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An Experimental Analysis of Performance and Emission on IDI Diesel Engine Fuelled with Different Blends Biodiesel, Diesel Additive and Diesel

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Abstract

The scarcity of conventional fossil fuel, their increasing cost and the detrimental effects of combustion engendered pollutants seems to make alternative sources more appealing. The present experiment assess the performance and emission distinctive of a diesel engine using dissimilar blends of methyl ester of Mahua and ethanol with mineral diesel. In different concentrations of ethanol and biodiesel were studied. The results show that ethanol, biodiesel and diesel blends lead to a positive effect on the reduction in the nitrogen oxide. Brake thermal efficiency was better in different blends (methyl ester of Mahua oil, ethanol and diesel) as compared to the pure diesel. Also a comparative trade-off analysis was done in between BThE, BSFC and NOx to reflect the performance and emission characteristics at a time.

Keywords:— Mahua Biodiesel, Ethanol, trade-off study

I. Introduction

Environmental contamination and depletion in fossil fuel resources forced scientists and engineers to concentrate investigation on renewable alternative to conventional fossil fuel. An immense deal of explorations work mainly on diesel engines has taken place not only in the design are but also in penetrating an alternative fuel [1-4]. Many researchers have concluded that biodiesel holds pledge as an alternative fuel. At present biodiesel produced mainly from meadow crop oils like rape seed, sun flower etc. We can see the various properties shown in the table 1 with comparing pure diesel. Transestrification, also called alcholysis, is the displacement of one alcohol from an ester by another alcohol in a process similar to hydrolysis. RCOOR'+R''OH→ RCOOR'' +R''OH. Triglycerides are readily transesterified in the presence of alkaline catalyst at atmospheric pressure and at a temperature of approximately 600 to 700 [4-5]. Automobile sector contributes a significant amount of carbon dioxide, one of the principal greenhouse gasses [6]. In more than 30 million miles of in-field demonstrations, B20 showed similar fuel consumption, horsepower, torque, and haulage rates as conventional diesel fuel. Mahua oil has an estimated annual production potential is very high in India [1-3]. This research was focused on the engine performance, emission and trade-off characteristics of MME and diesel additive like ethanol, when used in a diesel engine [3, 5, 9-11].

II. Experimental Procedure and Specifications

The engine was used for experimental work consist of single cylinder, four stroke, diesel engine which connected to eddy current type dynamometer (Figure 1). Specifications of the engine are shown in Table 1. The exhaust gas analyzer AVL Digas 444 will be used for exhaust gas analyzer. The emissions such as Nitrogen oxide (NOx) (Table 2) is measured as n-hexane equivalent ppm (parts per million). Together they constitute the emission characteristic for the combustion process. The measuring pipe of the analyzer is directly applied on the exhaust manifold of the engine after the calorimeter. The experiments are conducted by using diesel (D100), BLD1, BLD2, BLD3, BLD4 at different load conditions on the engine from 0 to 100% in appropriate steps at a compression ratio (CR) 20:1. The performance test is carried out on a single cylinder indirect injection diesel engine using pure diesel, the methyl ester of mahua oil, ethanol and their blends with diesel. The load range taken is from no load to full load. Table 3 shows the basic fuel properties of biodiesel used in this study in addition to ethanol and diesel.

Table 1: Engine specification

Make and type	**Kirloskar/Varsha**
Engine type	Horizontal four stroke/ single cylinder diesel engine
Stroke length	74mm
Swept volume	0.381 litres
Compression ratio	20:1
Power	4hp
Rated speed	1700-1800 rpm
Bore size	74 mm
Dynamometer	
Lubrication	Forced
Starting	Crank
Fuel	Diesel
Maximum	load 4 kg
Cooling	Air

Table 2: Measurement range of exhaust gas analyzer

Measurement parameter	Measurement range
Oxygen (O2)	0--22 Vol %
Carbon mono-oxide (CO)	0--10 Vol%
Nitric oxide (NO)	0--5000 ppm
Carbon dioxide (CO2)	0--20 Vol %
Hydro Carbon (HC)	0--20000 ppm

Table 3: Properties of Biodiesel, Diesel and Ethanol

Properties	Diesel	MME	Ethanol
Density@ 150 C (gm/ cc)	0.813	0.831	0.789
Viscosity@ 400 C (Cst)	2.46	4.46	1.22
Flash Point (0ºC)	55	175	13
Cetane Number	52	43	41.4

III. Results and Discussion

A. Engine Performance

I. Brake Specific Fuel Consumption

As clear from the figure that BSFC shows a persistent trend of reduction with load for all fuel, which may be due to the higher percentage increase in brake power with load as compared to increase in the fuel consumption. The brake specific fuel consumption (BSFC) values for different fuel blends at different loads shown in Figure 2. The BSFC values of all fuels decease at increasing in load. BSFC for ethanol and mahua biodiesel blends (BLD1, BLD2, BLD3, and BLD4) was always lower than mineral diesel due to presence of diesel additives help for proper combustion [7].

II. Brake Thermal Efficiency (BThE)

BThE indicates the ability of the combustion system to accept the experimental fuel, and provides comparable means of assessing how efficient the energy in the fuel is converted to mechanical output The BThE of IDI diesel engine obtained for different fuels is shown in Figure 3 as a function of load for compression ratios of 20:1. The maximum BTE were BLD2 and BLD1, respectively. This could be attributed to the presence of increased amount of oxygen and presence of ethanol in all blends, which might have resulted in its improved combustion as compared to pure diesel [5].

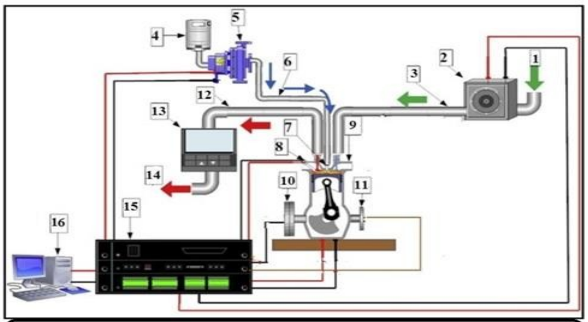
III. Oxide of Nitrogen (NOx)

NOx emissions increase in all cases as the load increases due to higher combustion temperature, as seen in Figure 4. The formation of NOx strongly depends upon fuel properties, temperature, oxygen presence, residence time under high temperature and injection-related factors [8-9]. Maximum of research and publications have described that use of oxygenated fuels indicates the greater formation of NOx because of cetane number, higher bulk modulus, viscosity and density of the biofuels [11]. Most of the major exhaust pollutant such as NOx (Figure 4) is reduced with the use of biodiesel and the additive

B. Trade-Off Analysis

The present study deals with a complete trade off analysis carried on full load levels involving NOx, BSFC and BThE diesel equivalent, which has been summarized in Figure 5. Thus, this study deals a scope to explore the best possible fuel combination at full load conditions, which will simultaneously reduce NOx at optimum fuel consumption and brake thermo efficiency.

Figure 5 shows the tradeoff graph at full load condition. Seeing the graph it is again marked that highest BThE for BL2 as well as lowest NOx and minimum bsfc compared to D100 and all other blends.



1= air inlet port; 2= Air box; 3=Intake manifold; 4=Pilot fuel tank; 5 =Pilot fuel pump; 6= Pilot fuel line; 7=Mechanical injector; 8=In-cylinder pressure sensor; 9= Test engine; 10=Dynamometer; 11=Crank angle encoder; 12= Exhaust manifold; 13=Exhaust gas analyser; 14 =Exhaust; 15=DAQ; 16=Engine control;

Figure 1: Experimental Setup

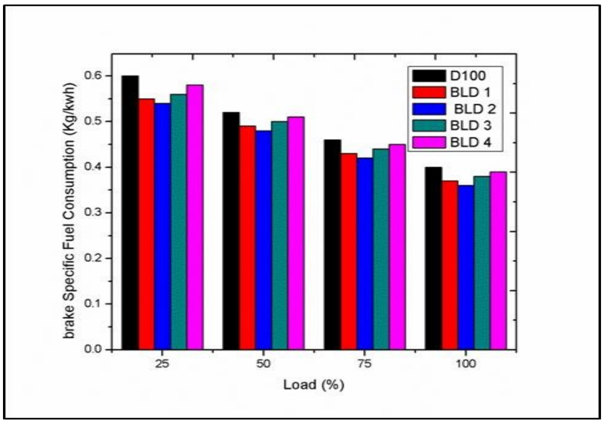


Figure 2: bsfc as a function of load for different fuel blends

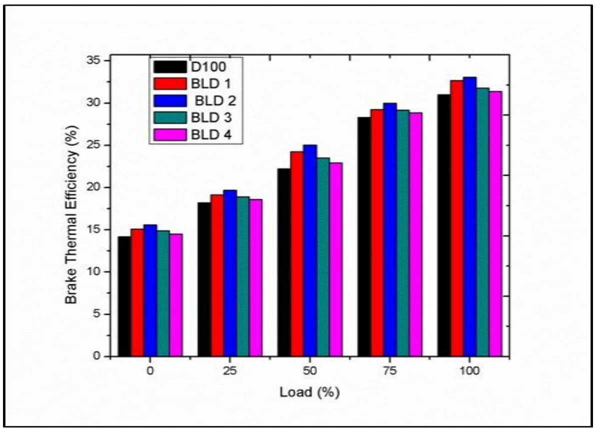


Figure 3: BthE as a function of load for different fuel blends

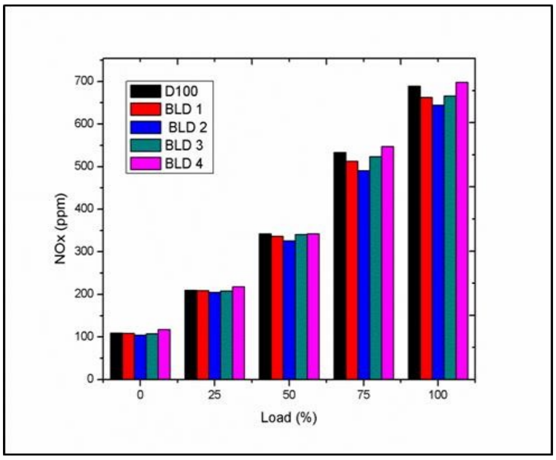


Figure 4: NOx as a function of load for different fuel blends

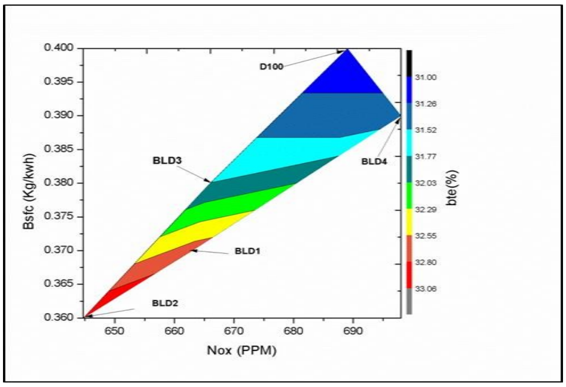


Figure 5: Trade-off between NOx-Bsfc with reference to BThE at 100% load condition

IV. Conclusions

The aim of the present experimental investigation was to analyses the performances and emissions of Mahua methyl ester and Ethanol blends with pure diesel. The subsequent conclusions are drawn from the investigational results:

- Mahua Biodiesel and Ethanol seems to have a potential to be used as a substitute fuel in Direct Injection diesel engines without any amendment.
- The brake thermal efficiency (Figure 3) all blends are better than pure diesel. Brake specific fuel consumption (Figure 2) is lower for all blends of MME, Diesel additive

and diesel than D100 at all load conditions.

- Most of the major exhaust pollutant such as NOx (Figure 4) is reduced with the use of biodiesel and the additive.
- In trade-off study it has been observed that at full load condition BLD 2 is the optimum blends for our uses.
- From experiment, it is concluded that BLD 2 could replace the diesel for diesel engine for getting better performance and less emission.

Nomenclature

MME Mahua methyl ester

D100 Pure diesel

BLD 1 20% MME+3%Ethanol+77% diesel
BLD 2 20% MME+6%Ethanol+74% diesel
BLD 3 20% MME+9%Ethanol+71% diesel
BLD 4 20% MME+80%diesel

bsfc Brake specific fuel consumption

BThE Brake thermal efficiency

NOx Oxide of Nitrogen

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REFERENCES:

[1] Deb, Madhujit, G. R. K. Sastry, P. K. Bose, and Rahul Banerjee. "An experimental study on combustion, performance and emission analysis of a single cylinder, 4-stroke DI-diesel engine using hydrogen in dual fuel mode of operation." International journal of hydrogen energy 40, no. 27, pp.8586-8598, 2015.

[2] Deb, Madhujit, Rahul Banerjee, Arindam Majumder, and G. R. K. Sastry. "Multi objective optimization of performance parameters of a single cylinder diesel engine with hydrogen as a dual fuel using pareto-based genetic algorithm." International Journal of Hydrogen Energy 39, no. 15, pp. 8063-8077, 2014.

[3] Panda, Jibitesh Kumar, G. R. K. Sastry, and Ram Naresh Rai. "A Taguchi-Fuzzy-Based Multi-Objective Optimization of a Direct Injection Diesel Engine Fueled With Different Blends of Leucas Zeylanica Methyl Ester and 2-Ethylhexyl Nitrate Diesel Additive With Diesel." Journal of Energy Resources Technology 139, no. 4, pp.042209,2017.

[4] Sastry, G. R. K., Madhujit Deb, and Jibitesh Kumar Panda. "Effect of fuel injection pressure, isobutanol and ethanol addition on performance of diesel-biodiesel fuelled DI diesel engine." Energy Procedia 66, pp.81-84, 2015.

[5] Özener, Orkun, Levent Yüksek, Alp Tekin Ergenç, and Muammer Özkan. "Effects of soybean biodiesel on a DI diesel engine performance, emission and combustion characteristics." Fuel 115, pp. 875-883, 2014.

[6] Rashedul, H. K., et al. "The effect of additives on properties, performance and emission of biodiesel fuelled compression ignition engine." Energy Conversion and Management 88, pp. 348-364, 2014.

[7] Hulwan, Dattatray Bapu, and Satishchandra V. Joshi.

"Performance, emission and combustion characteristic of a multicylinder DI diesel engine running on diesel–ethanol–biodiesel blends of high ethanol content." Applied Energy 88.12, pp. 5042-5055, 2011.

[8] Kumar, Sachin, et al. "Performance and emission analysis of blends of waste plastic oil obtained by catalytic pyrolysis of waste HDPE with diesel in a CI engine." Energy Conversion and Management 74, pp. 323-331, 2013.

[9] Panda, Jibitesh Kumar, Gadepalli Ravi Kiran Sastry, and Ram Naresh Rai. "Experimental analysis of performance and emission on DI diesel engine fueled with diesel-palm kernel methyl ester-triacetin blends: a Taguchi fuzzy-based optimization." Environmental Science and Pollution Research pp. 1-17, 2018.

[10] Hulwan, Dattatray Bapu, and Satishchandra V. Joshi. "Performance, emission and combustion characteristic of a multicylinder DI diesel engine running on diesel–ethanol–biodiesel blends of high ethanol content." Applied Energy 88.12, pp.5042-5055, 2011.

[11] Subbaiah, G. Venkata, K. Raja Gopal, Syed Altaf Hussain, B. Durga Prasad, and K. Tirupathi Reddy. "Rice bran oil biodiesel as an additive in diesel-ethanol blends for diesel engines." International journal of research and reviews in Applied sciences 3, no. 3, pp. 334-342, 2010.

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