Effect of Jatropha Biodiesel Blend with Diesel Fuel on Performance of Four Stroke Single Cylinder Diesel Engine

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Abstract

Petroleum based fuels play a vital role in rapid depletion of conventional energy sources. Along with their increasing demands, these are also major contributors of air pollution which is contributing to greenhouse effect and consequently to ozone layer depletion. Biodiesel either in neat form or as a mixture with diesel fuel is widely investigated to solve the twin problem of depletion of fossil fuels and environmental degradation. The main objective of the present study is to compare performance, emission and combustion characteristics of biodiesel derived from non-edible jatropha oil in a dual fuel diesel engine with base line results of diesel fuel. The performance parameters evaluated were: brake thermal efficiency, brake specific fuel consumption, power output. The results from the experiments suggest that biodiesel derived from non-edible oil like jatropha could be a good substitute to diesel fuel in diesel engine in the near future in view of comparable engine performance and reduction in most of the engine emissions, it can be concluded and biodiesel derived from jatropha and its blends could be used in a conventional diesel engine without any modification.
Keyword – Biodiesel, diesel engine.

Introduction

Diesel engines are mostly internal combustion engines and efficient prime movers that are run on fossil fuel. The rapid increase in the consumption of fossil fuel is resulting in climate change, which is considered to be the most important environmental problem of the present century.[3] Bio-diesel, which can be used as an alternative diesel fuel, is made from renewable biological sources such as vegetable oil and animal fats. It is biodegradable, nontoxic and possesses low emission profiles. Also, the uses of bio-fuels are environmentally beneficial. Use of conventional diesel fuel causes serious problem of air pollution and effects on the environment leading to effect like green house, some factors in diesel fuel results in high emission in diesel engine. The stringent emission norms have been an important driving force to develop the CI engines more environment friendly. The main pollutants from diesel engines are carbon monoxide, hydrocarbons, nitrogen oxides and Smoke intensity. The problem of increasing demand for high brake power and the fast depletion of the fuels demand severe controls on power and a high level of fuel economy. That's Many innovative technologies are developed to tackle these problems.[6]

The presented work here is aimed to explore the technical feasibility of jatropha biodiesel in compression ignition engines. jatropha curcas plant can thrive under adverse conditions. It is a drought-resistant, perennial plant, living up to fifty years and has capability to grow on marginal soils. It requires very little irrigation and grows in all types of soils.[1]

Jatropha curcas is unusual among tree crops is a renewable non-edible plant. From jatropha seeds jatropha oil can be extracted which have similar properties as diesel but some properties such as kinematic viscosity, solidifying point, flash point and ignition point is very high in jatropha oil. By some chemical reactions, Jatropha oil can be converted into biodiesel. Jatropha oil can also be used directly by blending with diesel. The purpose of this research work is to investigate the fuel properties of Jatropha oil and investigate the performance test of single cylinder diesel engine by using jatropha biodiesel blending with diesel fuel.[5]

Belnding

Straight vegetable oils (SVO) even though projected as an engine friendly fuel by many researchers have recently lost its attraction. Being highly viscous and less volatile, SVO's will result in poor spray atomization, vaporization, and pose serious threat to the engine health in the long run. More over many SVO's are edible oils whose continuous supply cannot be ensured in our country. Measures like blending, micro emulsification, transesterification have turned out to be effective methods of viscosity reduction in vegetable oils, thus making their usage in DI diesel engines feasible. Blending refers to the mixing of vegetable oil with other low viscosity fuels like diesel and alcohol. It results in reducing the viscosity of the blends and increasing the cetane number. The blends can be directly used in diesel engines for better results. The use of 100% vegetable oil was found to be possible with some minor modifications in the fuel system. In this experiment JBD20: A blend of 20 % raw Jatropha biodiesel and 80 %diesel fuel by volume is used.[7]

Experiment setup

The final product of biodiesel from Jatropha oil blending (JBD) with diesel is used as an alternative fuel to operate diesel. The Performance test are conducted on a computerized single cylinder, four stroke, direct injection, water cooled diesel engine test rig. The engine directly connected to eddy current dynamometer for variable loading. The schematic photograph of experimental setup is as shown in 1.1 figure. And the tested engine specification is shown in Table below. The engine has been run using biodiesel and required data are collected to calculate the engine performance parameters.

Table1.1: diesel engine specification

ENGINE:	HIMALAYA
No of Cylinder:	1
Engine HP	5.2 KW (7HP)
Cooling	Water cooling
Bore:	87.5mm
Stroke:	110mm
Compression Ratio:	17.5:01
Speed:	1500 rpm

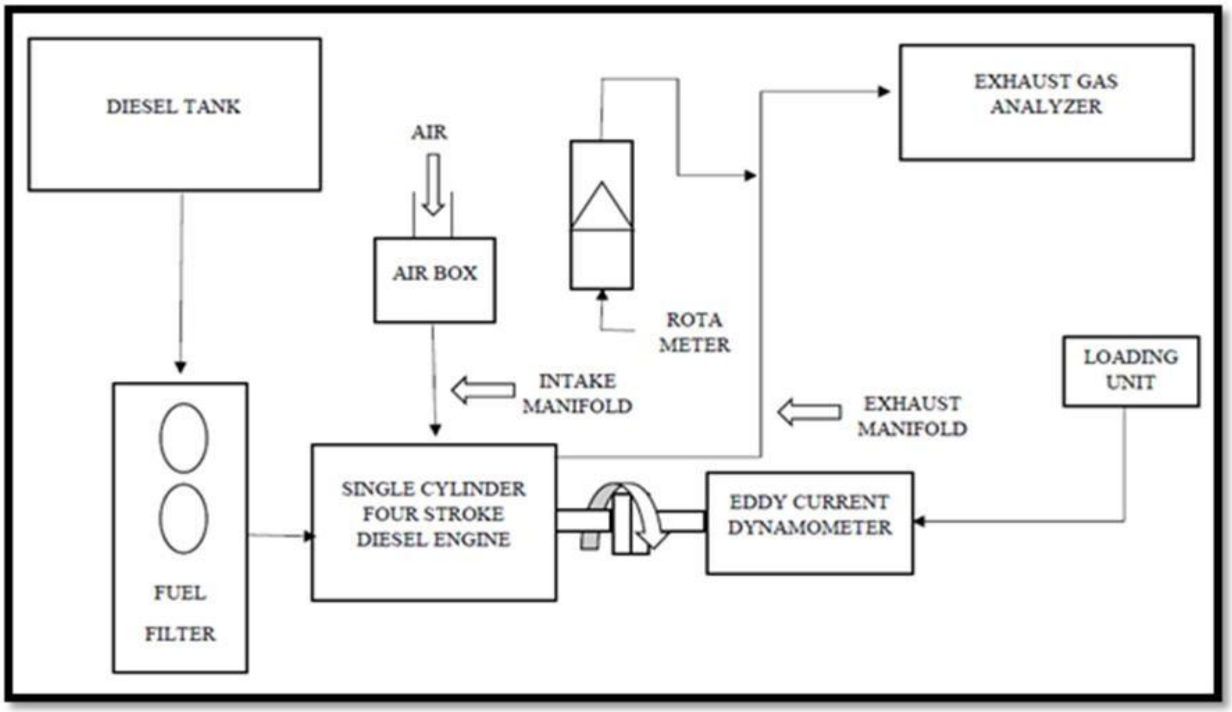

Fig1.1: Experimental setup

Table1.2: Performance reading of Base engine with Diesel

Sr. no	Brake Power (KW)	F.C. (Kg/hr)	S.F.C. (Kg/KW· hr)	H_F (KJ/hr)	Mechanical Efficiency %	Brake Thermal Efficiency %
1.	0.5417	0.7875	1.4537	33075	26.5318	5.8960
2.	1.1078	0.8770	1.1308	36834	34.0804	7.5794
3.	1.6975	0.9802	0.5774	41168.4	53.0883	14.8439

4.	2.3328	1.0939	0.4689	45943.8	60.8641	18.2790
5.	2.7321	1.2354	0.4521	51886.8	64.5566	18.9558
6.	3.2812	1.3239	0.4034	55603.8	68.6271	21.2437
7.	3.6771	1.4424	0.3922	60580.8	71.0262	21.8510

Table1.3: Performance reading of Base engine with Blending

Sr. no	**Brake Power (KW)**	**F.C. (Kg/hr)**	**S.F.C. (Kg/KW· hr)**	**H_F (KJ/hr)**	**Mechanical Efficiency %**	**Brake Thermal Efficiency %**
1.	0.5035	0.7422	1.4740	28527.3	25.1310	6.3539
2.	1.0651	0.8252	0.7747	31717.5	41.5227	12.0890
3.	1.6428	0.9152	0.5570	35176.7	52.2718	16.8124
4.	2.0892	0.9909	0.4742	38086.4	58.2079	19.7475
5.	2.6760	1.1036	0.4124	42418.1	64.0804	22.7110
6.	3.1428	1.2060	0.3837	46354.2	67.6919	24.4079
7.	3.6580	1.3790	0.3769	53003.4	70.9189	24.8451

RESULTS AND DISCUSSION

Brake thermal efficiency:

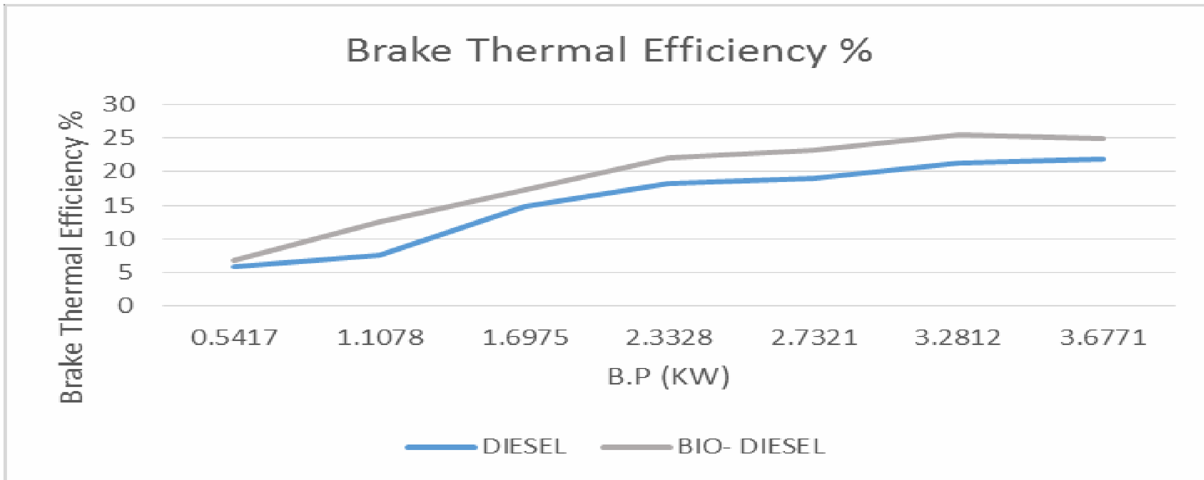

Fig1.2: Figure 6.4: B.P. Vs brake Thermal Efficiency for Diesel and Bio-Diesel fuel

The variation of brake thermal efficiency of the engine with jatropha biodiesel is shown in Fig. 1.2 and compared with the brake thermal efficiency obtained with diesel. From the test results it was observed that initially with increasing load the brake thermal efficiencies of the jatropha biodiesel blends and the diesel were increased and the maximum thermal efficiencies were obtained and then tended to decrease with further increase in load, but the brake thermal efficiencies of the jatropha blends were higher than that with diesel fuel. The maximum values of thermal efficiencies for 20% Blend jatropha biodiesel diesel at 70% load. This mainly happens due to oxygen molecules present in the jatropha blend improves the combustion characteristics.

Brake specific fuel consumption:

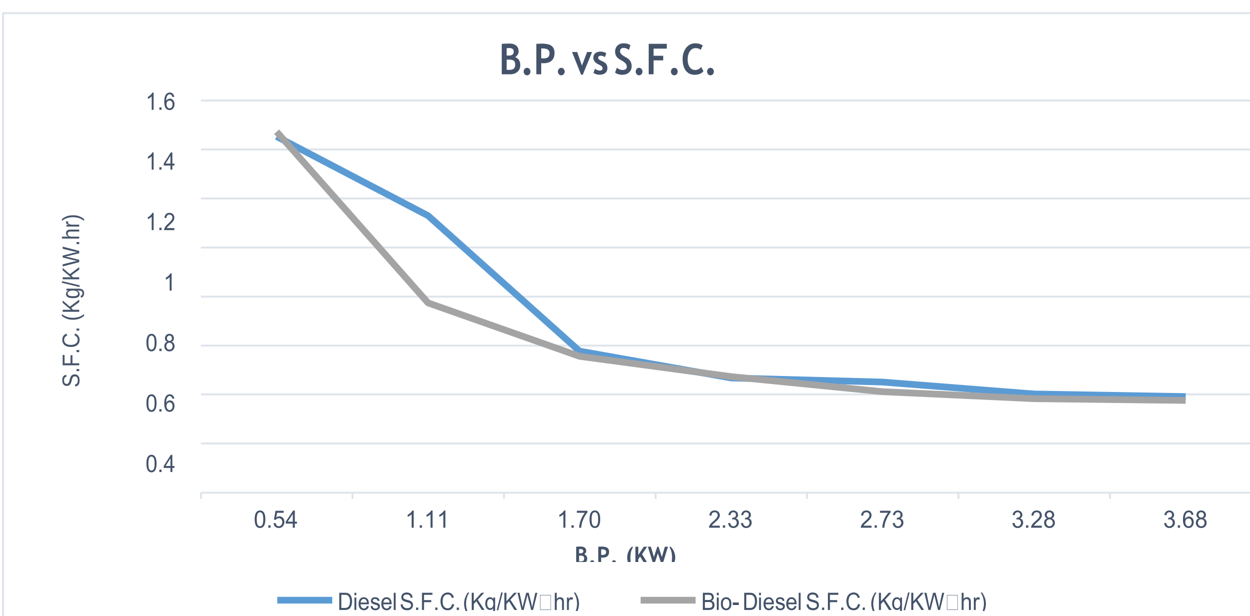

Fig1.3: B.P. vs S.F.C. For Diesel and Bio-Diesel

Exhaust Gas Temperature:

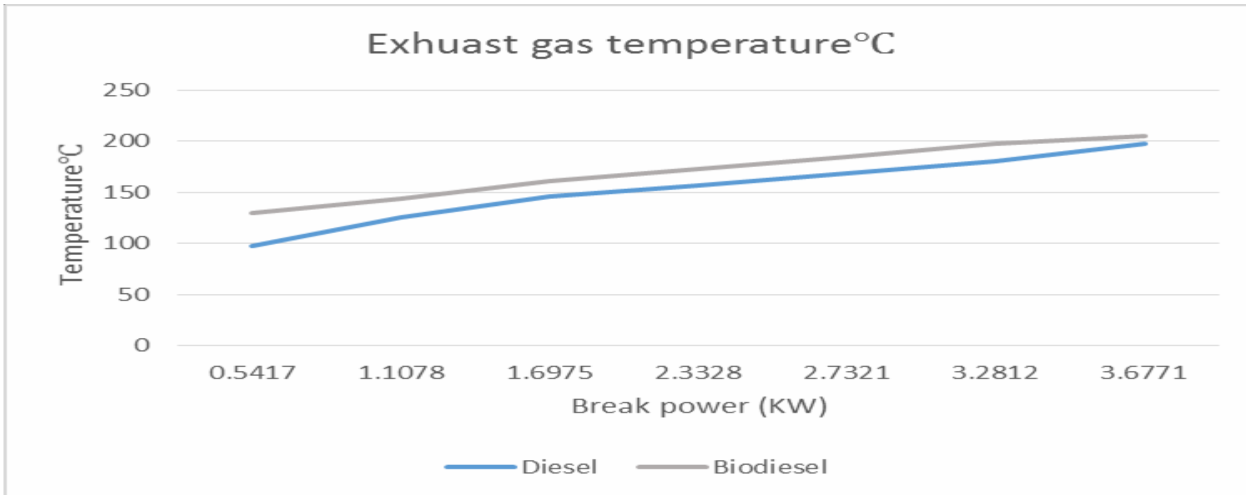

Fig1.4: Exhaust Gas Temperature of diesel & biodiesel

The exhaust gas temperature gives an indication the amount of waste heat going with exhaust gases. The exhaust gas temperature of the different biodiesel blends is shown in Figure1.4. The exhaust gas temperature of blended fuels and biodiesel at 70% load condition was 204℃. The exhaust gas temperature increased with increase in load. The exhaust gas temperature reflects on the status of combustion inside the combustion chamber the reason for raise in the exhaust gas temperature may be due to ignition delay and increased quantity of fuel injected.

Conclusion

• Biodiesel is a viable substitute for petroleum-based diesel fuel. Its advantages are improved lubricity, higher cetane number, cleaner emissions (except for NOx), reduced global Warming, and enhanced rural development.

• The main aim of the present investigation was to make blending of diesel fuel with jatropha biodiesel and to make it suitable fuel for use in a C.I. engine and to evaluate the performance of the engine with the modified Blending fuel with diesel fuel. Significant improvement in break thermal efficiency and specific fuel consumption was achieved by mixing 20% of vegetable oil with 80% of diesel.

• Diesel fuel with20% blending with jatropha biodiesel increases break thermal efficiency by 13.7 % as compared to diesel fuel.

• As load increases the break specific fuel consumption decreases and for both fuel, however the 20% jatropha biodiesel blend shows 3.90 % reduction in break specific fuel consumption compared to diesel fuel.

• Also the percentage of the exhaust temperature of the gases using jatropha biodiesel blend increases by 6.9%

• However, the properties of the blends may be further improved to make use of higher percentage of jatropha oil in the blend using jatropha oil of purer grade which may be obtained by pretreatment of the oil. Moreover, the long term durability of the engine using bio- diesel as fuel requires further study.

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