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Performance and Emission Characteristics on Biodiesel Fueled Engine with Influence of Effect of 2-Methoxy Ethyl Acetate (Additive)

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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 transesterification process using KOH as catalyst. The performances and emission characteristics of 2-methoxyethyl acetate an oxygenating additives mixed with B20 (20% of biodiesel +80% of diesel)in various proportion are 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.Iit has also little effect on reduction of NO_X and CO. The use of transesterified Jatropha oil and its blend will reduce the dependence on fossil fuels and also decreases considerably the environment pollution.
Keywords: 2-methoxy ethyl acetate, performance, emission, Jatropha methyl ester.

1. Introduction

Global air-pollution is a serious problem. Much of this pollution is caused by the use of fossil fuel for transportation. 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.[1,3,4]. 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 . So jatropha oil can be used as a ignition accelerator.[5,6,7]

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%.[2,9]. The metal based additives (Mg and Mo) improved flash point, pour point and viscosity of the biodiesel fuel, depending on the rate of additives. CO emissions & smoke capacity decreased by 56.42% & by 30.43%, respectively. In general, low NOx & CO_2 emissions were found with the biodiesel fuels. [8]. The DMC fueled engine has lower NO_x emissions & 2-3% Higher effective thermal efficiency when compared to diesel.[10].

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. When a higher percentage of biodiesel is used in the diesel engine during cold weather, its thickness will be more than diesel fuel and special systems may be required. Therefore it is recommended that a blend of 20% biodiesel with diesel fuel may be used without changing any parts.

The different types of fuel additives are such as cetane improvers, combustion catalysts, deposit modifiers, flow improvers, smoke suppressants and oxygenated fuel additives.

By adding these additives on Diesel, Biodiesel or Biodiesel blend with diesel and 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 5ml, 7.5ml, 10ml, 15ml, 20ml, 25ml added per litre of B-20(20% Biodiesel and 80% Diesel). The Biodiesel used is methyl ester of Japopha oil.

The load test were conducted for analyzing the performance and emission characteristics with constant speed at 1500 rpm in D.I. Diesel engine

2. 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 fuel consumption of biodiesel blend 2-5% higher than that of conventional DF. Another advantage of biodiesel blend is the simplicity of fuel preparation, which only requires mixing of the components.

Several studies have shown that diesel/biodiesel blend reduces smoke, particulate, unburnt hydrocarbon, carbon dioxide and carbon monoxide emissions oxides of nitrogen emissions are slightly increased. 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 prevented using branched-chain esters, such as isopropyl esters.

2.1. Biodegradability

Biodegradability is desirable, in the event of a spill or leak of fuel to the environment. Blending biodiesel with diesel accelerates its Biodegradability and it has been reported that blends of 20% biodiesel 80% diesel fuel degrade twice as fast as near diesel. Furthermore, experiments with blends of biodiesel and diesel at concentrations ranging from 20% to 80%, showed that biodiesel can promote and speed up the Biodegradation of diesel as the more biodiesel present in a biodiesel /diesel mixture.

2.2. Storage and Handling:

Store in closed containers between 50° F and 120° F. Keep away from oxidizing agents, excessive heat, and ignition sources.

3. Experimental Investigation

3.1. Description

Fig. 6.1 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.

3.2. Experimental procedure

The load test was conducted by maintaining a constant speed at 1500rpm.

1. The water flow is started and maintained constant throughout the experiment
2. The load, speed and temperature indicators were switched on.
3. The engine was started by cranking after ensuring that there is no load.
4. 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.
5. The fuel consumption is measured by a stop watch.
6. Then the load is applied gradually, which is connected to the Eddy Current Dynamometer. The load to the engine is varied as 0, 25, 50, 75 & 100% of the full load of the engine.
7. Experiments were conducted using sole fuel diesel. i.e. diesel and the corresponding fuel consumption, smoke density, exhaust gas temperature and exhaust emissions are measured and noted .
8. Then the engine is allowed to cool down before changing the fuel and then the experimental procedure was repeated for

- B20 (20% MEOJ + 20% diesel),
- B20 added with 2-methoxy ethyl acetate of various proportion such as 5ml, 7.5ml, 15ml,.20ml, 25ml per litre of B20.

And the corresponding fuel consumption, exhaust gas temperature, smoke density & exhaust emission were measured. After investigating the performance characteristics and emission characteristics, the best blend of B20 with 2-methoxy ethyl acetate was determined.

Table 1. Physical Properties of 2- Methoxy Ethyl Acetate

1.	Boiling point	145°C
2.	Melting point	-65°C
3.	Relative density (water = 1)	1.01
4.	Solubility in water	Miscible
5.	Vapour pressure, kPa at 20°C	0.27
6.	Relative vapour density(air = 1)	4.1
7.	Relative density of the vapour/air-mixture at 20°C(air = 1)	1.01
8.	Flash point	45°C c.c.
9.	Auto-ignition temperature	380°C
10.	Explosive limits, vol% in air	1.5 (93°C) - 12.3 (93°C)
11.	Octanol/water partition coefficient as log Pow	0.121

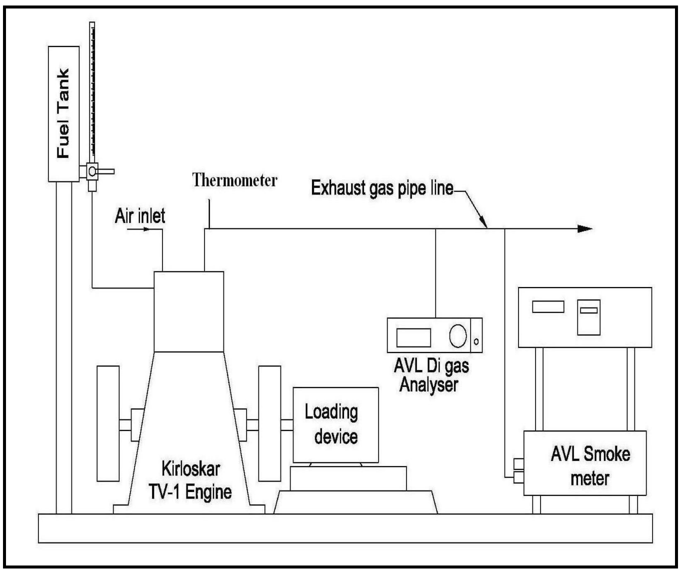

Fig.1 Experimental setup

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

4. Results and Discussion

The specific fuel consumption, brake thermal efficiency and exhaust emission characteristics of 2-methoxyethyl acetate in various proportion is mixed with B20 (20% MEOJ +80% Diesel) is discussed in the following headings.

4.1. Emission Characteristics

4.1.1. Smoke density

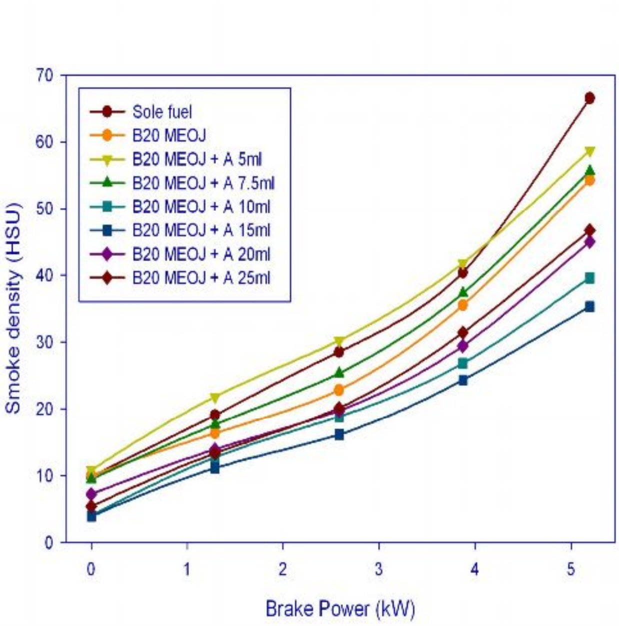

Fig.2. Brake Power vs Smoke Density

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

4.1.2. Hydrocarbon (HC) Emission

Fig.3 shows that the Hydro Carbon emission of B20 (20% MEOJ + 80% diesel) the various proportion of 2-methoxyethyl acetate added with B20, Biodiesel & Diesel. The unburnt hydrocarbon increased in B20 and significant decrease of unburnt Hydrocarbon in 2-methoxyethyl acetate with B20 in 15ml 2-methoxyethyl acetate with B20 is more effective in reduction of unburnt hydrocarbon.This reveals that the HC emissions tends to reduce as the oxygen content of fuel increases.

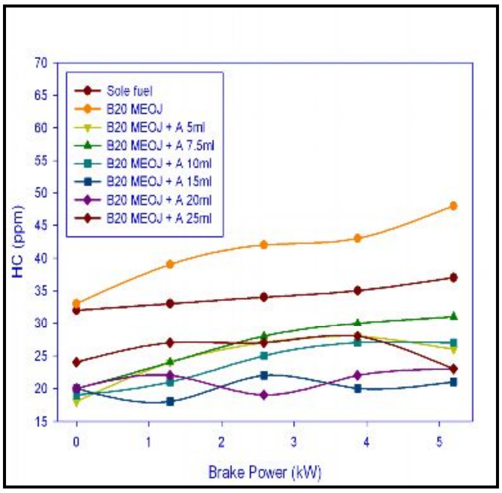

Fig.3 Brake Power vs Hydrocarbon

4.1.3. Nitrogen Oxides (NOx) Emission

Fig.4 shows the NO_X emission of B20 the various blends of 2-methoxyethyl acetate added with B20, Biodiesel & 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. The 2-methoxyethyl acetate added with B20 is compared with diesel there is a significant reduction in emission of NOx in 20ml of 2-methoxyethyl acetate with B20 is more effective in reduction of NOx .

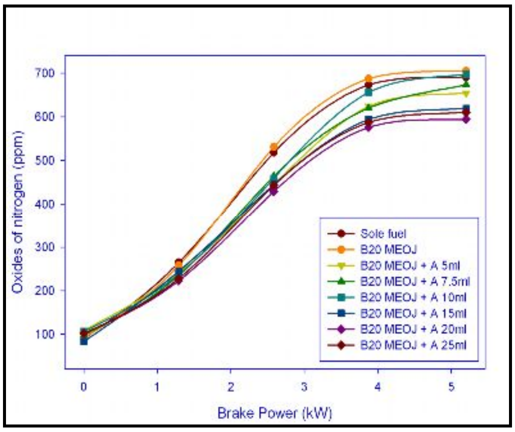

Fig.4 Brake Power vs oxides of nitrogen

4.1.4. Carbon dioxide (CO_2) Emission

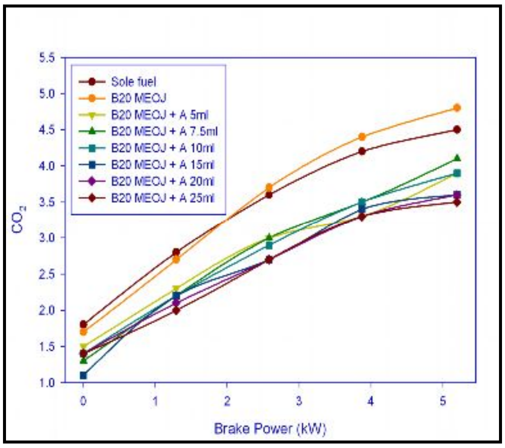

Fig.5 Brake Power vs Carbondioxide

Fig.5 shows the carbon dioxide emission of B20 with 2-methoxyethyl acetate in various proportion, B20 & diesel. The carbon dioxide emission has minor increase in B20 compared with diesel. There is an significant reduction in carbon dioxide emission in 2-methoxyethyl acetate with B20 when compared to diesel. In 25ml of 2-methoxyethyl acetate added with B20 is more effective in reduction of carbon dioxide. This is due to the presence of more oxygen content in 2-methoxyethyl acetate

4.1.5. Carbon monoxide Emission

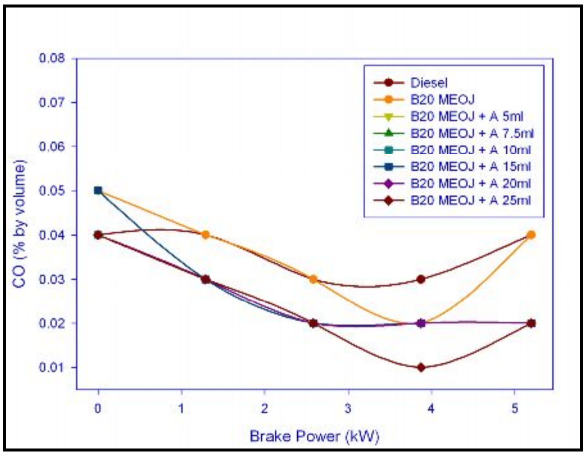

Fig .6 Brake Power vs Carbon monoxide

Fig .6 shows the carbon monoxide emission of B20 with 2-methoxyethyl acetate in various proportions, B20 & Diesel. There is a small amount of decrease in carbon monoxide in B20 when compared to diesel and also significant reduction of carbon monoxide in 2-methoxyethyl acetate with B20 when compared to diesel. This is due to the presence of more oxygen content in 2-methoxyethyl acetate which makes better combustion resulting reduced CO emissions.

4.2. Performance Characteristics

4.2.1. Specific Fuel Consumption

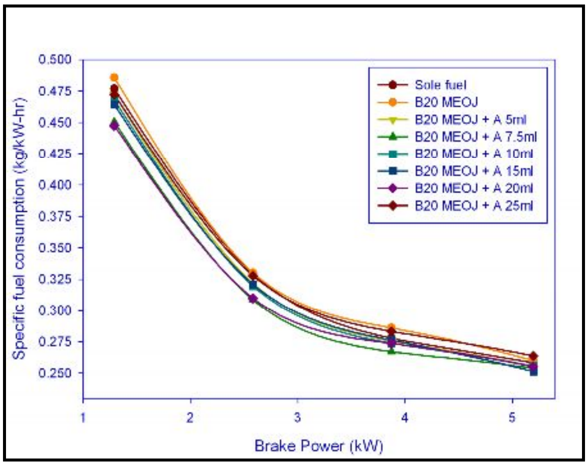

Fig.7 Brake Power vs specific fuel consumption

B20 has lower calorific value than that of diesel. Hence the specific fuel consumption is slightly higher than that of diesel. Even though when B0 is added with 2-methoxyethyl acetate the fuel consumption is slightly lower than the diesel. Fig.7 shows the specific fuel consumption of various blend of 2-methoxyethyl acetate with B20 diesel.

4.2.2. Brake Thermal Efficiency

Fig.8 shows the Brake Thermal efficiency for various blends of 2-methoxyethyl acetate with B20, B20 & diesel, The fuel consumption to engine in case of MEOJ is more compared to diesel but B20 blends with 2-methoxyethyl acetate is low compare to diesel about 1% to2%. The improvement in Brake Thermal Efficiency is due to constant volume combustion and the larger increase of molecules by fuel injection , which leads to better combustion efficiency especially at higher loads.

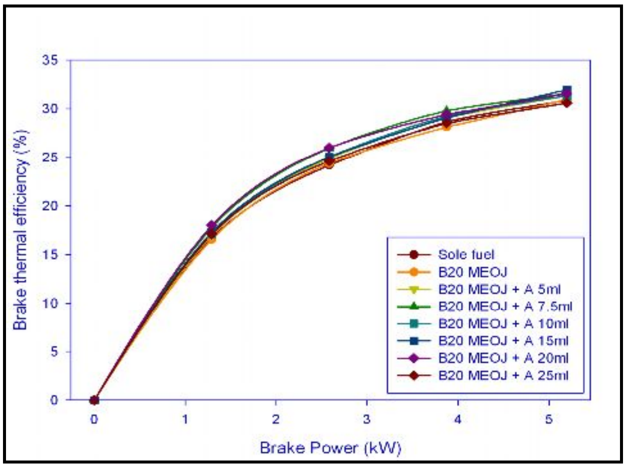

Fig.8 Brake Power Vs Brake Thermal Efficiency

From analyzing the performance and emission characteristics test of various proportion of 2-methoxy ethyl acetate with B20, It is concluded that II the 15ml of 2-methoxy ethyl acetate with B20 is the best blend.

5. Conclusion

The performance and emission characteristics of 2-methoxy ethyl acetate in various proportion such as 5ml, 7.5ml, 10ml, 15ml, 20ml, 25ml 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 when compared to diesel.
3. The brake thermal efficiency of 2-methoxy ethyl acetate with B20 is increased about 1% to 2%.
4. The 15ml of 2-methoxy ethyl acetate with B20 is the best blend in reducing emission as well as improving the performance.

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