance as maximum efficiency with lower emission and CR15 gives better results for B20 blend.

Index Terms—Calophyllum Inophyllum, Biodiesel, Diesel engine, Performance, Emissions.

I. INTRODUCTION

Biodiesel is methyl or ethyl ester of fatty acid made from virgin or used vegetable oils (both edible and non-edible) and animal fat. The main sources for biodiesel production can be non-edible oils obtained from plant species such as Jatropha curcas (Ratanjyot), Pongamia pi nna (Karanja), Calophyllum inophyllum (Nagchampa), Hevca bra siliensis (Rubber) etc. Biodiesel can be blended in any proportion with mineral diesel to create a biodiesel blend or can be used in its pure form. Just like petroleum diesel, biodiesel operates in compression ignition (diesel) engine, and essentially requires very little or no engine modifications because biodiesel has properties similar to mineral diesel. It can be stored just like mineral diesel and hence does not require separate infrastructure. The use of biodiesel in conventional diesel engines results in substantial reduction in emission of unburned hydrocarbons, carbon monoxide and particulate. This review focuses on performance and emission of biodiesel in CI engines, combustion analysis, wear performance on long-term engine usage, and economic viability.

A. Calophyllum Inophyllum

Calophyllum inophyllum is a species of family Guistti fereae, native to India, East Africa, Southwest Asia, board leaved evergreen tree occurring as a littoral species along the beach crests. Although sometimes occurring inland and adjacent low land forest. Although wilding occur, it can be moderately difficult to propagate. Its slow growth and large seeds make it unlikely that the tree will become an invasive weed if introduced into new areas. Tree grow to height of 8-20 m (25 - 65ft), and also tree grows best in direct sunlight, but grows slowly. Annual yield of 20-100 Kg/tree of whole fruits have been reported. Trees begin to bear significantly after 4-5 years. The nut kernel contains 50-70% oil and the mature tree may produce 1-10 kg of oil per year depending upon the productivity of the tree and the efficiency of extraction processes. A use of the total calophyllum inophyllum tree has got excellent medicinal properties.
II. PREPARATION OF CALOPHYLLUM BIODIESEL

A. Oil Extraction Process

Calophyllum Inophyllum Oil is extracted from the seeds of Calophyllum Inophyllum tree. In case of esterification processes, calophyllum oil is preheated at different temperature and then the solution of sulfuric acid and methanol is added to the oil and stirred continuously at different temperature. After separation, the remaining product was further used for transesterification to obtain methyl esters. The calophyllum oil was converted to methyl ester by transesterification.

<table>
<thead>
<tr>
<th>Sr.no.</th>
<th>Parameter</th>
<th>Calophyllum Oil Methyl Ester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density (gm/cc), 15°C</td>
<td>0.892</td>
</tr>
<tr>
<td>2</td>
<td>Kinematic viscosity (cSt), 30°C</td>
<td>3.87</td>
</tr>
<tr>
<td>3</td>
<td>Flash Point (°C)</td>
<td>176</td>
</tr>
<tr>
<td>4</td>
<td>Fire Point (°C)</td>
<td>182</td>
</tr>
</tbody>
</table>

B. Preparation of Blends and Properties of Calophyllum Inophyllum Biodiesel

Blends of biodiesel and conventional hydrocarbon-based diesel are products most commonly distributed for use in the tail diesel fuel market place. Much of the world uses as system known as the "B" factor to state the amount of biodiesel in any fuel mix.

- 0% biodiesel, 100% Diesel is labeled B00
- 10% biodiesel, 90% Diesel is labeled B10
- 20% biodiesel, 80% Diesel is labeled B20
- 30% biodiesel, 70% Diesel is labeled B30
- 100% biodiesel, 0% Diesel is labeled B100

III. EXPERIMENTAL SET-UP

The experimental setup consists of single cylinder, four strokes, diesel engine connected to eddy current dynamometer for variable loading. The set as stand-alone type independent panel box consisting of air box, fuel tank, manometer etc. The set up enables study of engine for brake specific fuel consumption, brake power, mechanical efficiency, and emission characteristics like CO₂ and HC.

The various components of experimental set up are described. Fig.3.1 shows Schematic of setup and fig.3.2 shows the Actual experimental setup. The important components of the system are- CI engine, eddy current dynamometer, calorimeter, pressure sensor, temperature sensor, software- national instrument, gas analyzer- Airrex HG540.

Table 3.1 Specification of the engine
<table>
<thead>
<tr>
<th>Make</th>
<th>Kirloskar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Engine</td>
<td>Four stroke, single cylinder, CI diesel engine</td>
</tr>
<tr>
<td>Speed</td>
<td>1500 rpm</td>
</tr>
<tr>
<td>Bore</td>
<td>87.5 mm</td>
</tr>
<tr>
<td>Stroke</td>
<td>110 mm</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>17.5</td>
</tr>
<tr>
<td>Method of cooling</td>
<td>Water cooled</td>
</tr>
</tbody>
</table>

IV. RESULTS

Test is to be carried out on different loading condition (0 to 12 kg) and different compression ratio (13 to 17) for various blends (B00, B10, B20, B30, B40, B50, B70 and B100). It is shows that B20 blend gives efficient performance with lower emission (CO₂ and HC). Different characteristics shown below for B20 as-

- **Brake specific fuel consumption (BSFC)**

It is observed from graph at lower load condition, BSFC is maximum and after its decreases with increase in load. Also BSFC is optimum for high load condition. Compression ratio (CR15) gives minimum brake specific fuel consumption (BSFC).

- **Brake power (BP)**

It is observed that increase in load, increases the brake power also for compression ratio (CR 15) graph shows maximum brake power than other compression ratio (CR) values.

- **Mechanical efficiency**
It is observed that increase in load with respect to mechanical efficiency increases. At compression ratio (CR15) gives maximum mechanical efficiency at load (6 kg).

d) Carbon dioxide ($CO_2$) emissions

Emission of $CO_2$ at various compression ratios and with different load of blended fuel (B20) was studied. As load increases $CO_2$ content increases but for compression ratio (CR15) gives minimum than other compression ratio (CR).

e) Hydrocarbon (HC) emissions

Emission of HC at various compression ratios and with different load of blended fuel (B20) was studied. As graph shows lower emission for CR15 than other compression ratio (CR) values.

V. CONCLUSION

The experiment was conducted at variable compression ratio with different load conditions. The performance and emissions conclusion drawn as below,

- B20 blend gives optimum performance (BP, Mechanical efficiency, BSFC) with lower emission ($CO_2$ and HC) and it is considered as best blend.
- CR15 is best compression ratio (CR) for diesel engine with B20 fuel and it is observed lower emission rate at CR15.
- Also load (6 kg) gives optimum performance (BP and Mechanical efficiency) and it is considered as best load.

REFERENCES


