Performance Analysis of CI Engine using Pungam Biodiesel as an Alternative Fuel

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Abstract— Biodiesel is an alternative fuel of diesel, is described as fatty acid methyl ester from vegetable oil or animal fats. The main objective of our project is to reduce higher viscosity of pungam oil by Transesterification and to increase the performance and emission characteristics of diesel engine. By using the biodiesel from pungam oil, the performance test of biodiesel blend (B5, B10, B15, B20, B25, B30) in 650 rpm mechanical loaded CI engine is tested. By using different blends we have identified the engine parameters such as brake thermal efficiency, specific fuel consumption, and mechanical efficiency. In this finally we have resulted which blend is better and which consumes less fuel.

Key words: C.I Engines, Transesterification, SFC, BTE, BMEP

I. INTRODUCTION

Biodiesel is defined as a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. Biodiesel is typically created by reacting fatty acids with an alcohol in the presence of a catalyst to produce the desired mono-alkyl esters and glycerin. After reaction, the glycerin, catalyst, and any remaining alcohol or fatty acids are removed from the mixture. The alcohol used in the reaction is typically methanol, although ethanol and higher alcohols also have been used. The main advantage of using biodiesel is to reduce dependence on imported petroleum and to lower net greenhouse-gas emissions. Biodiesel typically has improved lubricity and ignition quality relative to diesel fuel. And also biodiesel is renewable; that is it is not a fixed resource like fossil fuels that could be completely consumed. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulphur and aromatics. It is usually used as petroleum diesel additive to reduce levels of particulates, carbon monoxide, hydro carbons and toxics from diesel powered vehicles. When used as an additive, the resulting diesel fuel may be called B5, B10 or B20, representing the percentage of the biodiesel that is blended with petroleum diesel. There are variety of oils that are used to produce biodiesel, the most common ones being pongam, soybean, rapeseed, and palm oil which make up the majority of worldwide biodiesel production. Other feedstock can come from waste vegetable oil, jatropha, mustard, flax, sunflower, palm oil or hemp. Biodiesel can be blended in any proportion with mineral diesel to create a biodiesel blend or can be used in its pure form. Biodiesel is gaining more and more importance as an alternative fuel due to the depletion of petroleum resources and price hike of petroleum products. The chemical reaction that converts a vegetable oil or animal fat to biodiesel is called “Transesterification”. This is a long name for a simple process of combining a chemical compound called an “ester” and an alcohol to make another ester and another alcohol. The term “biodiesel blend” refers to a blend of pure biodiesel with petrol-diesel, typically represented by the letter B followed by a number. The number refers to the volumetric percentage of biodiesel. Biodiesel can be used in standard diesel engines in any percentage from B5, which is 5% biodiesel mixed with 95% petrol known as B5. Thus different blends are tested in 650rpm CI engine the engine performance are represented in graph and better blend result is noted as final result.

II. LITERATURE REVIEW

P. L. Naik and D.C.Katpatal (2013) was investigated the Performance Analysis of CI engine using pongamia pinnata (karanja) Biodiesel as an Alternative fuel. The main objectives of the work is reduce the higher viscosity of pongam oil using the esterification process followed by the transesterification process. The important property of fuel such as density, viscosity, flash point and calorific value of pungam biodiesel are compare to the diesel properties & find the performance and emission characteristics of diesel engine such as specific fuel consumption, mechanical efficiency, thermal efficiency for the different blends (B10, B20, B30) for the various loads and the result of this investigation the B20 biodiesel gives the better performance without any modification of diesel engine.

A.Patel, R. Patel, M. Patel and P.Rathod (2016) was researched the Performance Analysis of Four Stroke Single Cylinder CI Engine Using Karanja Biodiesel-Diesel Blends. In this project work the opportunities of utilizing 100% pure karanja biodiesel and increasing the chance of using the Karanja Biodiesel-Diesel in the diesel engines. In this research the blends of Karanja Biodiesel-Diesel is K10, K20, K40, K60, K80 and pure Karanja Biodiesel are taken and the load varies 1.3,5,7 and 9kg & the results are compared to the performance of the diesel fuel from the research the K20 Biodiesel blend gives the more performance with lesser fuel consumption.

N.Stalin and H .J. Prabhu (2007) was studied the Performance Test of IC Engine Using Karanja Biodiesel Blending with Diesel. The constant increase of the cost of the diesel and consider the environmental advantages the biodiesel are used as an alternate fuel. The Biodiesel from the karanja oil was produced by the alkali catalyzed transesterification process and the experiment done on the proxy brake-diesel engine setup, using the duel fuel the specific fuel consumption, mechanical efficiency, thermal efficiency are calculated. The result indicates B40 was used as the alternate fuel in diesel engine without any modification. The cost of the B40 duel fuel is lesser than the pure diesel.

Venkata Ramesh Mamilla, M.V.Mallikarjun, Dr. D. Lakshmi Narayana Rao (2008) was studied the Preparation of Biodiesel from Karanja oil. Biodiesel was prepared from the
non-edible oil pungam by transesterification of the oil with methanol in the presence of NaOH as catalyst. A maximum conversion of 92% (oil to ester) was achieved at 60°C. Important fuel properties of biodiesel produced from karanja oil like viscosity, flash point, fire point, calorific value are measured and compare to the exist.

Gaurav Dwivedi, M. P. Sharma (2013) was researched the Performance Evaluation of Diesel Engine Using Biodiesel from Pongamia Oil. In the cost of fuel, the search for alternative fuels has become more important, looking a huge demand of diesel for transportation, power generation and agricultural sector, the biodiesel is effective substitute of diesel. The aim of the present work is production of biodiesel from pungam and the properties of various blends of Pungam biodiesel. The main problem with biodiesel is its higher viscosity than diesel. The higher content of viscosity leads to formation of gums in the biodiesel which will affect its performance. The results are also compared with the Jatropha curcas biodiesel and Waste cooking biodiesel. The research has indicated that up to B20, there is no need of any modification. From the test result reduction of CO emissions is reduced and the increase in fuel consumption and the increase in NOx emission on conventional diesel engine. So the pungam biodiesel is alternate to diesel in future.

Sanjay Mohite, Sudhir Kumar, Sagar Maji (2016) was Experimental Studies on use of Karanja Biodiesel as Blend in a Compression Ignition Engine. Karanja oil (Pongamia Pinnata) is non edible in nature and is available in India. An experimental investigation was made to evaluate the performance, emission characteristics of a diesel engine using different blends of methyl ester of karanja with diesel Karanja methyl ester was blended with diesel in proportions of 5%, 10%, 15%, 20%, 30%, 40%, 50% and 100% by mass and studied under various load conditions in a compression ignition (diesel) engine. The performance parameters were found to be very close to the diesel. The brake thermal efficiency and mechanical efficiency were better than diesel for some specific blending ratios under certain loads. The emission characteristics were also studied and levels of carbon dioxide, carbon monoxide, nitric oxide and hydrocarbons were found to be higher than pure diesel.

III. EXPERIMENTAL PROCEDURE

A. Methods of preparation of biodiesel

1) Decoking Process
Decoking is the process of using 1 litre of raw pungam oil is heated at 70°C with 2ml of orthophosphoric acid (H3PO4) with constant stirring and then pour in the filter. After few hours the treated oil will be separated as layer should be drain and again the top layer is used for another treatment.

2) Esterification
The oil from the decoking process should be treated again with 125ml of ethanol and 2ml of conc. sulphuric Acid (H2SO4) is heated at 65°C for 2 hours with constant stirring and then pour in the filter the layers will be separated and bottom layer should be drain and again the top layer is used for another treatment.

3) Transesterification
The oil from the esterification process should be treated with 15ml of ethanol and 4.5g of potassium hydroide (KOH) is heated at 65°C for 2 hours with constant stirring and then pour is the filter the layers will be separated and bottom layer should be drain and again the top layer is used for another treatment.

4) Hot Water Treatment
Transesterified crude bio-diesel is mixed with 50°C hot water will remove the remaining impurities in the biodiesel and the bio diesel will heat 110°C will remove the water content in the pure diesel

B. Experimental Setup

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<table>
<thead>
<tr>
<th>Parts of the CI engine</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Engine make</td>
<td>Top land</td>
</tr>
<tr>
<td>2) Power(bp)</td>
<td>4.4kw</td>
</tr>
<tr>
<td>3) Speed(n)</td>
<td>650rpm</td>
</tr>
<tr>
<td>4) Bore(b)</td>
<td>80mm</td>
</tr>
<tr>
<td>5) Stroke(sl)</td>
<td>110mm</td>
</tr>
<tr>
<td>6) Type of lubrication</td>
<td>Water cooled</td>
</tr>
<tr>
<td>7) Fuel used</td>
<td>Diesel</td>
</tr>
<tr>
<td>8) Circumference of brake drum</td>
<td>300mm</td>
</tr>
</tbody>
</table>

Table 1: Engine Specifications

IV. EXPERIMENTAL PROCEDURE

The experimental set up consists of a single cylinder, four stroke, constant speed, water cooled, direct injection compression ignition engine with hemispherical open combustion chamber developing 4.4 kw at 650 rpm. The engine has a bore of 80 mm, stroke of 110 mm and a compression ratio of 16.5. The fuel injection system of the engine comprised of a plunger type pump with an injector having three spray holes, each 0.28 mm diameter. The injector needle lift pressure and fuel injection timing of the engine were 185 bar and 27°b TDC respectively. The engine was coupled to an electrical generator and loaded by variable resistance loading bank. This type of engine is widely used as a prime-mover for operating water pumps in rural farms and the same model engine is be fitted for small electric power generation systems. Thermocouples were used to measure the inlet and outlet temperature of cooling water.
V. RESULT AND DISCUSSION

According to the observed data from the experiment the calculations are done & using Graphical method the different performance characteristics of IC diesel engine like specific fuel consumption, mechanical efficiency and thermal efficiency, brake mean effective pressure, indicated mean effective pressure for different blends of pungam biodiesel – diesel with varying load is being done (0 %, 25 %, 50 %, 75 %, 100 % of full load condition).

A. Specific Fuel Consumption

The variations of brake power with specific fuel consumption under various blends of pungam biodiesel are shown in fig 2. From the above graph it is clear that D100 requires high fuel consumption than the blends and also B25 requires low fuel consumption.

![Fig. 2: Variations of brake power with specific fuel consumption](image)

B. Mechanical Efficiency

The variations of brake power with mechanical efficiency under various blends of pungam biodiesel are shown in fig 3. From the above graph it is clear that B25 requires high mechanical efficiency than D100.

![Fig. 3: Variations of brake power with mechanical efficiency](image)

C. Thermal Efficiency

The variations of brake power with thermal efficiency under various blends of pungam biodiesel are shown in fig 4. From the above graph it is clear that B25 requires high thermal efficiency than D100.

![Fig. 4: Variations of brake power with thermal efficiency](image)

D. Brake Mean Effective Pressure

The variations of brake power with brake mean effective pressure under various blends of pungam biodiesel are shown in fig 5. From the above graph a brake mean effective pressure is equal for all blends.

![Fig. 5: Variations of brake power with brake mean effective pressure](image)

E. Indicated Mean Effective Pressure

The variations of brake power with indicated mean effective pressure under various blends of pungam biodiesel are shown in fig 6. From the above graph indicated mean effective pressure is low for B25

![Fig. 6: Variations of brake power with indicated mean effective pressure](image)

VI. CONCLUSION

1) Pungam biodiesel fuel seems to have a potential to use as alternative fuel in diesel engines. Blending with diesel reduces the viscosity considerably.

2) The fuel consumption of all blend is slightly more than the diesel at all varying loads. But B25 pungam biodiesel blend has considerable lesser fuel consumption than all among blends and diesel at lower loading conditions.

3) And also pungam biodiesel gives more mechanical efficiency than other blends. From the above discussion it is very clear that B25 requires more mechanical efficiency than diesel(D100)

4) Pungam biodiesel requires more thermal efficiency when compared with diesel, from the blends it is clear that B25 has more thermal efficiency than diesel(D100)

5) So we have discussed from the above results that B25 is better than from the other blends.

REFERENCES


