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EXPERIMENTAL ANALYSIS OF MULTI-CYLINDER C.I. ENGINE BY USING RUBBER SEED OIL AS A BIO-DIESEL BLEND WITH DIESEL FUEL

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Abstract: It is clear from the above deliberations that, nowadays India is facing the twin problems of fast exhaustion of fossil fuels and environmental degradation. Hence, there is an urgent need to reduce dependence on petroleum derived fuels for better economy and environment. In this investigation raw rubber seed was crushed and esterified by which the viscosity is lowered. This esterified blend with pure diesel and injected into the constant speed direct injection Multi cylinder diesel engine without any modification in the engine. This biofuel was blended with diesel in various proportions, such as 20% (Biodiesel 20% + diesel 80%), 40%, 60%, on volume basis and named as B20, B40, B60. The performance and emission analysis were studied by maintaining the injection pressure and injection timing for different engine load conditions. From the test result, the performance characteristics such as, brake thermal efficiency (BTE) and brake specific fuel consumption (BSFC) were analyzed. The BTE was increased and the BSFC was decreased at a blend B20 when compared to the other biofuel blends. The emission analysis shows that the carbon monoxide (CO), nitric oxide (NOx) and unburned hydrocarbon (UHC) were decreased at B20 than that of the emissions corresponding to the other blend fuels.

Keywords: Multi cylinder diesel engine, rubber seed oil, performance and emission.

1. Introduction

The most promising biofuels, and closest to being competitive in current markets without subsidy, are ethanol, methanol, vegetable oils and biodiesel. Ethanol is used as fuel or as oxygenate to gasoline. Biodiesel is a derivative of vegetable oils and is made from virgin or used edible and non-edible vegetable oils and animal fats through a chemical process named trans-esterification. Biodiesel can be blended in any ratio with petroleum diesel fuel. Its higher Cetane number increases the combustion even when blended in the petroleum diesel. Forson F.K., and Oduro E.K (2004) conducted a test in a single-cylinder DI with water cooled engine operating on diesel fuel and blends of Jatropha oil in different proportions by volume basis. CO and CO_2 were same for all fuels (Diesel and blended fuels); the Jatropha fuel blend was observed to be the lower net contributor of CO, HC and smoke opacity whereas NO_x and brake specific fuel consumption were increased with different biodiesel fuel blends. Ismet Celikten et al (2010) investigated the 100% diesel (SD), 50% rapeseed oil

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methyl ester and 50% diesel (B1), 50% hazelnut oil methyl ester and 50% diesel (B2), 25% rapeseed oil methyl ester, 25% rapeseed oil methyl ester and 50% diesel (B3) were used in a four-cylinder, four-stroke, 46 kW, direct injection diesel engine. The study revealed that with the increase in rapeseed methyl in the blend, smoke and CO emissions were decreased, whereas NO_x and CO_2 emissions increased. Sahoo et al (2009) used Jatropha, Karanja and Polanga oil based methyl esters blended with conventional diesel having sulphur content less than 10 mg/kg with variable speed. Brake specific fuel consumptions for all the biodiesel blends with diesel increases with increase in biodiesel in the blends and decreases with speed. There is a reduction in smoke for all the biodiesel and their blends when compared with diesel. Frank Lujaji et al (2011) evaluated the effects of blends containing croton mogalocarpus oil (CRO)-Butanol (BU) diesel on engine performance, combustion, and emission characteristics in a four cylinder Turbocharged Direct Injection (TDI) diesel engine. The BSEC of blends was found to be high when compared with that of D2 fuel. The CO_2 and smoke emissions of the BU blends were lower in comparison to D2 fuel. Avinash Kumar et al (2009) investigated the effect of temperature on viscosity of Karanja oil. The results showed improvements in performance parameters and reduction in oxide of nitrogen, when lower blends were used with and without preheating. It was concluded that up to 50% by volume of Karanja oil blends with and without preheating could replace diesel. Su Han Park et al (2011) used exhibited unstable ignition characteristics because of higher ethanol blending ratio causing a long ignition delay and decrease in NO emissions due to the high heat of evaporation of ethanol, along with increased CO and HC emissions. Banapurmath N.R et al (2008) carried out experiments with direct-injection diesel engine operated with methyl esters of Honge oil, Jatropha oil and sesame oil. Engine performances in terms of higher brake thermal efficiency and lower emissions includes HC, CO and NO_X with sesame oil methyl ester operation were observed compared to methyl esters of Honge and Jatropha oil operation. Edwin Geo. V et al (2010) studied the performance, emission and combustion characteristics of a direct injection diesel engine fuelled with rubber seed oil. The BTE of the engine was improved from 26.5% with neat biodiesel to a maximum of 28.5% with DEE injection rate of 200 g/h. Smoke, hydrocarbon and carbon monoxide emissions were reduced with DEE injection at the maximum efficiency. Hossain. A.K and Davies. P.A (2012) tested a multi-cylinder water cooled CI engine with jatropha and karanja oils. Compared to fossil diesel, the BSFC was 3% higher for the plant oils and the brake thermal efficiency was almost similar which resulted in higher CO2 and NOx emissions by 7% and 8% respectively.

At full load, the plant oils gave around 3% higher peak cylinder pressure and 5% shorter combustion duration than fossil diesel.

2. Result and Discussion

2.1 Brake Thermal Efficiency

The Figure 1.1 shows the variation of BTE in percentage with varying Multi cylinder engine load for Biofuel with reference to the pure diesel fuel. From the experimental result, it is found that for the pure diesel fuel, the BTE is increased with the increase in load conditions. For the designed pressure of 220 bar and injection timing of 24°bTDC maintained at constant speed with variation in engine loads, the BTE for the diesel is increased from 0% to 25% at full load condition.

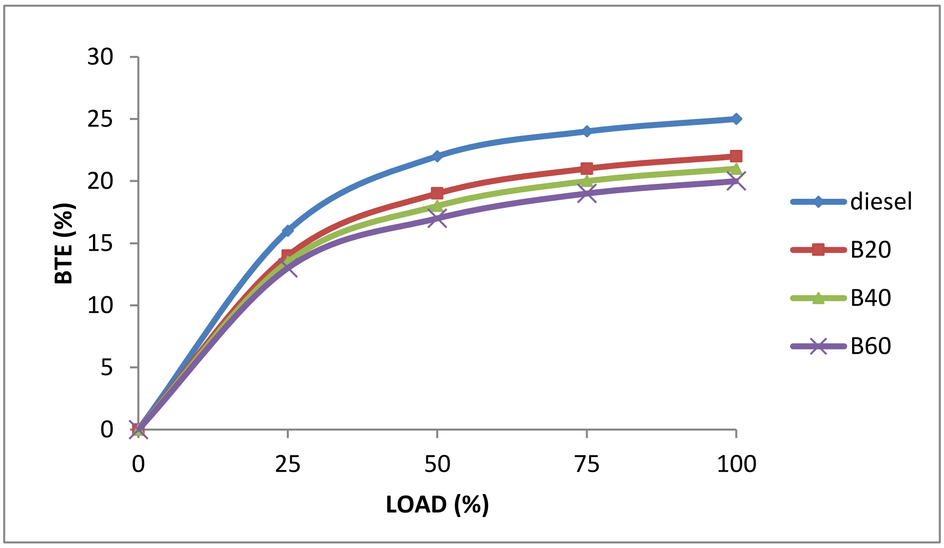

Figure 1.1 BTE for the tested fuels and various load conditions

For the Biofuel B20, the BTE is gradually increased but lower than that of diesel fuel which varies from 0% to 23% at full load condition. When the Biofuel concentration is increased with the diesel fuel, the calorific value was lowered and the BTE is getting reduced. If the biodiesel concentration is increased as B40, BTE is increased from 0% to 21% at the higher load condition and is very closer to that of B20 further increasing the blend to B60. Due to the high temperature inside the combustion chamber, the biodiesel is preheated which leads to complete combustion of biodiesel.

2.2 Brake Specific Fuel Consumption

The Figure 2.1 shows the brake specific fuel consumption for pure diesel fuel and the biodiesel blends for different Multi cylinder engine loads at various mixing ratios. The BSFC is the main parameter to quantify the engine efficiency. The BSFC for the blended fuels such as B20 and B40 are found slightly higher than that for the diesel fuel which varied from 0.5

kg/kW-h at no load condition to 0.38 kg/kW-h at full load condition. It may be due to the high calorific value and less viscosity of biodiesel the BSFC is lower and slightly higher than that of the diesel fuel. Particularly for the blend fuel of B100, the BSFC is very high compared to other blended fuels and pure diesel in range of 0.68 kg/kW-h at no load condition to 0.42 kg/kW-h at full load condition.

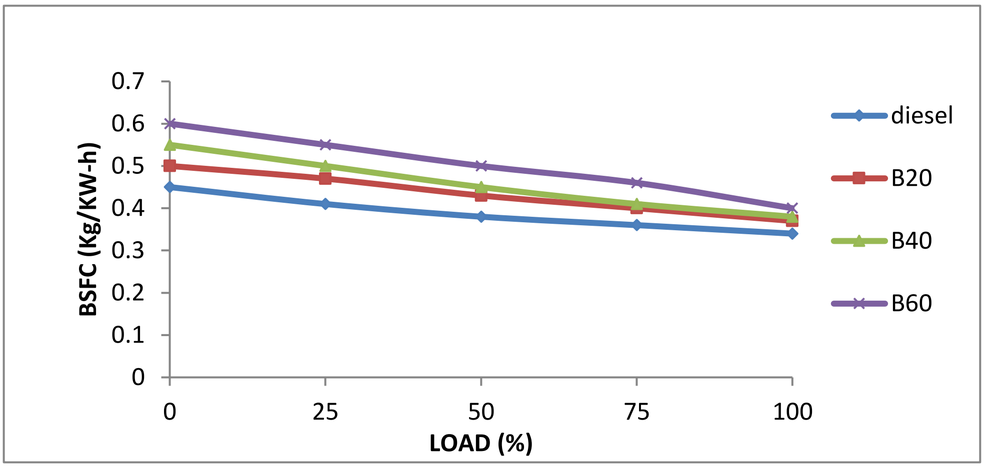

Figure 2.2 BSFC for tested fuels with various load conditions

The lower heating values and higher densities of those fuels require larger mass of fuel flow for the same energy output from the engine, leading to the increase of the brake specific fuel consumption to compensate the reduced chemical energy in the fuel.

2.3 Carbon Monoxide Emission

The CO emission for the blended bio fuels were compared with that of the diesel and the figure 6.8 shows the emissions with respect to the engine load conditions.

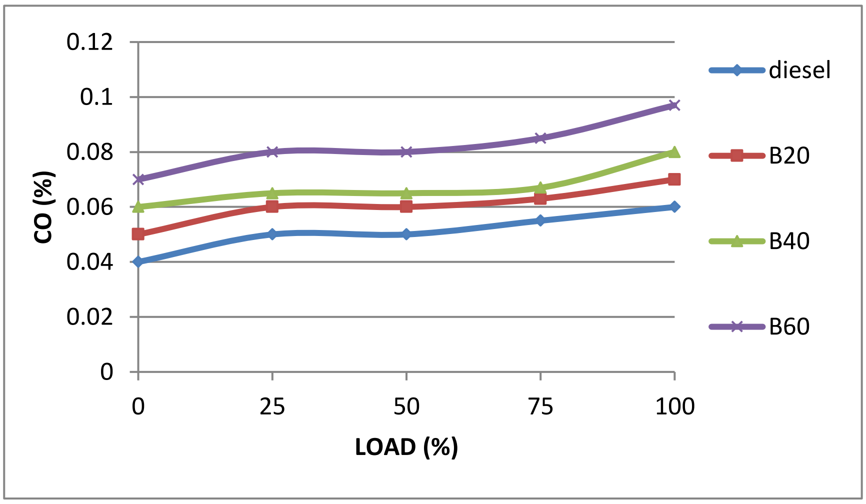

Figure 2.3 CO for tested fuels with various load conditions

From the plot it is found that, when compared to the pure diesel fuel, the CO emissions of blended fuels is decreasing at no loads and increasing at full load conditions. The blends B20 and B40 also emit lower amount of CO which ranges from no load as 0.05% to the full load as 0.08%. The other biodiesel blends such as B60, B80 emit large amount of CO compared to the pure diesel fuel ranging from 0.06% at zero load condition and 0.12% at the full load condition. The reason is, when operated with a fuel-rich equivalence ratio at high engine load, the oxygen available is not enough to convert the entire carbon to carbon dioxide; as a result, some fuel does not get fully burned, and some carbon ends up and emitted as carbon monoxide. At low engine loads, over-lean mixture areas, low in-cylinder temperatures, and bad atomization conditions influenced by the high viscosity of biodiesel at low temperatures can lead to higher CO emissions.

3. Conclusions

The experimental investigation of a Multi cylinder with variable speed diesel engine and various proportions of bio-blends for the injection pressure of 240 bar. The BTE of the B20 blended fuel was very much closer to that of the pure diesel fuel and it was varied from 19% at no load condition to 30% at full load condition. For the blend fuels such as B20, B40 and B60, the corresponding BSFC was very closer but higher than that for the diesel fuel. For the blend B20, The blends B20 and B40 produce lower CO emission than other blends and they give better performance closer to diesel. B20 blends emit 0.05 to o.11 ppm of CO at all loads. From no load to full load conditions The CO and UHC emissions for B20 were decreased to 0.29% and 13 ppm respectively. The blend B20 gave better result than other blend fuels and the engine parameters are more or less similar to that of the diesel fuel at the higher injection pressure of 240 bar.

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