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Research Article

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Performance and Emission Characteristics Investigation of Jatropa Methyl Ester under the Influence of Butanol in a CI Engine

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ABSTRACT

Biodiesel is a promising alternative fuel or in combination with petroleum diesel for environmental benefits. In this study, the biodiesel used is Jatropha oil, which is manufactured from jatropha curus by trans-esterification process using KOH as catalyst. The performances and emission characteristics of jatropha blended with diesel along with butanol (n-butanol) is studied. The butanol additive is mixed with B20 (20% of biodiesel +80% of diesel) in various proportion and analysed in Kirloskar TV-1 engine. A minor increase in brake thermal efficiency with significant improvement in reduction of smoke density, hydrocarbon (HC), carbon dioxide (CO_2) compared to diesel. It has also little effect on reduction of NO_X and CO. The use of trans-esterified Jatropha oil and its blend will reduce the dependence on fossil fuels and also decreases considerably the environment pollution.

Keywords: N-butanol; Performance; Emission; Jatropha methyl ester

INTRODUCTION

Global air-pollution is a serious problem. Much of this pollution is caused by the use of fossil fuel. The emission coming out of an automobile engine usually contain smoke, particulate matter, carbon monoxide (CO), unburned hydrocarbon (HC), and the oxides of nitrogen (NOx). Testing plan biodiesel and NPAA additives to control NO_x and CO while improving efficiency in diesel engine. It was found that B20X fuel shows better overall performance such as improved brake power, reduced exhaust emissions and shows better lube oil quality as compared to other tested fuels. [1-4]. The results on jatropha oil blend with diesel in various proportions 97.4%/2.6%, 80%/20% and 50%/50% by volume in that 2.6% jatropha oil fuel blend produces higher brake power and brake thermal efficiency as well as minimum value of fuel consumption. From the investigation , the engine emission such as smoke, HC, and CO are reduced when MEA is added in diesel however, MEA has a little effect on NOx emission and engine thermal efficiency increases about 2% [2,5-7].

Biodiesel mixes well with diesel fuel and stays blended. Biodiesel has a higher cetane number than petroleum diesel fuel, no aromatics, and contains 10-11% oxygen by weight. These characteristics of biodiesel reduce the emission of carbon monoxide (CO), hydrocarbons (HC), and particulate matter (PM) in the exhaust gas compared with diesel fuel. However, NO_x emission of biodiesel increase because of combustion and some fuel characteristics. By adding additives to Biodiesel blend with diesel they get effective result in reducing emission characteristics and also considerable improvement in performance characteristics. In this present work the effect of 2-methoxy ethyl acetate (an oxygenated additive) in various proportion with B20 on performance and emission characteristics were discussed. The various proportions of 2-methoxy ethyl acetate such as 5 ml, 7.5 ml, 10 ml, 15 ml, 20 ml, and 25 ml added per litre of B-20(20% Biodiesel and 80% Diesel). The biodiesel used is methyl ester of Jatropha oil. The load tests were conducted for analyzing the performance and emission characteristics with constant speed at 1500 rpm in D.I. Diesel engine.

Blending of Esters with Diesel

Blending conventional Diesel Fuel (DF) with esters (usually methyl esters) of vegetable oils is presently the most common form of biodiesel. The most common ratio is 80% conventional diesel fuel and 20% vegetable oil ester, also termed as "B20" indicating the 20% level of biodiesel. There are number of experiments shows that significant emission reductions with these blends. The imitation of biodiesel is its tendency to crystallize below 0°C. Such crystals can plug fuel lines and filters, causing problems in fuel pumping and engine operation. This recrystallization may be prevented using branched-chain esters, such as isopropyl esters.

EXPERIMENTAL SECTION

Description

Figure 1 shows the experimental set up which consists of Kirloskar TV-1 engine, gas analyser, AVL smoke meter and loading device. The engine was coupled with loading device (eddy current dynamometer) to vary the load of the engine. The exhaust pipe of the engine is connected to AVL smoke meter to measure the smoke density and gas analyser is to measure the exhaust emission (CO, CO_2, NOX, HC,O_2) and a thermometer is installed in exhaust pipe to measure the temperature of exhaust gas.

Experimental Procedure

- The load test was conducted by maintaining a constant speed at 1500 rpm.
- The water flow is started and maintained constant throughout the experiment.
- The load, speed and temperature indicators were switched on.
- The engine was started by cranking after ensuring that there is no load.
- The engine is allowed to run at the rated speed of 1500 rev/min for a period of 20 minutes to reach the steady state.
- The fuel consumption is measured.
- Then the load is applied gradually as 0, 25, 50, 75 and 100%.
- Experiments were conducted using diesel and smoke density, exhaust gas temperature and exhaust emissions are measured and noted.
- Then the experimental procedure was repeated for B20 (20% MEOJ + 20% diesel).

B20 added with butanol of various proportions such as 5 ml, 7.5 ml, 15 ml, 20 ml and 25 ml per litre of B20.
And the corresponding fuel consumption, exhaust gas temperature, smoke density and exhaust emission were measured. After investigating the performance characteristics and emission characteristics, the best blend of B20 with butanol was determined (Tables 1 and 2).

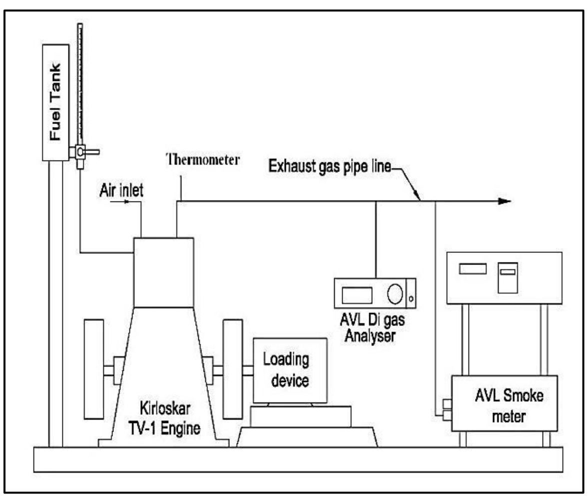

Figure 1: Experimental setup

Table 1: Physical properties of butanol

1	Boiling point	118°C
2	Cetane Number	~25
3	Density @ 20°C (kg/m^3)	810
4	Solubility in water	Miscible
5	Lower Calorific Value (Mj/kg)	33.1
6	Kinematic Viscosity @ 20°C (mm^2/s)	3.6
7	Latent Heat of Vapourization (kJ/kg)	585
8	Oxygen % (by weight)	21.6
9	Stoichiometric air-fuel ratio	11.2
10	Molecular Weight	74

Table 2: Specification of the test engine

Type	Vertical, Water cooled, Four stroke
Number of cylinder	1
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Maximum power	5.2 kW
Speed	1500 rev/min
Dynamometer	Eddy current
Injection timing	23° before TDC
Injection pressure	220 kgf/cm^2

RESULTS AND DISCUSSION

The specific fuel consumption, brake thermal efficiency and exhaust emission characteristics of butanol in various proportion is mixed with B20 (20% MEOJ +80% Diesel) is discussed in the following headings.

Emission Characteristics

Smoke density:

Smoke emissions are due to lean air fuel mixture or rich air fuel mixture. The smoke or soot primarily comprises of carbon particle. Figure 2 shows the smoke density of butanol, biodiesel and diesel. A vast reduction in smoke density is observed in B20 compare to diesel and also there is reduction in smoke density when butanol is added with B20% and the 15 ml of butanol added with B20 is more effective in reduction of smoke density.

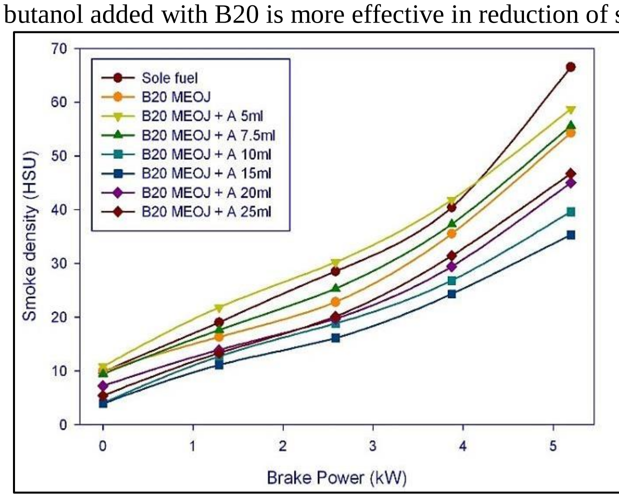

Figure 2: Brake power vs. smoke density

Hydrocarbon (HC) emission:

Figure 3 shows that the Hydro Carbon emission of B20 (20% MEOJ + 80% diesel) the various proportion of butanol added with B20, Biodiesel and Diesel. The unburnt hydrocarbon increased in B20 and significant decrease of unburnt Hydrocarbon in butanol with B20 in 15 ml. This reveals that the HC emissions tends to reduce as the oxygen content of fuel increases.

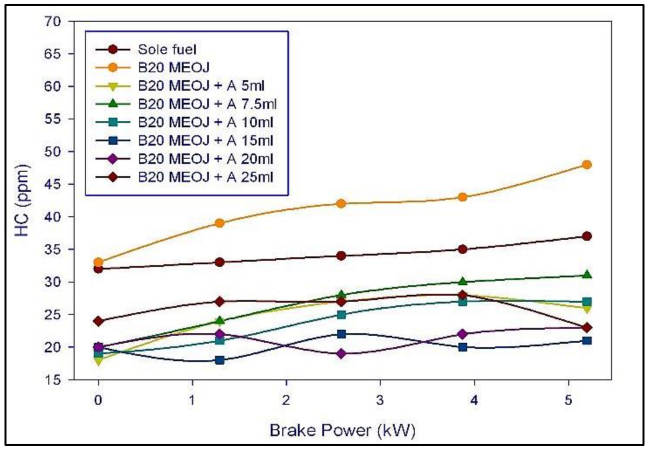

Figure 3: Brake power vs. hydrocarbon

Nitrogen oxides (NOx) emission:

Figure 4 shows the NO_X emission of B20 the various blends of butanol added with B20, Biodiesel and Diesel. By comparing B20 with diesel, the emission of NO_X has increased. This is due to the MEOJ provide additional oxygen for the formation of NOx. There is a significant reduction in emission of NOx in 20 ml of butanol with B20. It is more effective in reduction of NOx.

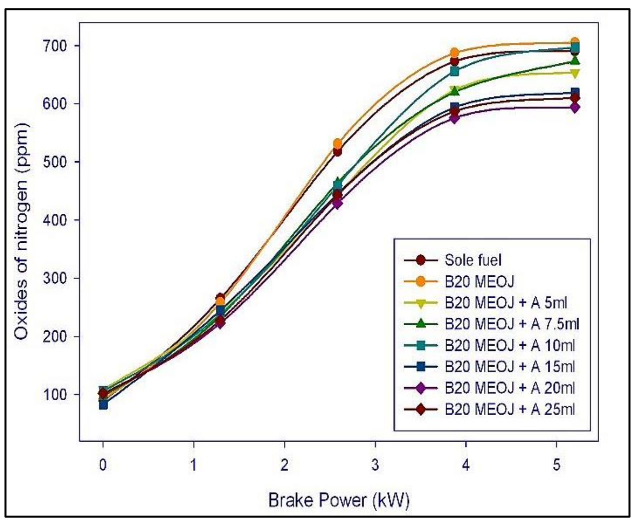

Figure 4: Brake power vs. oxides of nitrogen

Carbon dioxide (CO_2) emission:

Figure 5 shows the carbon dioxide emission of B20 with butanol in various proportion, B20 and diesel. The carbon dioxide emission has minor increase in B20 compared with diesel. There is a significant reduction in carbon dioxide emission in butanol with B20 when compared to diesel. 25 ml of butanol added with B20 is more effective in reduction of CO_2. This is due to the presence of more oxygen content in butanol.

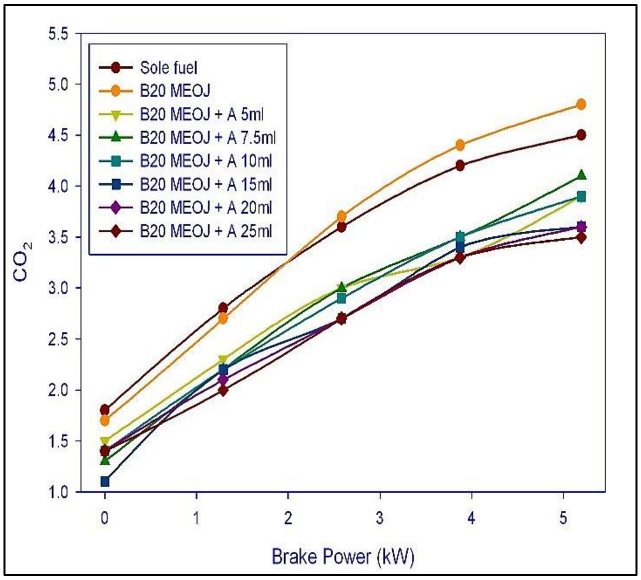

Figure 5: Brake power vs. carbon dioxide

Carbon monoxide emission:

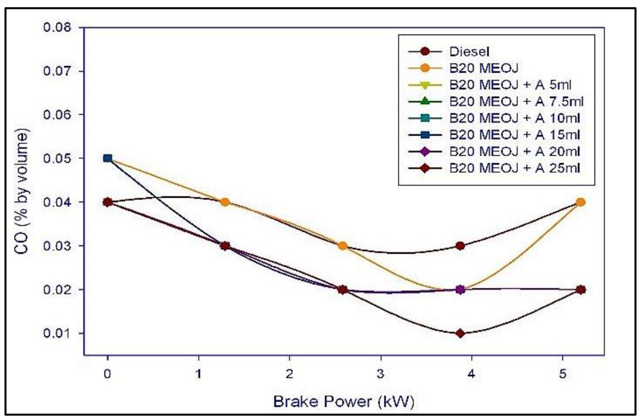

Figure 6: Brake power vs. carbon monoxide

Figure 6 shows the CO emission of B20 with butanol in various proportions, B20 and Diesel. There is a small amount of decrease in CO in B20 when compared to diesel and also significant reduction of carbon monoxide in butanol with B20 when compared to diesel.

Performance Characteristics

Specific fuel consumption:

B20 has lower calorific value than that of diesel. Hence the specific fuel consumption is slightly higher than that of diesel. Figure 7 shows the specific fuel consumption of various blend of butanol with B20 diesel.

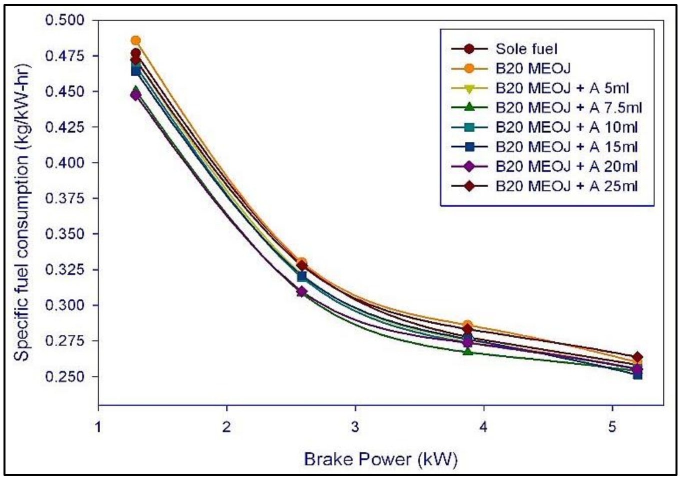

Figure 7: Brake power vs. SFC

Brake thermal efficiency:

Figure 8 shows the Brake Thermal efficiency for various blends of butanol with B20. The improvement in Brake Thermal Efficiency is due to constant volume combustion and the larger increase of molecules by fuel injection. It is concluded that 15 ml of butanol with B20 is the best blend.

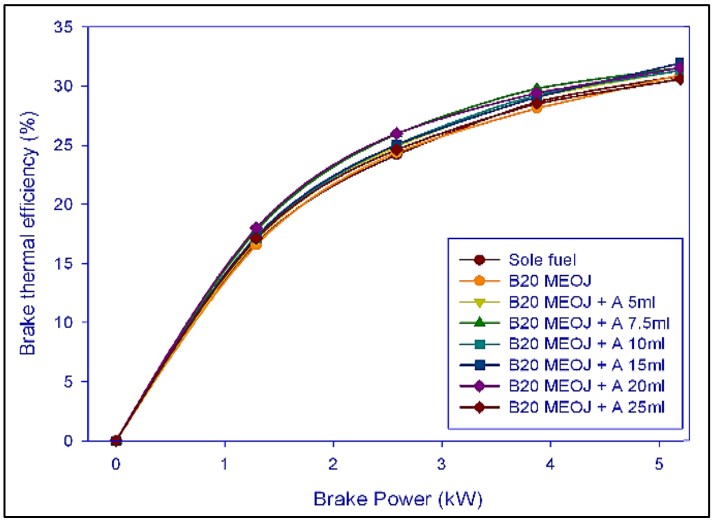

Figure 8: Brake power vs. Brake thermal efficiency

CONCLUSION

The performance and emission characteristics of 2-methoxy ethyl acetate in various proportion such as 5 ml, 7.5 ml, 10 ml, 15 ml, 20 ml, 25 ml are mixed with B20 (20% of methyl ester of jatropha oil blend with 80% of diesel fuel) have been analysed and compared to base line diesel fuel. The experimental result are summarized as follows

1. There is a significant reduction of smoke density, hydrocarbon and carbon dioxide in 2-methoxy ethyl acetate with B20 when compared to diesel.
2. A small amount of reduction in Nitrogen oxides and carbon monoxides in 2-methoxy ethyl acetate with B20
3. The brake thermal efficiency of 2-methoxy ethyl acetate with B20 is increased about 1% to 2%.
4. The 15 ml of 2-methoxy ethyl acetate with B20 is the best blend in reducing emission as well as improving the performance.

REFERENCES

[1] M Canachi; A Erdil; E Arcaklioglu. *Appl Energy*. **2006**, 83(6), 594-605.
[2] C Beatrice; C Bertoli; GN Del; M Migliaccio. *SAE Int*. **1999**, 10-25.
[3] D Agarwal; A Kumar; Agarwal. *Biomass Bioenergy*. **2007**, 31.
[4] G Yanfeng; L Shenghua; G Hejun; Hu Tiegang; Z Longbao. *Appl Thermal Eng*. **2007**, 27(1), 202-207.
[5] FK Forson; EK Oduro; E Hammond-Donkoh. *Renewable Energy*. **2004**, 29(7).
[6] RC Tupe; CJ Dorer. *SAE Int*. **1986**, 861179.
[7] S Herbatman; K Virk. *SAE Int*.**1989**, 892119.