PERFORMANCE CHARACTERISTICS OF BIODIESEL USING RICE BRAN OIL ON 4 STROKE SINGLE CYLINDER DIESEL ENGINE

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ABSTRACT

Day by day biofuels are gaining importance because of depletion of fossil fuels and because of energy security. Replacement of biofuels to the regular conventional fuels is one of the valuable methods to attain better performance as well as to reduce unwanted emissions. In the Present paper rice bran oil is selected as a biofuel and conducted series of experiments to measure the Performance characteristics. From the results, it is clearly seen that performance improves slightly with the usage of rice bran oil and shows beneficial nature in reduction of emission characteristics which is logical to observe. It is observed that NOx emissions for B30 biodiesel is 20ppm less than that of Diesel and for B15 biodiesel it is 10ppm less than diesel. Unburnt HC is nearly 40ppm less for B30 compared with diesel and 10ppm less for B15 biodiesel. For B30 biodiesel CO emissions is 1% less than that of diesel and for B15 biodiesel CO emissions is 0.5% less than diesel. Reduction of emissions is due to better combustion and low friction with higher lubrication because of high viscosity and stability.

Key words: Biodiesel, diesel, esterification, KOH pallets, methanol, rice bran, transesterification

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1. INTRODUCTION

1.1. Biodiesel

Biodiesel means combination of oil with diesel to form a fuel by using transesterification process. When the triglycerides of oils react with alcohol it leads to form Alkyl ester and glycerol. To overcome the pollution and reduce the usage of coal and fossil fuels has led to research on secondary fuels or alternate fuels like biodiesels. This alternative fuel revolution started in the 19th century. The utilization of biodiesel lead to reduction of pollutants. The pollutants are reduced by 50% compared to fossil fuels. In biodiesel, blend is used most commonly. Blend means mixing of one oil with another oil. For preparation of biodiesel, vegetable oils like soybean oil, palm oil, sunflower oil, rice bran oil, rape seed oil are used. As the oils are produced from natural seeds, more impurities are presented in the oil. Very minute filters are used for purification of oil. Cleaning the oil is very important because it leads to blocking of engine. Some special designs are made to the engines for the usage of biodiesels more effectively. But it is used because the biodiesel is cheaper than fossil fuels. Most of the properties are higher for biodiesel due to more oxygen content in it. According to the ASTM D7467 specifications, the biodiesels are compactable in any diesel engine with slight modifications but the blends must be in the range of B6 to B20. After completion of World War 2 the biodiesel became main sources of fuels for France, Belgium, United Kingdom, Portugal, Germany and Italy. In present, the usage of biodiesel in India is increasing day to day. Many NGO’s are working for educating the people for the usage of biodiesels.

1.2. Rice Bran

Rice is abundantly available in Southeast Asian countries like India, Sri Lanka, Indonesia, etc. Half of the world population depends on rice. Rice bran is the by-product obtained after the milling of rice. Rice bran is kernel of the rice. It is generally between 6 to 10 mm long and easily removed during milling process. At present, in India rice bran has no major use. Most of the rice bran is burnt or dried out. By effectively using the rice bran to make the oil, we can use it as cooking oil as well as preparing biodiesel. Oil is extracted from rice bran and used for household purposes. Rice bran oil contains high Oxygen (O2) content which leads to good combustion of fuels when blended.

2. LITERATURE REVIEW

M Sarveshwar Reddy, Nikhil Sharma, Avinash Kumar Agrawal conducted an experiment on karanja (K20,K5), jatropha (J20,J5) , biodiesel blend(B20,B5), baseline mineral diesel in a non-firing engine fuel injector equipment simulator. The dimensional loss, weight loss and surface texture variations of bio diesel are measured using optical microscopy before and after the endurance test was compared. And stared that Biodiesel and Vegetable Oil such as Jatropha and Karanja blends provide superior fuel lubricity and reduce engine wear. However higher blends can cause operational issues related to injector coking, poor combustion and emission characteristics.

S SanthuPrabhu, M A Ashokan, Rahul Roy, Steff Francis, M.K.Sreelkeh conducted an experiment on waste cooking oil with Butylated hydroxytoluene (BHT) and n-butanol as additive which was made as biodiesel and was used in diesel engine. Further the release rate of heat of B20, B30+BHT, B40 are almost equal to diesel fuel. BHT+B30 blend found that B.S.F.C of this fuel is 7.3% higher than that of diesel and BTE is 4.6% lower than that of diesel. But for higher blends the B.S.F.C and BTE decreases constantly.

T Umesh, Manjunath H N, Rukmangadha P and Dr. Madhu conducted an experiment on 4 stoke single cylinder CI engine stating that B20 blend has better performance characteristics.
than any other fuels. According to the test he said that emission levels of HC, NOx & CO2 emissions decreased with increase in blending percentages. At last he concluded that B20 has maximum brake thermal efficiency and minimum specific fuel consumption. The experiment also added that there is an increase in oxygen content in biodiesel than that of diesel. For B40 and B50 blends there is a decrease in hydro carbons and also carbon dioxide emissions. NOx is reduced at all blends for all loads which reduces the pollution.

3. MATERIALS AND METHOD

3.1. Materials
Rice bran oil is available in the local market. Methanol is purchased from the scientific store near the college. The experiment is conducted on the 4 Stroke single cylinder Diesel engine available at VR Siddhartha College of Engineering in Vijayawada. The emission analysis equipment is also available in the college.

3.2. Properties of Diesel and Biodiesel

<table>
<thead>
<tr>
<th>Fuel properties</th>
<th>Rice bran oil biodiesel</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (gm/cc)</td>
<td>0.872</td>
<td>0.831</td>
</tr>
<tr>
<td>Viscosity</td>
<td>4.81</td>
<td>3.21</td>
</tr>
<tr>
<td>Flash point(°C)</td>
<td>157</td>
<td>76</td>
</tr>
<tr>
<td>Cetane number</td>
<td>51.6</td>
<td>47.2</td>
</tr>
<tr>
<td>Calorific value(KJ/KG)</td>
<td>41382</td>
<td>44585</td>
</tr>
</tbody>
</table>

3.3. Preparation of Biodiesel
Transesterification process is generally used for preparing biodiesel. The rice bran oil is taken into a measuring jar and heated continuously till it reaches 600°C. Then Methanol is added at regular intervals in specified amount. The oil is heated and stirred continuously for 2 hours and KOH pellets are added for speeding up the reactions. Then the oil is allowed to settle for 48 hours. After settling, Glycerol is formed on the top of the oil due to density difference. The glycerol is separated carefully without spilling out the oil.

3.4. Blending of Oil and Diesel
The oil is mixed with diesel in definite proportion and stirred till it is mixed thoroughly. For obtaining B15 biodiesel, 85% of diesel is mixed with 15% of oil. Similarly, for B30 biodiesel 70% of diesel is mixed with 30% of oil.

3.5. Experimental Engine Setup
The engine consists of single cylinder and a dynamometer. The exhaust pipe is connected to the smoke analyser for calculating the emissions.

3.6. Engine Specifications
4-STROKE SINGLE CYLINDER DIESEL ENGINE
- SPEED: 650rpm
- BHP: 6hp
- BORE: 110mm
- STROKE: 150mm
Here the tensions are acted as the loads for this engine.

The engine is filled with the fuel and started. Then the loads are set and the engine starts running. The smoke is analysed by analyser and values are noted down. The time taken for combustion of 20ml of fuel is noted where the flowrate of the fuel is constant. This experiment is conducted using Diesel, B15 biodiesel and B30 biodiesel.

4. RESULTS AND DISCUSSIONS

The performance and emission analysis of the diesel and biodiesel are conducted on the 4 stroke single cylinder diesel engine which runs at 650rpm for different loads. The results of fuel consumption, mechanical efficiency, thermal efficiency, mean effective pressure, specific fuel consumption, CO, NOx and unburnt HC emissions are analysed and the results are compared for diesel, B15 and B30 fuels.

4.1. Fuel Consumption

From chart-1, at 25% load fuel consumption for diesel is high compared to biodiesels because of complete combustion of biodiesels due to the presence of oxygen. At higher loads due to high calorific value in diesel the fuel consumption is more. At full load the fuel consumption of B30 biodiesel is 0.3 Kg/hr more compared to diesel.
4.2. Indicated Power

From the chart-2, it is observed that IP of diesel is more than biodiesel. Brake power is observed as constant for all three fuels at specific loads whereas the friction power is observed to be less for biodiesel as the oil blended with diesel acts as lubricant.

![Chart 2 Indicated power to load variation](image)

4.3. Mechanical Efficiency ($\eta_{mech}$)

From the chart-3, the mechanical efficiency of higher is more compared to diesel. As Indicated power is more for diesel mechanical efficiency of diesel is less.

![Chart 3 Mechanical Efficiency to load variation](image)

4.4. Thermal Efficiency

4.4.1. Brake Thermal Efficiency ($\eta_{bth}$)

From the chart-4, it is observed that the brake thermal efficiency is more for diesel. Friction power is not considered for Brake thermal efficiency. So it is observed that the efficiency is more for diesel. At small loads, the efficiency is almost equal for all the three fuels as the brake power is constant at same loads.
4.4.2. Indicated Thermal Efficiency ($\eta_{ith}$)
From the chart-5, diesel has higher efficiency compared to biodiesel blends. The efficiency is higher for diesel as the indicated power is more for diesel.

4.5. Indicated Mean Effective Pressure
From the chart-6, it is observed that the mean pressure is high for diesel. Indicated mean effective pressure depends on indicated power. So it is more for diesel as it has high indicated power.
4.6. Specific Fuel Consumption

4.6.1. Brake Specific Fuel Consumption
From the chart-7, it is justified that it is almost equal for diesel and biodiesel. Brake specific fuel consumption depends on brake power. Indicated power is not considered. So the friction is not considered. Hence, the bsfc is almost equal for all fuels at all loads.

.Chart 7 Brake specific fuel consumption to load variation

4.6.2. Indicated Specific Fuel Consumption
From the Chart-8, it is justified that the indicated specific fuel consumption is higher for higher blends of biodiesel. More fuel is consumed for biodiesel as the friction power is considered and due to high Oxygen content.

.Chart 8 Indicated specific fuel consumption to load variation

4.7. Carbon Monoxide (CO) Emissions
Carbon monoxide occurs due to the lack of oxygen content. If required amount of oxygen is available for combustion then the carbon monoxide forms into carbon dioxide. In biodiesel the oxygen content is more compared to diesel. So biodiesel emits less amount of Carbon monoxide. From Chart-9, at less load the CO emissions is almost equal for diesel and biodiesel. Whereas at higher loads the CO emissions is higher for diesel.
4.8. Unburnt Hydro Carbons (HC)

Presence of unburnt hydrocarbons in exhaust pipe indicates that the fuel is partially or not burnt. This may be due to the lack of adequate temperature and Oxygen content. From the Chart-10, biodiesel has less unburnt Hydro carbons compared to diesel.

4.9. NO\textsubscript{x} Emission

Presence of unburnt hydrocarbons in exhaust pipe indicates that the fuel is partially or not burnt. This may be due to the lack of adequate temperature and Oxygen content. From the Chart-10, biodiesel has less unburnt Hydro carbons compared to diesel.
5. CONCLUSION

By conducting experiment on 4 stroke diesel engine it is observed that NOx emissions for B30 biodiesel is 20ppm fewer than that of Diesel whereas B15 biodiesel emits 10ppm less than diesel. Unburnt HC is nearly 40 ppm less for B30 compared with diesel and 10ppm less for B15 biodiesel compared to diesel. For B30 biodiesel CO emissions is reduced by 1% of volume at full load compared to diesel. For B15 biodiesel CO emissions reduced by 0.5% compared to diesel. At 25 % load Indicated Specific Fuel consumption less for B30 and B15 because of the better combustion of biodiesels due to presence of O2 content in biodiesel but when the load increases ISFC increases. Mean effective pressure will be high for diesel because of the high calorific value for diesel. Indicated thermal efficiency is higher for diesel compared to B15 and B30. For B15, B30 Indicated thermal efficiency increases till 25% load and at high loads it decreases because of less fuel consumption till 25% load and high fuel consumption at higher loads. Mechanical efficiency is higher for B30 compared with diesel because the friction power is high for diesel.

REFERENCES


