EXPERIMENTAL INVESTIGATION ON DI ENGINE PERFORMANCE USING DIFFERENT BLENDS OF JATROPHA BIODIESEL, DIESEL AND DI ETHYL ETHER

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ABSTRACT

Biodiesel refers to a vegetable oil- or animal fat-based diesel fuel consisting of long chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids with an alcohol. Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable oils. Biodiesel can be used alone, or blended with diesel. Biodiesel, a promising substitute as an alternative fuel has gained significant attention due to the predicted shortness of conventional fuels and environmental concern. The utilization of liquid fuels such as biodiesel produced from Jatropha oil by transesterification process represents one of the most promising options for the use of conventional fossil fuels. The production of biodiesel is limited by land area but jatropha trees can be cultivated in any kinds of land.Jatropha is a wildly growing hardy plant, in arid and semi-arid regions of the country on degraded soils having low fertility and moisture. It can be cultivated successfully in the regions of heavy rainfall even it can be cultivated even on fallow and barren lands. Jatropha vegetable oil is one ofthe main non edible sources available in India. In view of the above, a study was carried out with the following objectives:Production of Jatropha oil ethyl ester or Jatropha oil biodiesel by two step esterification process, Determination of characteristic fuel properties of different blends of Jatropha oil ethyl ester , Di ethyl ether and diesel BDE1,BDE2,BDE3 AND B100 AND DIESEL. And Performance evaluation of a CI engine on blended fuels.

After the investigation the results we found that The density of B100used in the experiment was 7.69 % higher than the diesel .The viscosity of Jatropha biodiesel was about 35% higher than the diesel.The gross heat of combustion of raw neem oil is found to be 2.61% lower than the diesel.The performance evaluation of 4.4 kW diesel engine under the fuel consumption test on blends of Jatropha,DEE and diesel was found satisfactory on the basis of brake power, brake specific fuel consumption and brake thermal efficiency.The engine was able to develop power similar to diesel on all the Jatropha-DEE- diesel blends.The brake thermal efficiency of the engine on BDE2 was found higher than diesel on lower load .The engine performance was the best on BDE2 as the brake thermal efficiency was found to be high at lower load and overall BTE of BDE3 was highest and BSFC was found to be second lowest on BDE2 blend as BSFC was lowest on BDE1.

Key words-Transesterification, biodiesel, blended fuels

1.Introduction

By the time we are getting modernized and industrialized. As civilization is growing, transport becomes essential part of life. As a result vehicles and engines are increasing. But energy sources used in these engines are limited and decreasing gradually. About 100 years ago, the major source of energy shifted from recent solar to fossil fuel (hydrocarbons). By Technology ,we generally are utilising more and more of hydrocarbon fuels, making civilization vulnerable to decrease in supply.Therefore due to the crisis of fossil fuel depletion and environmental degradation interest in use of biodiesel fuels has been increased because of having characteristics of renewability ,biodegradability and beneficial effects on environment . Consequently, in the recent years systematic efforts have been made to persuade investigation in vegetable oils‘s utilization as alternative to diesel in the compression ignition engines.Biodiesel is the fuel that is generally produced from vegetable oils ,edible oil and non edible, recycled waste vegetable oils and animal fat. Biodiesel has many major benefits, and some minor verdicts. B100 can reduce CO2 emissions by 78% and lower the diesel fuel’s carcinogenic properties by 94%. As per the EPA, biodiesel degrades at a rate four times faster than conventional diesel for automobiles. Biodiesel could also lower the dependency on U.S. for imported oil and increase our energy security. It acts as a solvent, which helps to loosen deposits which cause clogs from the insides of an engine. As estimated a biodiesel blend of just 1% could increase fuel lubrication ability by as much as 65 percent{19}. It is also safe to humans, non-toxic (about 10 times less toxic than table salt). Because it burns at a higher temperature than diesel, it has less tendency to combust accidentally. This makesstorage regulations and movement easier. Biodiesel has a few drawbacks. One problem is that Nox emissions increase in biodiesel. Often, in diesel fuel manufacturing, there is increase in nitrogen oxides by decreasing the particulate matter in the emissions, which is very harmful. Currently, researched are being done to reduce this problem.Problems occurs when we operate engine with use of vegetable oil for a long time. The problems which occurs are basically (1) choking on the injectors to such an extent that fuel atomization does not happens properly as a result of plugged orifices, (2) carbon deposits, (3) oil ring sticking and (4) thickening of the lubricating oil because of contamination by the vegetable oils.In Some older diesel vehicles clogging with higher concentrations of biodiesel can be occured... Most biodiesels are manufactured at B5 and B20, which are low concentrations of biofuel to diesel. Most automobile manufacturers guarantee of using this with no modification to the engine whatsoever.Both edible oils such as Rapeseeds, Cottonseeds ,Soybean, Canola, Sunflower, etc. and non edible oils like Jatropha, Karanja, Neem, Mahua etc. have been tried as alternative fuel of diesel in various countries.Jatrophacurcas is unusual among tree crops a renewable non-edible plant. From jatropha seeds jatropha oil can be extracted which have similar properties of conventional fuel but some properties such as kinematic viscosity, solidifying point, flash point and ignition point is much higher in jatrophaoil{2}. But if we do some chemical reactions, Jatropha oil can be converted into biodiesel. Jatropha oil can also be used directly by mixing it with diesel.The production of biodiesel is limited by land area but jatropha trees can be cultivated in any kinds of land.Jatropha is a wildly growing hardy plant, in arid and semi-arid regions of the country on degraded soils having low fertility and moisture. It can be cultivated successfully in the regions of heavy rainfall even it can be cultivated even on fallow and barren lands. Jatropha vegetable oil is one ofthe main non edible sources available in India.

In view of the above, a study was carried out with the following objectives:

1. Production of Jatropha oil ethyl ester or Jatropha oil biodiesel by two step esterification process.

2. Determination of characteristic fuel properties of different blends of Jatrophaoil methyl ester , Di ethyl ether and diesel.
3. Performance evaluation of a CI engine on blended fuels.

2.Production of biodiesel

By researches it is proven that oils and fats can be converted in to biodiesel by esterification process. In this work the methyl ester of jatropha oil is produced by the Transesterification process. In the transesterification of jatropha oil we do heating of oil then addition of KOH and methyl alcohol after that stirring of mixture, separation of glycerol then washing with distilled water and heating for water removal. By this process produces the alkyl esters and reduces viscosity and increases cetane number. In a transesterification reaction, we take in account: concentration of free fatty acids in oils ,water in the reagents, molar ratio of reagents, , temp., reaction time, types of alcohol, and types of catalysts. In this research work we used di ethyl ether with biodiesel of jatropha oil. They are mixed and stirred in the magnetic stirrer for proper mixing. This mixture was kept under investigation for more than 24 hours to see the separation of fuels. It was confirmed that no separation of diethyl ether and biodiesel taking place. The blends percentages are shown in table 1

Table 1 Fuel Blends Selected for Engine Test

S.NO.	Types of Fuel	Fuel Constituents		Diesel Replacement in %	
		Jatropha oil biodiesel in % vol.	Di ethyl ether in % vol.	Diesel fuel in % vol.	
1.	Diesel	-	-	100	-
2.	BDE1	10	5	85	15
3.	BDE2	20	10	70	30
4.	BDE3	30	15	55	45
5.	B100	100	0	0	100

3. Characteristic Fuel Properties of diesel, jatropha biodiesel, as well as their blends with diesel and di ethyl ether

Table 2: Characteristics of Diesel, B100 and different blends of Diesel, BD and DEE

S.NO.	Types of Fuel	Density in	Dynamic	Gross Heat of combustion	Gross Heat of	Flash point in	Fire	Cloud	Pour point in ^{0}c

		gr/cm3 at 15^{0}c	**viscosity in pa-s**	**(kcal/kg)**	**combustion (MJ/kg)**	**^{0}c**	**point in ^{0}c**	**point in ^{0}c**	
1.	Diesel	.8172	.00313	10311.0	42.1	52	58	-13	-17
2.	BDE1	.8336	.00324	10379.95	43.45	27	34	-3.7	-13.8
3.	BDE2	.8412	.00362	10956.61	45.79	33	38	-5.6	-10.9
4.	BDE3	.8527	.00375	11244.94	47.01	36	41	-3.5	-10.8
5.	B100	.8801	.00423	9792.44	41.00	105	113	-2	-6

4.Test Engine

A kirloskar make, constant speed, four stroke, single cylinder, direct injection compression ignition engine was selected for the study. The engine is commonly used in agricultural operation such as irrigation pumps, milling and as stationary power source for different field operation as well as a prime mover in electric generators for house hold usage. The major specification of the engine are shown in Table 3

Table 3 Engine Specification

Make	Kirloskar
Model	TAF1
Rated Brake Power (bhp/kW)	6/4.4
Rated Speed (rpm)	1500
Number of Cylinder	1
Bore x Stroke (mm)	87.5x110
Displacement volume (cc)	662 cc
Compression Ratio	17.5:1
Cooling System	Air Cooled
Lubrication System	Forced Feed
Starting system	Manual hand start (with handle)

5. Experimental Procedure

The Engine set up includes the following facilities:

- A eddy current dynamometer with electronic controller.
- A kirloskar make, 4.4 kW, constant speed of engine
- A fuel consumption measuring unit.

5.1 Fuel consumption test

The fuel consumption test was carried out on fuel samples shown in Table 3.1 .The performance of the engine on selected fuels was evaluated at the following load condition.

- No load
- 25 percent of the rated load
- 50 percent of the rated load
- 75 percent of the rated load
- 100 percent of the rated load

The following parameters were measured during the test:

- Brake power, kW
- Fuel consumption, l/h
- Brake specific fuel consumption
- Brake thermal efficiency

6. RESULTS AND DISCUSSION

6.1 Engine Performance on Selected Fuels

The performance of the engine was evaluated on diesel, BDE1, BDE2, BDE3and B100 under the fuel consumption test at different load condition in terms of brake power, fuel consumption, brake specific fuel consumption, brake thermal efficiency.

6.1.1 Brake power

The brake power, corresponding brake load and speed of the engine when operating on diesel, BDE1, BDE2, BDE3 and B100 at no load, 25, 50, 75 and 100 percent brake load are plotted in Fig.1. The figures indicate an increase in brake power with increase in brake load of the engine under all fuel types. The figures and table also reveal that with increase in brake load there was an increase in brake power and decrease in engine speed on all the blends. It was observed that the engine was able to develop similar power on all fuel types at every selected brake load condition. This could be due to the reason that the volumetric fuel flow rate on biodiesel was higher thus contributing energy supply near to diesel.

The above observation are in line with the findings of **John*et al.* (1985)**, **Mareno*et al.* (1999), Bol (2003) and Kundu (2006)** who reported that an engine operating on vegetable oil ester- diesel blends produces as much power as that of diesel fuel.

6.1.2 Fuel consumption

The observed fuel consumption (l/h) of the engine on diesel and Jatropha-diesel-DEE blends is shown in Fig 3 shows the relationship between brake load and the fuel consumption of the engine on different fuel types.It is observed from the figure that the fuel consumption ofthe engine gradually increased with increase in brake load and was found to maximum at 100 percent brake load on all selected fuel types.

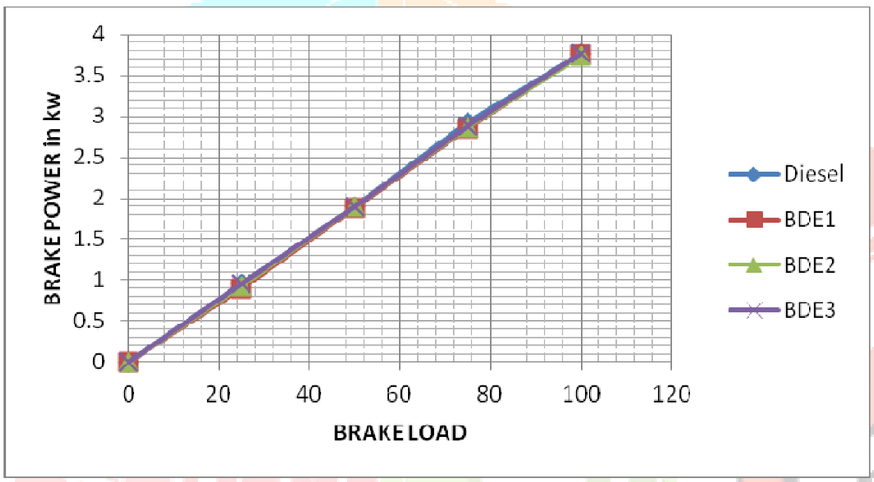

Fig 1-The Brake power, corresponding brake load when operating on Diesel, B100 and different blends of Diesel, BD and DEE

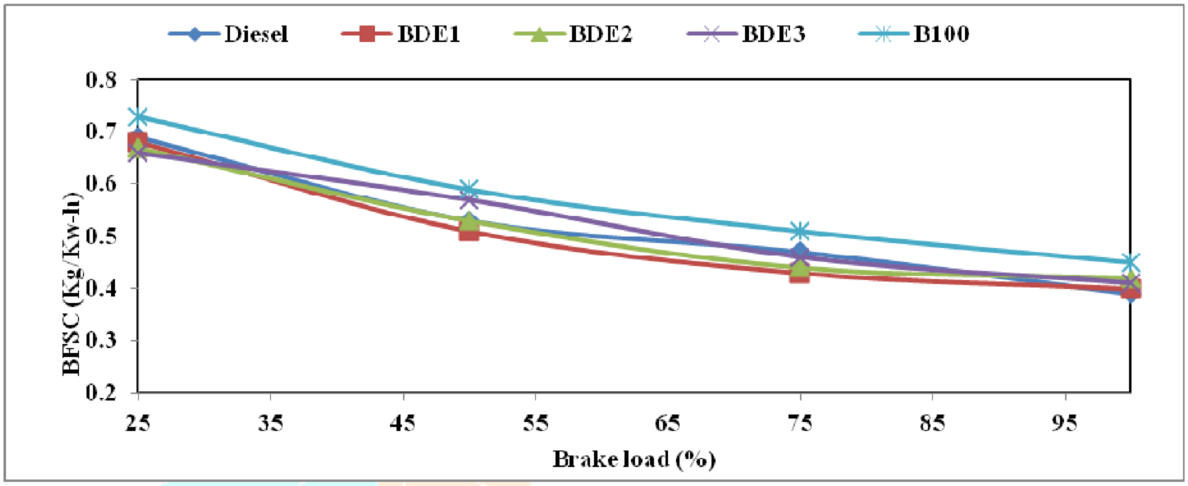

Fig 2-The Brake specific fuel consumption (kg/kW-h) corresponding to brake load when operating on Diesel, B100 and different blends of Diesel, BD and DEE

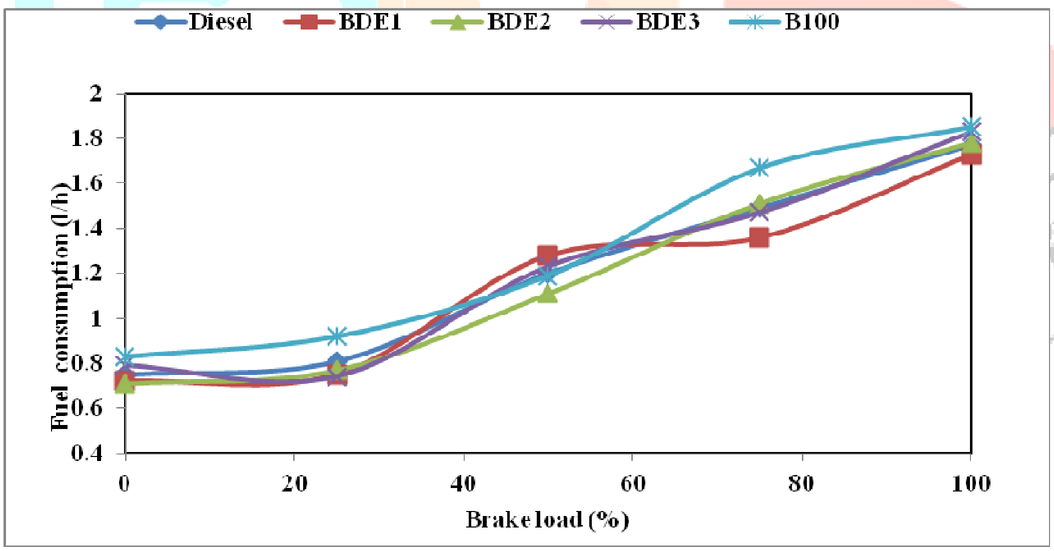

Fig 3-Fuel consumption (l/h) corresponding to brake load when operating on Diesel, B100 and different blends of Diesel, BD and DEE

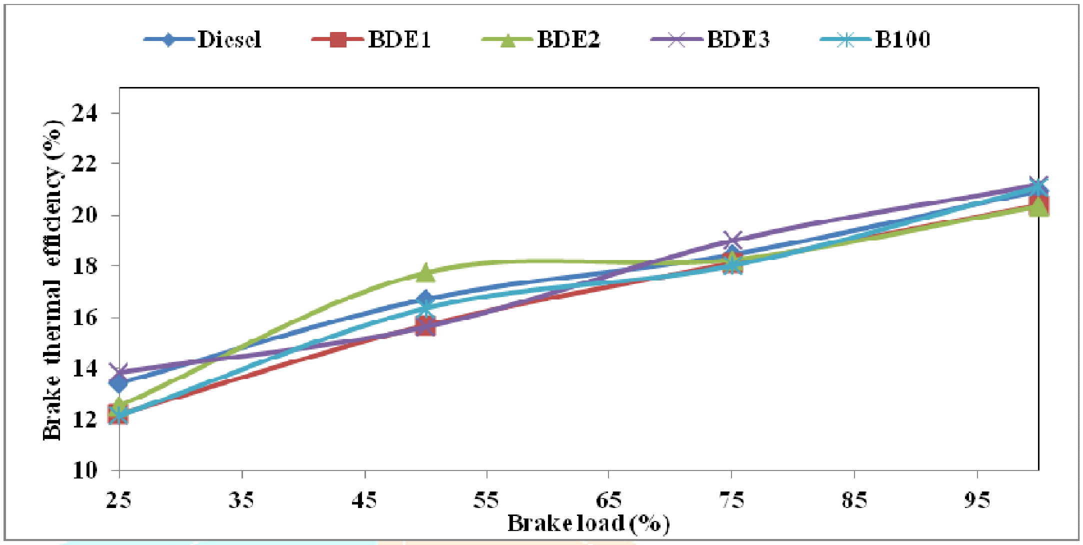

Fig 4-Brake thermal efficiency corresponding to brake load when operating on Diesel, B100 and different blends of Diesel, BD and DEE

6.1.3 Brake specific fuel consumption

Table 2 shows the brake specific fuel consumption (BFSC) of the engine on various fuel types at different load conditions. The relationship between the brake fuel consumption of the engine and brake load on different fuel types is presented in Fig 2. The brake specific fuel consumption of engine when developing rated power on diesel was found to be 0.39 kg/kW-h. it was observed that BSFC of the engine at rated load (100 percent load) condition was 0.4, 0.42, 0.41, 0.45kg/kW-h on BDE1,BDE2,BDE3 and B100 respectively. As the calorific value of B100 is lower than diesel so BSFC of B100 is higher than Diesel.

6.1..4 Brake thermal efficiency

The relationship between brake thermal efficiency and the brake load is shown in Fig 4. Brake thermal efficiency of the engine on diesel at rated brake load was observed to be 20.92 percent. The comparison of observed brake thermal efficiency indicates that when engine developed its rated power, it was 20.38, 20.34, 21.21, 21.11 percent on BDE1, BDE2, BDE3 and B100 respectively. It is clear from the figure that the BDE3 ,B100 are having higher brake thermal efficiency than diesel . And at lower load BDE2 has higher Brake thermal efficiency than Diesel.

On the basis of fuel consumption test, engine performance was found satisfactory on all selected fuel blends. All the blends were able to produce as much as power as diesel. The engine consumed 1.85l/h fuel on B100 while on diesel 1.77l/h at rated load condition. TheBSFC was lowest in BDE1. The brake thermal efficiency of the engine on low loads was found higher than diesel in BDE2.Fuel Consumption was almost lower thandiesel . Based on the above 100 percent Jatropha Biodiesel may be recommended as CI engine fuel. The engine performance was best on BDE 2 as overall performance on the basis of Brake thermal efficiency, BSFC, Fuel consumption .

7.CONCLUSIONS

A 4.4 kW, constant speed diesel engine was tested on diesel, BDE 1(DEE-5%,BD-10%,D-85%), BDE2(DEE-10%,BD-20%,D-70%), BDE3(DEE-15%,BD-30%,D-55%) andB100. The performance of the engine was found to be satisfactory on the blends. On the basis of the results obtained from the whole Investigation, the following conclusion can be drawn:

1) The density of B100used in the experiment was 7.69 % higher than the diesel .
2) The viscosity of Jatropha biodiesel was about 35% higher than the diesel.
3) The gross heat of combustion of raw jatropha oil is found to be 2.61% lower than the diesel.
4) The performance evaluation of 4.4 kW diesel engine under the fuel consumption test on blends of Jatropha, DEE and diesel was found satisfactory on the basis of brake power, brake specific fuel consumption and brake thermal efficiency.
5) The engine was able to develop power similar to diesel on all the Jatropha-DEE- diesel blends.
6) The brake thermal efficiency of the engine on BDE2 was found higher than diesel on lower load .
7) The engine performance was the best on BDE2 as the brake thermal efficiency was found to be high at lower load and overall BTE of BDE3 was highest and BSFC was found to be second lowest on BDE2 blend as BSFC was lowest on BDE1.
8) The discussion indicates that Jatropha B100 may be recommended as CI engine fuel. However for the better performance of the engine BDE2 may also be recommended. Further, the engine emission on Jatropha oil ethyl ester may be investigated.

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