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EXPERIMENTAL INVESTIGATIONS ON DIESEL ENGINE WITH BIO-DIESEL

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Abstract- Renewable fuels have played a significant role in the swift industrialization, transportation and agriculture of the planet. Due to the risk of supply crisis, effect of gas emissions and increase in prices of fossil fuels, there is urgent need to investigate the possibility of using renewable fuels. Biodiesel is one of the alternative fuels for replacing the diesel fuel. Karanja biodiesel is considered as one of the most prospective renewable energy sources of India. In the present work experimental investigations are carried out to evaluate the performance of single cylinder, four stroke, direct injection dual fuel, variable compression ratio engine with pure diesel, Karanja biodiesel(B5, B10, B15, B20)by varying load(25%, 50%, 75%, 100% load) and at rated speed 1500rpm. Initially the experiments are conducted with injection opening pressure 200 bar and at compression ratio of 17. The effects of various performance and emission parameters are computed. The Results obtained from experimental investigations are presented karanja biodiesel. The blends of karanja in the diesel under standard conditions have shown distinct performances at various loads, B20 has stood best of all the other blends with the brake thermal efficiency and BSFC equal to that of pure diesel

1. INTRODUCTION

The internal combustion engines have become an important part of the fulfilment of the human needs. Automotive propulsion, the supply of motion to the machinery heavy and decentralized power generation are the chief applications of internal combustion engines. The conventional running of internal combustion demands petroleum products such as Diesel, petrol, Gasoline etc., as fuels. The combustions products and the residues of the engine combustion allowed into the atmosphere are leaving adverse effects on the human health and the environment. Many types of research and are being conducted to find the solution for the reduction of the internal combustion engine pollutants. Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source and in many cases exerts a very small carbon footprint.

Biodiesel has viscosity close to diesel fuels. These esters contain 10 to 11% oxygen by weight, which may encourage more combustion than hydrocarbon based diesel fuels in an engine. Biodiesel has lower volumetric heating values (about 12%) than diesel fuels but has a high cetane number and flash point.Some of the enviable fuel properties of biodiesel derived from different vegetable oils are presented in Table.1. Due to rapid price increase in petroleum fuels, there is a growing demand for the search for sustainable, environment friendly and cost effective alternative substitute renewable fuel [2]. He found that VOs in order of decreasing OSI are Castor, Mahua, Neem, Karanja can berecommended as potential feed stocks for biodiesel production while other SVOs are not due to their instability but may require considerable effort to make the fuel stable. CP and CFPP of edible SVOs in decreasing order are found:Castor, Rape seed Soya bean while non-edible SVOs in decreasing order are Mahua, Neem, Karanja, Jatropha, Soybean indicating that there is a need to improve the cold flow properties using additives. Out of all SVOs the Castor oil has highest OSI and good cold flow properties and recommended as the best SVO for biodiesel production.

Fast pyrolysis of biomass is one of the most recent renewable energy processes to have been introduced [7]. Fast pyrolysis has now achieved a commercial success for production of chemicals and is being actively developed for producing liquid fuels. Bio-oils have been successfully tested in engines, turbines, and boilers, and have been upgraded to high-quality hydrocarbon fuels, although at a presently unacceptable energetic and financial cost. He reveals several aspects that in turn will serve as an aid for bio oilvalorization [3]. Such as, evaluating characterization techniques involved in understanding salient features of bio-oil, insight of bio-oil pre-treatment methods for water removal to increase heating values and decrease risk of catalyst poisoning in subsequent hydro processing, studies

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regarding model compound upgrading, reaction mechanism and finally, provides brief review of common catalysts for hydro treatment of bio-oil in order to yield value added chemicals and fuels. Fuels from biomass (bio fuels) are used to mitigate the greenhouse gases produced through the utilization of fossil fuels. Non-edible or waste biomass can be pyrolyzed to produce bio-oil., canola Michael J. Haasinvestigated the production of fatty acid methyl esters (FAME; biodiesel) from soap stock (SS), a by-product of edible oil refining that is substantially less expensive than edible-grade refined oils.He found an acid oil with a free fatty acid (FFA) content greater than 90% [6].An economic analysis suggested that the production cost of soap stock biodiesel would be approximately US$ 0.41/l, a 25% reduction relative to the estimated cost of biodiesel produced from soy oil.The objective of this work is to conduct performance test on horizontal single cylinder variable speed Greaves engine with various blends of cotton seed oil (B5, B10, B15, B20, B40 & B100) and comparing the performance of cotton seed oil with diesel [5]. The most common ratio is 80% conventional diesel fuel and 20% vegetable oil ester, also termed “B20,” indicating the 20% level of biodiesel. The overall comparison shows that B20 diesel with blend 20% yields the optimum value, with less fuel consumption and higher efficiencies than diesel and it is feasible us it in the diesel engine with no modification.

He critically reviews the facts and prospects of bio fuelutilization especially, three edible biodiesels namely soybean, rapeseed, palm and two non-edible viz. jatropha and cottonseed to reduce engine exhaust gas, noise emission and petro dependency [4].Based on various bio fuel feedstock’s, this paper generally found that biodiesel fuels are considered as offering many benefits, including sustainability, reduction of greenhouse gas emissions and many harmful pollutants along with noise emission, regional development, social

Structure and agriculture, and security of supply.This experimental study was aimed to find out performance characteristics and smoke emission with 10%, 20% and 30% biodiesel blend with diesel at varying loads (brake power) of 0.5 to 3.5 kW at a constant speed of 1500 rpm [1]. Brake thermal efficiency, brake specific energy consumption, exhaust gas temperature, mechanical efficiency, volumetric efficiency, air fuel ratio and smoke opacity of biodiesel blended fuel were evaluated and compared with diesel and it has been found satisfactory. On the basis of experimental study, the B20 Karanja biodiesel blend is found more useful among all tested fuels in terms of brake thermal efficiency.

Table 1. Properties of different Vegetable Oils

Oils	Kinematic viscocity	Density (kg/m^3)	Heating value (MJ/kg)	Cloud point(^{0}c)	Pour point(^{0}c)	Flash point(^{0}c)	Centane number
Diesel	2.75	835	42.25	-15	-20	66	47
Jatropha	49.9	921	39.7	16	8	240	40-45
Karanja	46.5	929	38.8	13.2	6	248	40
Rapeseed	37	911	39.7	-3.9	-31.7	246	37.5
Neem	57	938	39.4	8	295	47	0.96
Sunflower	33.9	916	39.6	7.2	-15	274	37.1
Soya bean	32.6	914	39.6	-3.9	-12	254	38
Coconut	27.7	915	37.1	-	-	281	52
Cotton seed	33.5	914	39.4	1.7	-15	234	42
Rice brain	28.7	937	38.9	13	1	200	30

2. EXPERIMNTAL METHODOLOGY

To reach the objectives of the research work and to obtain the outcomes that explain the behaviour of the engine, the experimental methodology is designed as below.The engine is run under normal diesel and the combinations B10, B15 and B20 and the values of the outcomes are noted.The above mentioned combinations of fuels are run under standardinjection pressures of 200 bar, Compression ratio of 17 CR. All above combinations are basically conducted at different load conditions.The readings at all the above conditions are noted, computed and compared with that of standard running condition and with each other so that the best combination and the best running condition can be obtained.The above explained chain of experimenting conditions is explained in the result and Discussions.

3. RESULT AND DISCUSSIONS

After going through all the experimental procedure and conducting numerous iterations as per the experimental methodology as mentioned experimental methodology, significant results are drawn and presented here. The

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presentations of the results are done in a classified manner of steps for the better understanding of the behavior of the engine at all the experimental conditions.

The main base of the experiment is the Karanja oil. In the case the performance, combustion, and emissions of the Karanja oil at various combinations with diesel is presented at base line of 200 bar constant injection pressure, standard compression ratio of 17 at different loading conditions.

3.1. Brake thermal efficiency

Brake thermal efficiency is an important performance parameter of an IC engine, it determines or evaluates the suitability of a particular running condition. The graph 3.1 shows the variations of brake thermal efficiency for various substitutions of Karanja in diesel at various loading conditions. The BTE at 75% load for rated IOP of 200 bar is 23.71% for B20 when compared to 22.21, 17.81, 19.91, 24.93% with B15, B10,B5, pure diesel. BTE increases with the increase in load due to proper combustion that was assisted by increased in-cylinder temperatures, accordingly improved vaporization of fuel resulting in improved BTE.

In figure 3.1. Pure diesel has shown 24.93% BTE at 75% load which was 1.22% less than that of B20, whichhas been very close to the performance of pure diesel, B15 also being a minute variation in the performance than that of B20 i.e. 1.5%. The B5 and B10 which are the small substitute's karanja have a deterioration of performance compared to that of pure diesel. Brake thermal efficiency varying with the substitution of Karanja; we infer that at part load there is almost no change in the brake thermal efficiency with the substitution of Karanja. At higher loads the scene is different, 5% and 10% lowering and then increasing at 15% and 20% substitution.

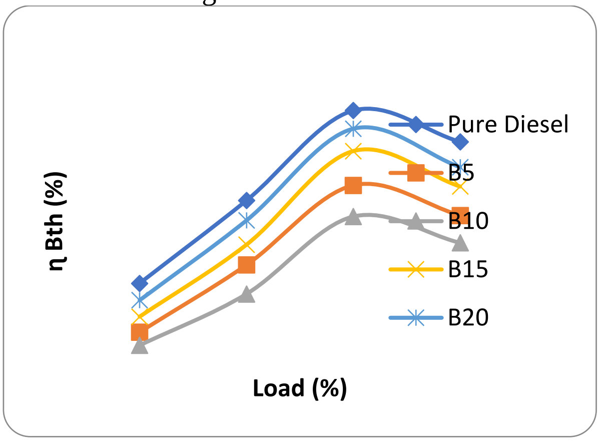

Figure 3.1: Brake thermal efficiency Vs. Load at various Blends

3. 2 Brake Specific Fuel Consumption:

Brake Specific fuel consumption is another important parameter that determines the performance of any engine. It is the specific quantity of fuel used to generate a unit of power. The Figure 3.2. shows the BSFC reduces with increase in load up to 75% and then 100% load small increments in all cases at various Blends of Karanja and Diesel.The BSFC at 75% load for rated IOP of 200 bar is 0.37 kg/kW-hr for B20 when compared to 0.42, 0.56, 0.49, and 0.38 kg/kW-hr with B15, B10,B5, and pure diesel. BSFC decreases with the increase in load due to proper combustion. The BSFC for 100% are higher than 75% is .041, 0.47, 0.63, 0.53, and 0.38 kg/kW-hr for B20, B15, B10, B5, and Pure Diesel. The BSFC is increased with increasing load at 100% because of the injection of less quantity of fuel due to the higher viscosity and lower heating value. The oxygenated biodiesels may lead to the leaner combustion resulting in higher BSFC.

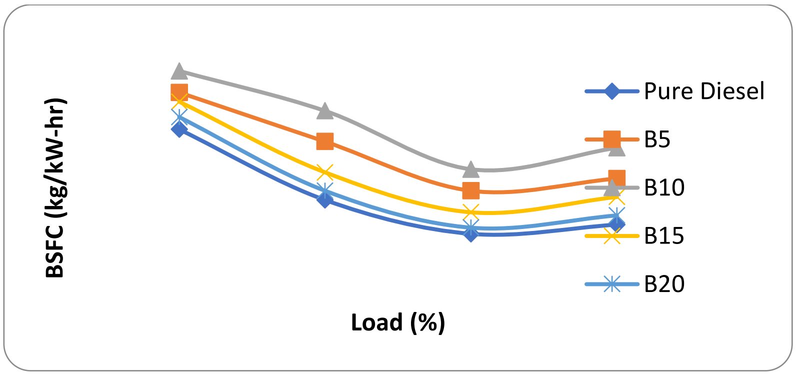

Figure 3.2: BSFC Vs. Load at various Blends

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3.3 Cylinder Pressure vs. Crank angle

Figure 3.3 shows the variation of cylinder pressure with crank angle for PD, B5, B10, B15, and B20 with 100% condition. The cylinder pressure increases with increasing blend percentage, but when compared to pure diesel cylinder pressure decreased. At full load of 100% for pure diesel, B5, B10, B15, and B20 is 52.53, 50.57, 50.78, 51.89, and 51.99 bar obtained. The cylinder pressure for B20 at 100% load condition was 0.54bar less than that of PD, which has been very close to the cylinder pressure of pure diesel. Peak pressure values increases with the increase of engine load from 25 to 75% due to the increase of pilot fuel mass and this results in elevated heat release. Peak pressure is dependent on the portion of energy liberated through premixed combustion, that in turn governed by the delay period. At full load condition there is substantial decrease of peak pressures with pure diesel, B20, B15, B10, and B5 for a given injection opening pressure because of the less burning of fuel and late combustion caused respectively by the decreased combustion duration and delay period.

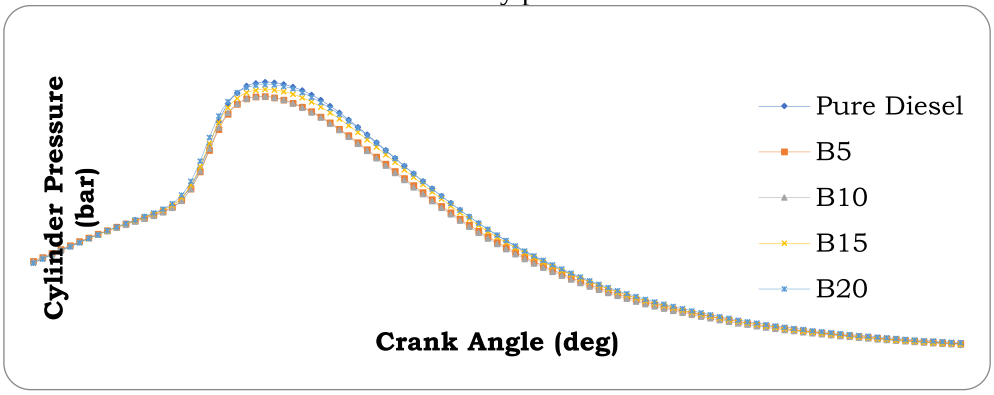

Figure 3.3: Cylinder Pressure Vs Crank Angle for various Blends at 100% Load

3.4 Carbon Monoxide (CO)

Carbon monoxide is an oxide of carbon that is partially oxidized during the combustion process and has adverse effect on the environment and human health by toxic. Carbon monoxide emissions occur due to the incomplete combustion of fuel. Initially the value of CO emission for all fuels decreases at lower loads up to 75% and then increases sharply for all the prepared test fuels shown in figure 4.8. The CO emissions at 75% load for rated IOP of 200 bar is 0.23% for B20 when compared to 0.025, 0.034, 0.028, 0.02 with B15, B10,B5, pure diesel. 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. It is also identified that CO concentration of B20 and Pure diesel is 77% and 17% lower than conventional diesel at rated load. This may be due to the oxygen content and less C/H ratio of biodiesel that causes complete combustion.

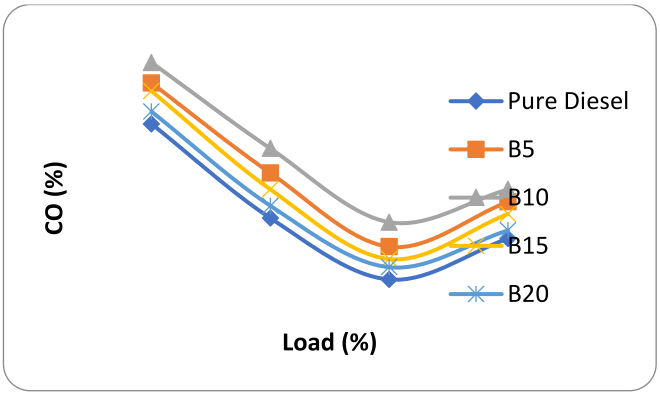

Figure 3.4: CO (% Volume) Vs Load at various Blends

3.5 Oxides of Nitrogen (NOx)

Oxides of Nitrogen are the automotive emissions that need to be adversely considered in engine life and environmental stand point. The variation of NOx with load for PD, B5, B10, B15, and B20 blends is presented in figure 4.11. The value of NOx emission increases for all fuels with increase in load. It is found highest for biodiesel due to higher content of oxygen than pure diesel. Moreover, the complete combustion of biodiesels results in a higher temperature, causing the formation of valance oxygen form dissociation, which eventually increases the NOx. At

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highest load NOx emission for diesel, B5, B10, B15 and B20 are found to be 398 ppm, 643 ppm, 1026 ppm, 1133 ppm and 1288 ppm respectively. It is found that NOx emission of B20 is increased by 891 ppm when compared to diesel at rated load and hike in NOx emission is greatly influenced by the percentage of biodiesel in blends.

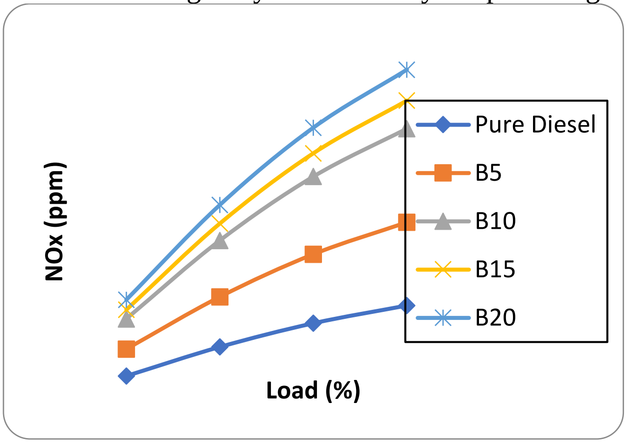

Figure 3.5: NOx (PPM) Vs Load at various Blends

3.6 Un-burnt hydro Carbons (UBHC)

The variation of hydrocarbon emissions with break power is shown in Figure 4.12. Unburned hydrocarbon (UBHC) is one of the important parameters for determining the emission behavior of diesel engine. The fuels used in the engine are hydro carbon fuels, the fully burnt or reacted hydro carbons generate power whereas the un-burnt hydro carbons come out of tail pipe as harmful emissions. The HC emissions depend upon mixture strength i.e. oxygen quantity and fuel viscosity in turn atomization. The HC emission increases with increase in load up to 75 % on the engine for all fuels and 100% it is reduced. The lower quantity substitutions of the karanja in blends such as 5, 10 and 15% show the increasing trends of the HC when compared to that of pure diesel. Higher quantity substitutions of the karanja in blends such as 20% show the decreasing trends of the HC when compared to that of 5,10, and B20% karanja blends.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 more near to the diesel. The blend B20 shows only 13% raise n the HCs compared to that of pure diesel which is better when compared to all other proportions.

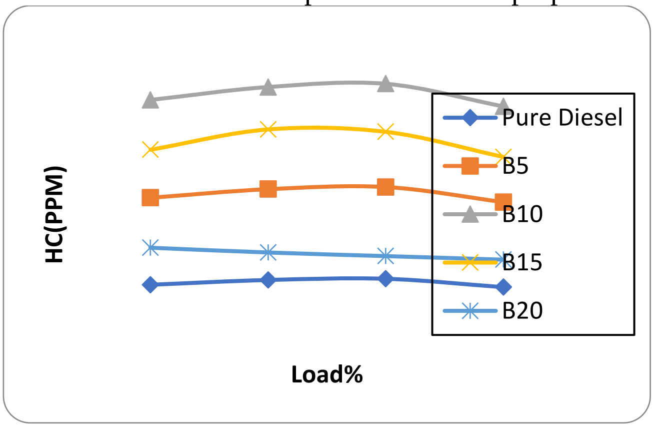

Figure 3.6 : HC (PPM) Vs Load at various Blends

4. CONCLUSIONS

The blends of karanja in the diesel under standard conditions have shown distinct performances at various loads, B20 has stood best of all the other blends with the brake thermal efficiency and BSFC equal to that of pure diesel.CO emissions under dual fuel mode operation are higher compared to the normal diesel. At full load conditions CO emissions was found to increase under dual fuel operation are closer compared to diesel.NOx emission increases with load as well as biodiesel concentration in the blending. The increment of NOx emission is 24% with neat biodiesel compared to mineral diesel. There is a considerable amount of CO and HC emissions reduction when pure biodiesel or its blends with diesel are used as fuel compare full load to part load.

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