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Performance & Testing on Single Cylinder Diesel Engine by Using Blends of Diesel and Karanja Biodiesel

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Abstract --- *This paper explores the possibility of utilizing biodiesel obtained from karanja oil by ultrasonic method as an alternative fuel in a diesel engine. Three different percentages of karanja biodiesel (10%, 20%, and 30%) on volume basis were blending with diesel proportionality. These blending were designated as B10 B20 and B30 where the numeric value refers to the percentage of karanja biodiesel. The blends were tested as fuels in a single cylinder, four strokes, and water cooled diesel engine. Results indicated that the biodiesel blends have higher fuel consumption than diesel and better break thermal effiency than that of diesel operation at full load. Overall, the nitric oxide (NO) and HC emissions were found to be lesser by about 4% and 20%, respectively, with the biodiesel blends emulsions compared to that of diesel operation at full load. The B20 blends gave a better performance and lower emissions compared to that of B10 and B30. It is suggested that the karanja biodiesel B20 blend can be used as a potential alternative fuel replacing 20% of petroleum diesel without any modification in current diesel engine*

Keywords: Biodiesel, karanja oil, diesel engine, Ultrasonic, Performance

I. INTRODUCTION

The gap between energy supply and demand increases exponentially as a result of increased population, improved civilization. The consumption of fossil fuels results in increased fuel prices and reduces the availability. The global warming potential (GWP) and ozone depletion potential (ODP) are also adversely affected by the greenhouse gases emitted from the combustion o f fossil fuels, other industrial sources, and wastes. Since the fuel crisis arose in the late 1970s, many countries started investing huge amount of money on deriving alternative fuels for heat and power applications. Focus was emphasized to use alternative fuels particularly in internal combustion (IC) engines as they are used in different sectors which include the following: transportation, agriculture, industry, and power. Biomass derived fuels were found to be potential alternative. Also the biodiesel has lower sulphur and aromatics contents and reduced CO_2 emissions compared with diesel fuel. By 2017, 20% blend of biofuels with diesel has been approved by the Gov. of India in 2009. About 38 million tones of petroleum products are consumed in India in the year 2007. It is expected that it may be doubled by the end of 2030. This implies a larger scope of production and use of biofuels in India. The aim of the present study is to experimentally investigate the effect of different karanja biodiesel blends on the performance of diesel engine

II. MATERIALS AND EXPERIMENT

Commercial diesel fuel used in India which was obtained locally is used as a base line fuel for this study. Karanja biodiesel is produced by ultrasonic methods at physic department at Saurashtrat University Rajkot and properties are test at third party mech tech laboratory at vadodara. Properties of karanja biodiesel compare with diesel is given in table

Table.1 Comparison of the property of Karanja biodiesel and diesel

Properties	Karanja biodiesel	Unit	Limit	Diesel
Appearance	Clear	----	----	Clear
Color	Brownish	----	----	----
Density at 15 °C	890	kg/m3	860-900	840
Kinematic viscosity at 40 °C	5.86 x10-6	m2/sec	3.5-5 x 10-6	4.86 x10-6
Flash point	>66	°C	Min 100	51
Sulphur contents	0.01	w/w%	Max 0.05	0.35-0.55
Water content	0.05	w/w%	0.02-0.05	0.005

Experiments were performed with Fender make single cylinder diesel engine. This is a single cylinder, water cooled open combustion chamber diesel engine. Technical details of the engine are given in Table 2. All experiments were performed after ensuring the full warm-up. A plan was designed for the experimental investigation. Blends B10, B20 and B30 of fuels were tested. The tests were conducted for different blends and were repeated for four times for every kind of fuel, in order to increase the reliability of the test results. For each of the fuel blend, the engine was run on four different loads, on Electric AC type Generator Dynamometer.

Table.2 Single cylinder Engine specifications

Parameter	Details
Engine	Single Cylinder four stroke diesel engine
Engine Name	FIELDER 5HP
Engine No.	120404
Capacity	533 cc
Cooling	Water cooled
Bore × Stroke	80 mm × 110 mm
Compression ration	18 : 1
Maximum Power	5 hp or 3.7 kw
Rated speed	1500 rpm
Lubricating oil	SAE 30/ SAE 40

The parameters like speed of engine, fuel consumption and time for blink on energy meter were measured at different loads for diesel and with various combinations of dual fuel. Brake power, brake specific fuel consumption and brake thermal efficiency was calculated using the collected test data. The engine was sufficiently warmed up at every stage and the cold water temperature was maintained at 52°C. The fuel injection pressure was maintained at 200 bars throughout the experiment. A thermocouple with a digital display meter was used to measure the exhaust gas temperature. Fig 01 shows the photograph of the DI Diesel engine. Exhaust parameter such as hydro carbon, carbon monoxide and Nitrogen oxide were measured by i3says 5 gas analyzer.

III. ENGINE TEST AND RESULT

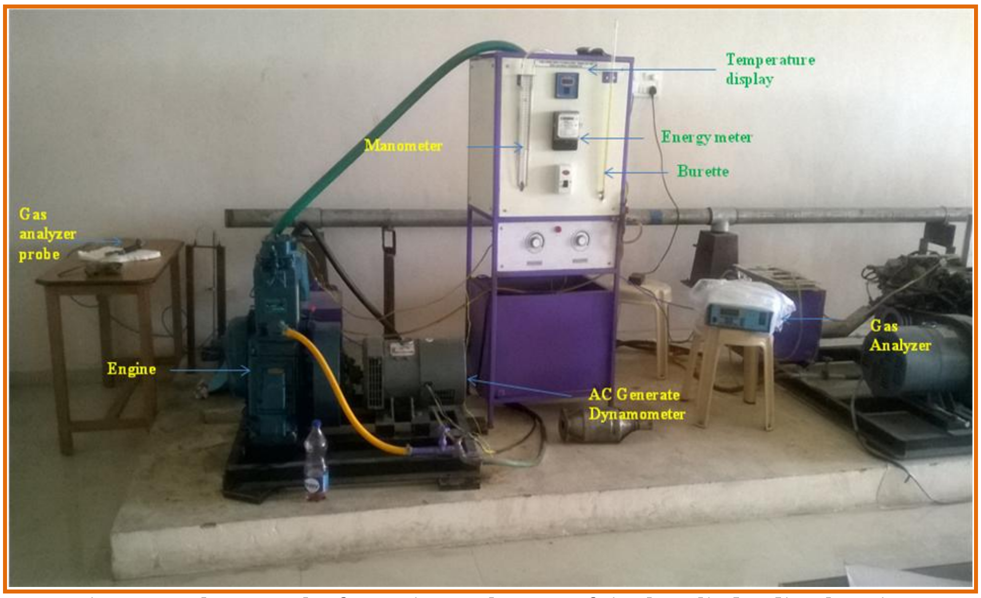

Figure 1. Photograph of experimental set up of single cylinder diesel engine

3.1 Engine Performance Analysis

3.1.1 Effect of fuel consumption on engine

Fig 5.2.1 shows the graph of fuel consumption Vs brake power, it is observed that as the break power increases the fuel consumption increases, for the pure diesel, maximum value 0.887 at 3.06 KW break power. In B10 and B20 it is nearer to diesel, where as in B30 it increases up to 14%. Karanja fuel is having a more fuel consumption as compare with the diesel fuel however the heating value is less than that of the diesel fuel.

3.1.2. Effect of specific fuel consumption on engine

Fig 2 shows the graph for specific fuel consumption Vs break power. It is observed that SFC is decreased as the break power is increases for the diesel and all fuel blends. The minimum value is 0.290 kg/kWhr for diesel at 3.06 kW BP and where as For B10 and B20 it is almost same but in B30 it is 0.331 at 3.06 kW BP. It is increased in blends of biodiesel than pure diesel.

3.1.3 Effect of Break thermal effiency on engine

Fig.3 shows the graph of brake thermal efficiency with break power, from that it is observed that it is increased with the break power. Maximum value of that are 28.34 achieved at 3 KW break power for B20 blend which is little increase to that of pure diesel.

3.1.4 Effect of Exhaust gas temperature on engine

From figure 4 we can conclude that EGT increases with increase in brake power for all fuels. In compare to BTE and BSFC trends, highest EGT is reached at maximum brake power for all fuels. Maximum EGT measured is 292ºC using Diesel fuel at brake power of 3.0 kW. B20 fuel shows approximately 12% reduction in EGT compared to Diesel. B30 fuel shows lower EGT compared to diesel fuel. The reason behind this may be the shift of peak cylinder pressure to TDC. As peak pressure is achieved at closer to TDC full expansion of gases during expansion stroke may results in lower EGT at outlet. Lower EGT using B20 fuel also helps in reduction of harmful NO_X emissions.

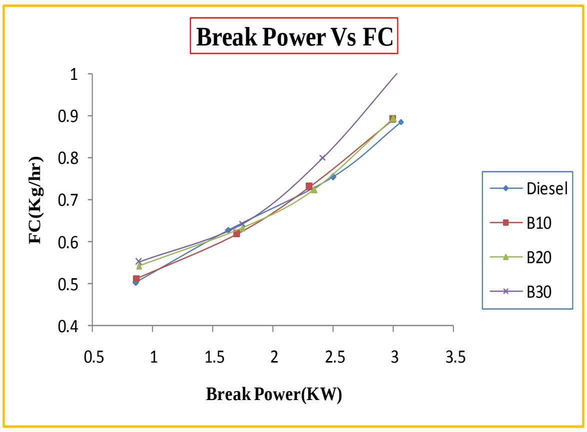

Figure 2. fuel consumption Vs Break power on engine

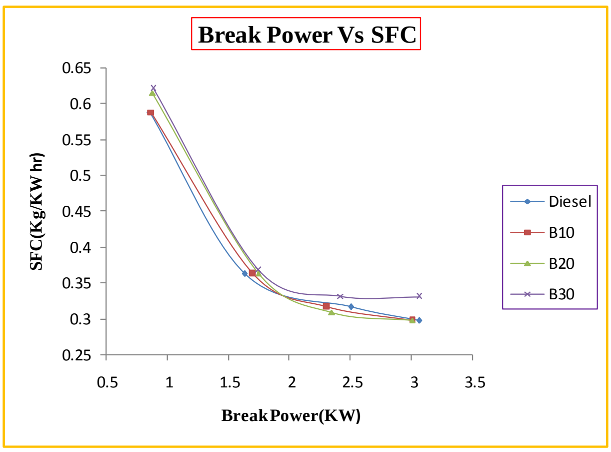

Figure 3. Specific fuel consumption Vs Break power on engine

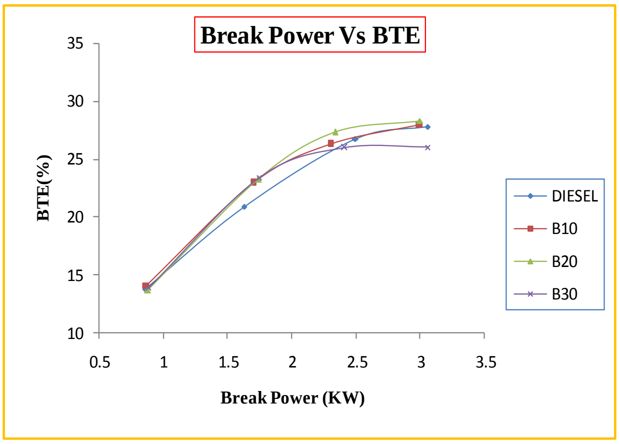

Figure 4. Break Thermal effiency Vs Break power on engine

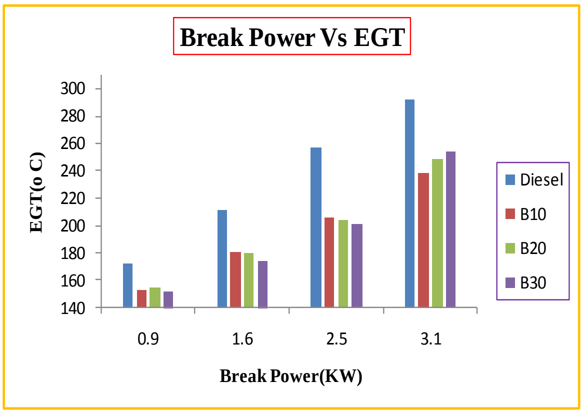

Figure 5. Exhaust gas temperature Vs Break power on engine

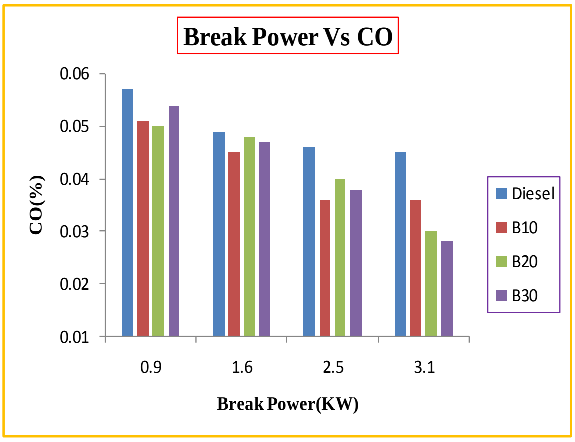

Figure 6. Co emission Vs Break power on engine

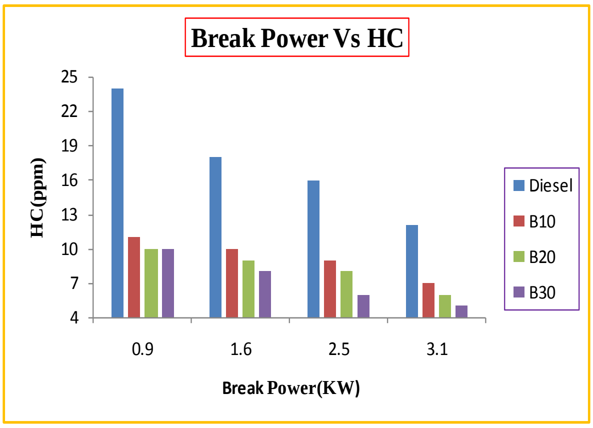

Figure 7. HC emission Vs Break power on engine

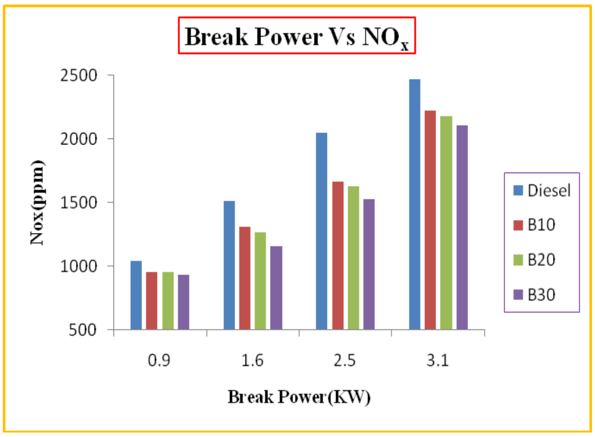

Figure 8. NO_x emission Vs Break power on engine

3.2 ENGINE EMISSION ANALYSIS

3.2.1 Effect of HC emission on engine

The variation of hydrocarbon emissions with break power is shown in Figure 6. The HC emissions depend upon mixture strength i.e. oxygen quantity and fuel viscosity in turn atomization. The HC emission decreases with increase in load on the engine. It is observed from the figure that the decrease in hydro carbon emissions with increase in biodiesel content in the blend. Lower heating value leads to the injection of higher quantities of fuel for the same load condition. More the amount bio diesel leads to more viscosity. Viscosity effect, in turn atomization, is more predominant than the oxygen availability, either inherent in fuel or present in the charge When compared to diesel, the oxygen availability in the bio diesels is more. So the HC emissions are less than diesel.

3.2.2 Effect of CO emission on engine

The variation of carbon monoxide emissions for is illustrated in Figure 7. It is observed that the CO emission is lower for karanja biodiesel blends as compared with diesel. With the higher combustion chamber temperatures, the combustion in the engine is more complete and the oxidation of carbon monoxide is also improved. Hence carbon monoxide present in the exhaust due to incomplete combustion reduces drastically. Due to the lower calorific value and higher viscosity of bio diesel, the combustion in the diesel engine is insufficient. Thus the temperature produced in the chamber is less and in turn increases the CO emissions. But the oxygen presents in the bio diesel acts as a combustion promoter during the combustion process, which results better combustion and compensate the increase in the emissions.

3.2.3 Effect of NO_x Emission on Engine

The variation of hydrocarbon emissions with break power is shown in Figure 8. The HC emissions depend upon mixture strength i.e. oxygen quantity and fuel viscosity in turn atomization. The HC emission decreases with increase in load on the engine. It is observed from the figure that the decrease in hydro carbon emissions with increase in biodiesel content in the blend. Lower heating value leads to the injection of higher quantities of fuel for the same load condition. More the amount bio diesel leads to more viscosity. Viscosity effect, in turn atomization, is more predominant than the oxygen availability, either inherent in fuel or present in the charge When compared to diesel, the oxygen availability in the bio diesels is more. So the HC emissions are less than diesel.

IV. CONCLUSIONS

As per the result obtained for the biodiesel production from karanja oil by ultrasonic methods and then tests conducted on a single cylinder, water cooled ,self-governed diesel engine for karanja biodiesel and diesel, after performing several experimental run and based on result obtained, following conclusions are made:

- It was found that blends of Karanja biodiesel and diesel could be successfully used with acceptable performance and better emissions than pure diesel up to a certain extent. From the experimental investigation, it is concluded that blends of karanja biodiesel with diesel up to 20% by volume (B20) could replace the diesel for diesel engine.
- It was observed that the Brake power (B.P), Brake thermal efficiency, break fuel consumption higher in 20% and 30% biodiesel blends with diesel fuel. The BSFC of biodiesel blends is higher than the diesel.
- The Brake thermal effiency of B10, B20 and B30 is nearer to equal compared with pure diesel. The exhaust gas temperature for the biodiesel blend is lower than the diesel.
- The Hydrocarbon and co emissions are less than diesel fuel as compared with biodiesel. The NOx emissions increase with the higher temperatures in the chamber. NOx emission is low for karanja bio diesel.

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