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PERFORMANCE AND EMISSION CHARACTERISTICS OF BIODIESEL DERIVED FROM COCONUT ACID OIL

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ABSTRACT

In order to maintain economic development and reduce global warming and prices of the oil, there is an increase in the research and development of alternate energy resources. Normally the vehicles running in pure diesel is found to produce more emission than biodiesel blended engine vehicles. So, we used Coconut Acid oil which can reduce the emission. In this paper, Coconut Acid Oil blended with diesel in various proportions like B5 (5% biodiesel, 95% diesel), B10 and B20 has been used at different load conditions in 4 stroke single cylinder diesel engine mounted on a eddy current dynamometer bed. Physical properties of Coconut Acid oil like density, viscosity and calorific value have been determined before engine testing. Hence suitable blends are selected for blending with Coconut Acid Oil in the diesel engine. The overall performance increase with the biodiesel blends is about 0.93% and emission has decreased by about 3.47%.

Keywords: Diesel engine, Coconut acid oil, Performance, Emission.

1. INTRODUCTION:

Energy has played a vital role in the economic development of the world. On this note energy has also played an important role in global warming. Biodiesel as a fuel is expected to reduce global warming [1]. Since the world is depleting in the resources of renewable sources of energy, the concept of biodiesel has bloomed [2]. It is now evident that fuel crises and energy resources are predicted to become the biggest problem in near future.[3] In order to save the world from harmful emissions such as Green house gases, it is the right time to enhance energy resources.[4] Thus, it is high time to find an alternate renewable energy resource which is clean, sustainable and economically reliable [5]. The country has to concurrently address the issues of increasing oil prices and energy security. In this perspective, the non-edible vegetable oils (such as jatropha, mahua, neem and pongamia) and their methyl esters biodiesel are considered as alternative fuels [6-8]. On the other hand, the methyl esters biodiesel derived from the vegetable oils have high oxygen content in their molecular structure, which, leads to occur complete combustion compared to pure diesel [9]. Several techniques have been tried by researches to use vegetable oils and the non-edible vegetable oils efficiently in diesel engines. Transesterification of vegetable oil provides a significant reduction in viscosity and improvement in cetane number thereby enhancing the physical properties [10]. Transesterification is an effective process of biodiesel production in which straight vegetable oils are treated with methanol in the presence of catalyst [15] Catalysts like sodium or potassium hydroxide are generally used [14]. Coconut Acid Oil is chemically modified in to biodiesel through a Transesterification process.

2. Materials and methods

2.1. Preparation of biodiesel.

Coconut acid oil was converted into its methyl ester by the Transesterification process. This involves making the triglycerides of Coconut acid oil to react with methyl alcohol in the presence of a NaOH catalyst to produce glycerol and fatty acid ester.[11] Methanol is extensively used because of its low cost and its physicochemical advantages with triglycerides and alkalies are easily dissolved in it. Specified amount (700 ml) of Coconut acid oil (300 ml), methanol and (3 g) sodium hydroxide were taken in a round bottom flask. The contents were stirred till ester formation began and the mixture was heated to 80^{o}c after that, it was cooled without stirring [12-13] Two layers are formed. The bottom layer consists of glycerol and top layer was the ester. The properties of diesel and Coconut acid biodiesel are given in Table 1.

Table 1. The properties of diesel and Coconut acid biodiesel

Parameter Name	COCONUT ACID OIL	Diesel	Unit
Kinematic Viscosity @ 40^{0}C	21.1	3.8	cst
Density @ 15^{0}C	926	830	kg/m^3
Heating value	37236	42800	(kJ/kg)
Cloud point	-3	−15 to 5	(°C)
Flash point	153	60	(°C)
Fire point	158	63	(°C)

Table2. Technical specifications of engine

Manufacturer	Kirloskar oil engines ltd, pune, india
Type of Engine	Vertical,4Stroke cycle, Single acting, Single cylinder, high speed compression ignition diesel engine
Speed	1800 rpm
Rating at 1500 rpm	5.2 kw
Bore (B) & Stroke (S)	87.5 & 110
Compression Ratio	17.5:1(std)
Fuel Injection Timing	27˚ BTDC
Method of Cooling	Water cooling

Injection pressure	200-205 bar

2.2. Experimental setup and procedure

The performance tests for the constant diesel–biodiesel are carried out on a computerized single cylinder four stroke direct injection variable compression ratio engine. The Table 2 shows the specification of the engine. No modification or adjustment has been made in the engine. The experimental set-up consists of a variable compression ratio engine is attached to an eddy current dynamometer. The Variable load tests are conducted for no load, 25%, 50%, 75% and 100. Five gas analyzer is used to measure the exhaust gas constituents such as HC, CO, NOx, O2 and smoke. All the experiments are conducted at the compression ratio of 17.5:1and fuel injection pressure of 200 bars and the injection timing recommended by the manufacturer was 27^0 bTDC and cooling water exit temperature at 60^0 C. The fuels which have been used in this study are as follows: Pure diesel (D100) and Coconut Acid Oil blended with diesel in various proportions like B5 (5% biodiesel, 95% diesel), B10 and B20 has been used. The test engine was fuelled with diesel B5, B10, B20 and D100 to conduct the experiments on an eddy current dynamometer prior, experiment were performed using different blends of biodiesel and diesel. Following major parameters were measured: Fuel flow rate, crank angle, instantaneous pressure in cylinders and combustion characteristics.

3.1 Brake thermal Efficiency (BTHE)

Brake Thermal efficiency is the ratio between the brake power to fuel power. It is observed from the figure that the BTHE of the B5 blend is higher than diesel fuel at full load. The increases in BTHE of B5 are due to the improvement of the combustion process on account of increased oxygen content in the fuels (Zhu et al. 2011). In the case of B20 blend, the drop in the thermal efficiency may be due to lower calorific values of the blend and poor mixture formation. Brake Thermal efficiency of blend B5 at 50% load is found to be 0.87% more than that of diesel. Similarly, the BTHE for blends B10 and B20 are found to be 0.98% and 0.96% more than that of diesel respectively. Net increase in BTHE for the blend is found to be 0.93%. Shown in Figure 3 .1

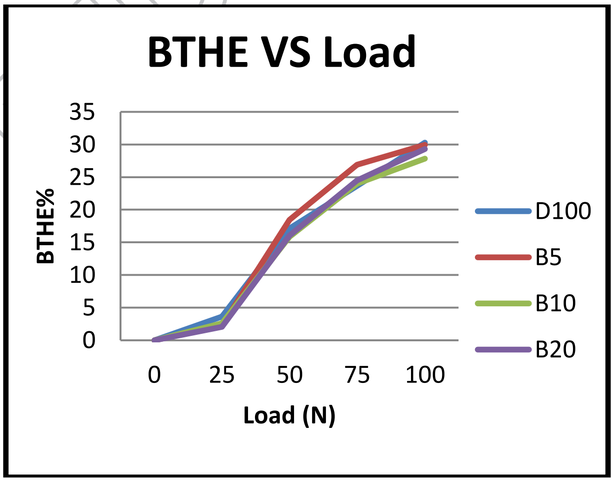

Figure 3.1. Brake thermal Efficiency (BTHE) vs. LOAD

3.2 Brake Specific fuel consumption (BSFC)

Brake specific fuel consumption is the ratio between fuel flow rate per unit power output. The variation of specific fuel consumption with load is given in Figure 3.2 Brake Specific efficiency of blend B5 at 75% load is found to be 0.96% more than that of diesel. Similarly, the BSFC for blends B10 and B20 are found to be 0.90% and 0.96% more than that of diesel respectively. Net increase in BSFC for the blend is found to be 0.94%. The net increase is due to combined effects of the higher fuel density, viscosity and low heating value of biodiesel. Also, the higher density of biodiesel has led to more discharge of fuel for the same displacement of the plunger in the fuel injection pump, thereby increasing the specific fuel consumption.

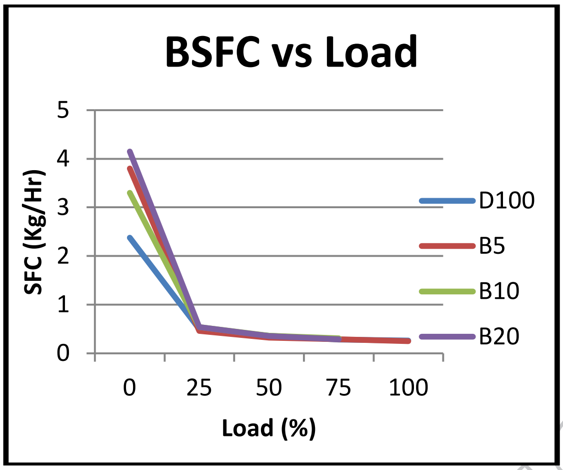

Figure 3.2 Brake Specific fuel consumption (BSFC) vs. LOAD

3.3 Carbon monoxide emission (CO)

Carbon Monoxide of blend B5 at 75% load is found to be 3.37% less than that of diesel. Similarly, the CO for blends B10 and B20 are found to be 3.37% and 3.37% less than that of diesel respectively. Net increase in CO for the blend is found to be 3.37%. This may be due to oxygen content of biodiesel and its blends. In addition, lower C/H ratio of biodiesel compare to diesel also reduces CO emission. Biodiesel contain oxygen in their molecule that resulted in complete combustion of the fuel and supplied the necessary oxygen to convert CO to CO2 Shown in Figure 3.3.

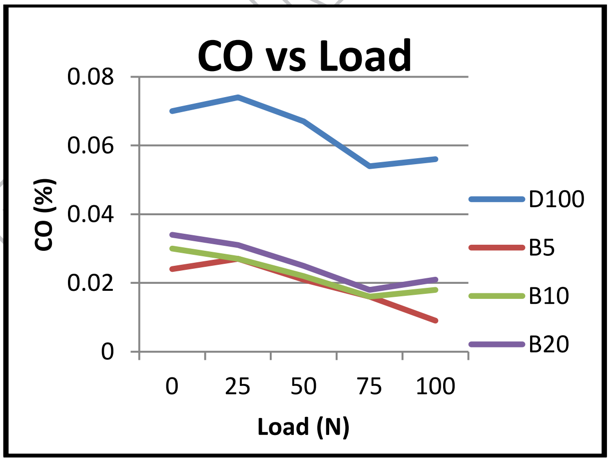

Figure 3.3.: Carbon monoxide emission (CO) vs. LOAD

3.4 Carbon dioxide emission (CO_2)

Carbon Dioxide of blend B5 at 25% load is found to be 1.86% less than that of diesel. Similarly, the CO2 for blends B10 and B20 are found to be 1.79% and 1.34% less than that of diesel respectively. Net increase in CO2 for the blend is found to be 1.66%. This may be due the high viscosity of biodiesel reduces cone angle which leads to reduction of amount of air entrainment in the spray resulting in hindrance in complete combustion Shown in Figure 3.4.

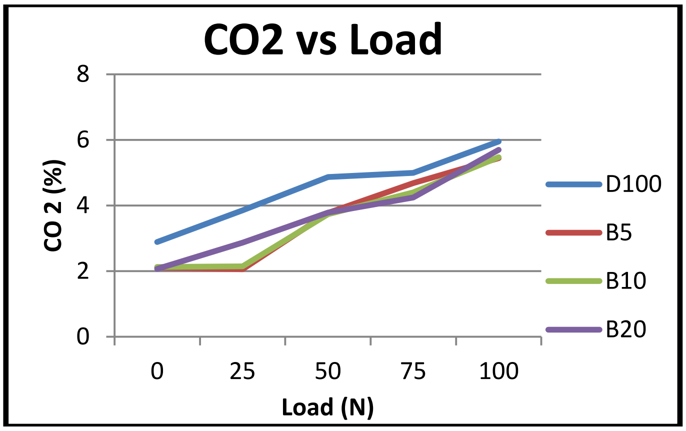

Figure 3.4 Carbon dioxide emissions (CO_2) vs. LOAD

3.5 Hydrocarbon emission (HC)

Hydrocarbon of blend B5 at 25% load is found to be 15.25% less than that of diesel. Similarly, the HC for blends B10 and B20 are found to be 5.54% and 3.21% less than that of diesel respectively. Net increase in HC for the blend is found to be 8.00%. HC emission increases due to higher fumigation rate and non-availability of oxygen relative to diesel Shown in Figure 3.5

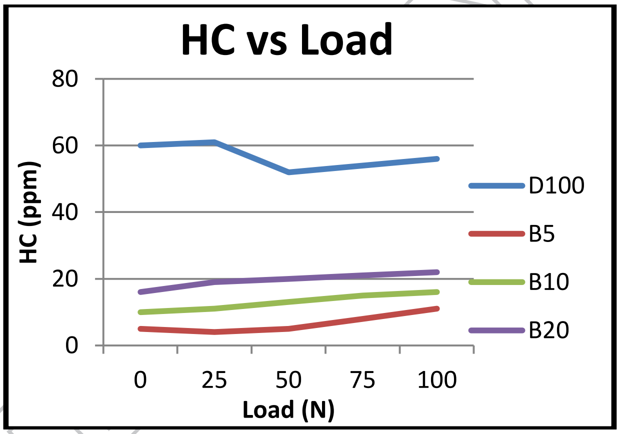

Figure 3.5: Hydrocarbon emission (HC) vs. LOAD

3.6 Nitrogen oxide (NO_X)

Nitrogen oxide of blend B5 at 75% load is found to be 0.87% more than that of diesel. Similarly, the NOX for blends B10 and B20 are found to be 0.87% and 0.87% more than that of diesel respectively. Net increase in NOX for the blend is found to be 0.87%. This may due to advanced start of combustion and faster burn rate, decreased radiation heat transfer, different adiabatic flame temperature and system response issues. Inbuilt oxygen of biodiesel is also responsible for extra NOx emission. Shown in Figure 3.6

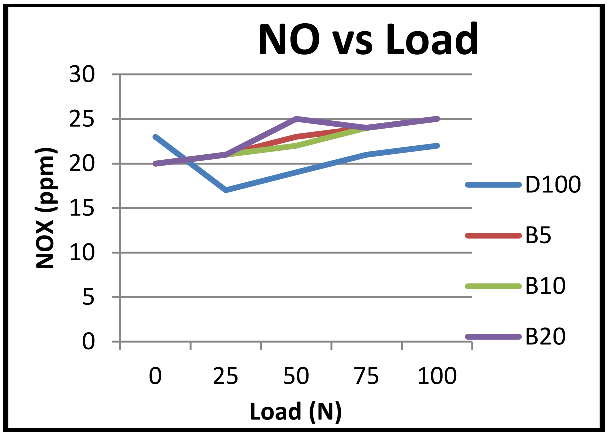

Figure 3.6: Nitrogen oxide (NO_X) vs. LOAD

CONCLUSION

Performance and emissions of diesel engine fuelled with blends of biodiesels of Coconut acid oil with diesel fuel are experimentally investigated. The results of study may be summarized as follows:

- Coconut acid oil based biodiesels can be directly used in diesel engines without any modifications.
- The performance is slightly increased while Brake specific fuel consumption is increased when using biodiesels.
- BTHE of Biodiesel is also increased while compare to diesel at all loads for all the blends.
- Emission Characteristics like Hydro Carbon, Carbon monoxide, Carbon dioxide showed positive results but Nitrogen oxide was little on the higher side when compared to Diesel.
- Hence the Coconut Acid oil proves to be suitable in place of pure diesel which reduces the Emission characteristics as well as improves the performance of the engine.

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