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Experimental Testing of Bio Fuel Extracted from Cassava

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Abstract— In this study, ethanol has been extracted from raw cassava root and blended with diesel. The performance of a constant speed, stationary diesel engine using ethanol–diesel blends as fuel has been evaluated experimentally. The experiments have been performed using 5, 10, 15 and 20% ethanol-diesel blends. Diesel fuel has been used as a basis for comparison the testing of various engine parameters such as BHP, RPM and efficiency. The efficiency observed for blending of 15% of ethanol in diesel with 1% additive is higher than any other proportion of the blending of diesel with ethanol.

Index Terms— Biofuel, Cassava, Brake Power, Thermal Efficiency.

I. INTRODUCTION

Cassava (Mnihotesculenta), also called manioc, is the third largest source of carbohydrate for human consumption in the world, with an estimated annual world production of 208 million tonnes. In Africa, which is the largest centre of cassava production, it is grown on 7.5 million hectares and produces about 60 million tonnes per year. Cassava is also known as yucca in Central America, mandioca or manioca in Brazil, tapioca in India and Malaysia and cassada or cassava in Africa and Southeast Asia.

It is a major resource of low cost carbohydrates and a staple food for 500 million people in the humid tropics. The crop is highly efficient in producing starch, it is year round available, it is tolerant to extreme stress conditions and it fits nicely within traditional farming systems. Fresh roots contain about 30% starch. Cassava starch is one of the best fermentable substances for production of ethanol. At the moment sugarcane is the most widely used crop bio-ethanol in the tropics, but sugarcane requires a lot of water. Since 2004, the world production of cassava roots has been greater than 200 million tons and reaches 240 million tons in 2009.

Biodiesel is methyl or ethyl ester of fatty acid made from animal fat and virgin or used vegetable oils (both edible as well as non-edible). The main resources for biodiesel production can be non-edible oils extracted from plant species such as *Jatropha curcas* (Ratanjyot), *Pongamia pinnata* (Karanj), *Calophyllum inophyllum* (Nagchampa, polanga), *Hevca brasiliensis* (Rubber) etc,.

Biodiesel operates in compression ignition (diesel) engine, and essentially require very little or no engine modifications as its properties are similar to mineral diesel. [7]

Researchers have shown that the engine power and torque drops with the introduction of biodiesel. This is generally attributed to higher viscosity and density and lower heating value. However, increase in power with increased content of biodiesel has also been reported.

There is consensus among the researchers that lower heating value of biodiesel is attributed to the decrease in engine power. Researchers have also agreed that the fuel consumption of an engine fueled with biodiesel becomes higher because it is needed to compensate the loss of heating value of biodiesel.

Ethanol is an alcohol most often chosen because of ease of production, can be obtained from various kinds of biomass such as maize, sugarcane, sugar beet, corn, cassava, red seaweed etc.,

II. LITERATURE REVIEW

Dwivedi and Sharma [1] performed evaluation of a 4 stroke, single cylinder diesel engine using biodiesel from Pongamia oil. They prepared different blends of Pongamia biodiesel with diesel namely B10, B20, B30, B40, B50, and B100. Comparison of performance has been done with diesel. Brake specific fuel consumption (BSFC) of B10 is same as diesel. All other samples have higher BSFC value. Sample B10, B20 have similar fuel properties as diesel.

Suthar *et al.* [2] evaluated the effects of neem oil biodiesel/diesel blends on the performance. They have reported multi cylinder, 4-stroke, and water cooled compression ignition engine. They prepared the blends of Neem oil biodiesel and diesel on volume basis as follows: B10: 10% Neem oil biodiesel and 90% diesel, B20: 20% Neem oil biodiesel and 80% diesel, B30: 30% Neem oil biodiesel and 70% diesel. Brake thermal efficiency with B20 fuel is 30.50%, which is higher compared to 29.89% of diesel. Maximum Brake Thermal Efficiency (BTE) with B10 and B30 fuels are found 27.97% and 28.45% respectively, which are lower compared to 29.89% with diesel. Lowest Brake Specific Energy Consumption (BSEC) for B10, B30 and diesel fuels is approximately 16%, 17% and 11% higher as compared to lowest BSEC for B20 fuel.

Liaquat *et al.* [4] studied the effect of coconut biodiesel blended fuels on engine performance. They have prepared three fuel samples, such as DF (100% diesel fuel), CB5 (5% coconut biodiesel and 95% DF), and CB15 (15% CB and 85% DF). Compared to diesel fuel, engine torque and brake power for biodiesel blends have decreased, mainly due to their respective lower heating values. The BSFC values for biodiesel blends are higher when compared to diesel fuel due to lower heating values and higher densities.

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Raheman *et al.* [5] evaluated using blends of biodiesel (B10 and B20) obtained from a mixture of mahua and simarouba oils (50:50) with High Speed Diesel. BSFC, in general, has been found to increase with an increase in proportion of biodiesel in the fuel blends with HSD. There has been a reduction in BTE with the increase in biodiesel percentage in the fuel blends due to the decrease in calorific value of fuel blend.

Bora *et al.* compared the performance of biodiesel prepared from the mixture of polanga oil, karangja oil and jatropha oil. Six samples have been prepared namely B20 (20% biodiesel by volume with 80% diesel by volume), B40 (40% biodiesel by volume with 60% diesel by volume), B60 (60% biodiesel by volume with 40% diesel by volume), B80 (80% biodiesel by volume with 20% diesel by volume) and B100 (100% biodiesel by volume). Brake specific fuel consumption (BSFC) values of blends are slightly higher than those of diesel fuel at all loads [6].

Rao has experimented on performance of Jatropha biodiesel on a DI-CI engine. For all loads, the fuel consumption of Jatropha biodiesel is more than that of diesel fuel. The BTE increases as the output power increases for both the fuels.

III. SPECIFICATION

Table 1: Specifications of Engine

Parameter	Specification
Type	Four stroke direct injection two cylinder diesel engine
Type of cooling	Water cooled
Rated power	10.3 kW (14 BHP) at 1500 rpm
Cylinder diameter	87.5 mm
Stroke	200 mm
Compression ratio	17.5 : 1
Capacity	1322

A. Experimental setup

Experimental observations have been carried out by with ethanol extracted from cassava blended with diesel for different proportions. Experiments have been carried out at a constant speed of 1500 rpm. Different performance parameters viz. brake power, indicated power and efficiency have been studied for blended diesel and compared with diesel fuel using four stroke direct injection two cylinder diesel engine. Table 1 shows the specifications of the engine.

B. Sample preparation

Ethanol has been extracted from cassava. A suitable range of proportion of diesel, ethanol and additive (water) has been taken as Ethanol: 0-5%, Additive (water): 0.2-5%, Diesel: remainder. Four samples have been prepared. Table 2 shows the composition of different samples prepared.

Table 2: Composition of different samples

Sample no.	Ethanol in % (ml)	Water in % (ml)	Diesel in % (ml)
1	5% (12.5 ml)	1% (2.5 ml)	94% (235 ml)
2	10% (25 ml)	1% (2.5 ml)	89% (222.5 ml)
3	15% (37.5 ml)	1% (2.5 ml)	84% (210 ml)
4	20% (50 ml)	1% (2.5 ml)	79% (197.5 ml)

IV. RESULTS AND ANALYSIS

Performance tests have been conducted by taking fuel as diesel and the prepared samples of blended diesel. Table 3, 4, 5, 6 and 7 shows testing conditions for different samples prepared. Rotational speeds and loads have been varied. Performance comparison has been made for diesel with biodiesel. The performance parameters studied for comparison are brake power, indicated power and torque at different loading conditions.

Table 3: Testing conditions for diesel

Sample	RPM	Load (kgf)	Temperature	
			T1 (°C)	T2(°C)
Diesel	1518	14.0	20	27
	1499	14.6	20	28
	1489	16.8	21	29
	1491	18.4	21	28

Table 4: Testing conditions for Sample no. 1

Sample no.	RPM	Load (kgf)	Temperature	
			T1 (°C)	T2(°C)
1	1569	7.9	21	29
	1555	12.9	20	28
	1567	18.0	21	29
	1565	17.3	21	29

Table 5: Testing conditions for Sample no. 2

Sample no.	RPM	Load (kgf)	Temperature	
			T1 (°C)	T2(°C)
2	1570	14.3	21	29
	1568	16.4	21	29
	1550	20.0	21	29
	1555	22.0	22	30

Table 6: Testing conditions for Sample no. 3

Sample no.	RPM	Load (kgf)	Temperature	
			T1 (°C)	T2(°C)
3	1568	12.0	29	36
	1563	15.0	31	38
	1552	16.3	36	43
	1541	19.4	26	33

Table 7: Testing conditions for Sample no. 4

Sample no.	RPM	Load (kgf)	Temperature	
			T1 (°C)	T2(°C)
4	1544	9.5	21	28
	1534	13.6	21	28
	1520	15.9	23	29
	1509	20.8	21	30

Based on the readings for diesel and four samples of blended diesel performance characteristics viz. torque, brake power, indicated power and efficiency of average data have been calculated.

The efficiency observed for blending of 15% of ethanol (sample no. 3) in diesel with 1% additive is higher than any other proportion of the blending of diesel with ethanol.

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An average of different engine speeds has been taken for fuel as diesel and BP, IP and efficiency has been calculated.

Table 8: Performance of diesel engine with diesel

Sample	Average rpm	Torque (Nm)	BP (kW)	IP (kW)	Efficiency (%)
Diesel	1499.25	48.99	0.50	3.13	15.9

An average of different engine speeds has been taken for fuel as blended diesel and BP, IP and efficiency has been calculated.

Table 9: Performance of diesel engine with blended samples

Sample no.	Average rpm	Torque (Nm)	BP (kW)	IP (kW)	Efficiency (%)
1	1564	51.11	0.68	3.83	17.75
2	1560.75	51	0.59	3.715	15.8
3	1556	50.85	0.51	2.07	24.6
4	1526.75	49.89	0.47	3.59	13.10

It has been seen that efficiency of sample no. 3 is highest when compared with other samples of blended diesel and diesel as well.

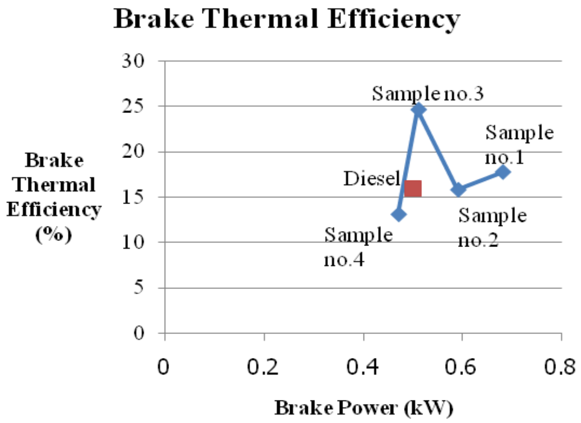

Fig 1. Variation of Brake Thermal Efficiency with Brake Power.

V. CONCLUSION

Biodiesel is a feasible substitute for diesel fuel. The production and consumption of biodiesel will increase in future. Based on the engine performance tests, following conclusions can be drawn.

1. Engine can be run with biodiesel, ethanol and its diesel blends, i.e. Sample no. 1, 2, 3 and 4 without any abnormality and engine modification.
2. It has been seen in comparison of blended diesel and diesel that sample no. 3 has highest efficiency.

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