

Performance and Emission Evaluation of C.I Engine Using Methyl Tertiary Butyl Ether on Various Methyl Esters

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ABSTRACT:In recent years due to depletion of fossil fuels, high oil prices and emission problems with conventional fuels such as gasoline and diesel, there has arisen a need for alternate fuels. Biodiesel is an important alternate fuel and that has been used here. In this paper blending method of Methyl tertiary butyl ether with diesel and its performance and emission characteristics were studied in detail. Transport vehicles greatly pollute the environment through emissions such as CO, CO₂, NOX, unburnt or partially burnt HC and particulate emissions. Fossil fuels are the chief contributors to urban air pollution and major source of Green House Gases (GHGs) and considered to be the prime cause behind the global climate change. Though diesel fuelled compression ignition engine can operate at high thermal efficiency creates more emission of HC and CO, the high level of NOX poses problems. The high combustion temperature and lean mixtures used are the reasons. This paper presents the results of performance and emission analyses carried out in diesel engine fuelled with Methyl Tertiary Butyl Ether(MTBE) and its blends with diesel, Mahua and Pongamia. Engine tests have been conducted to get the comparative measures of Brake Specific Fuel Consumption (BSFC), Brake Thermal Efficiency (BTE) and emissions such as HC, CO, NOX. The results indicates that Pongamia with methyl tertiary butyl ether shows far better emissions results than diesel and mahua.

KEYWORDS: Biodiesel, Compression Ignition Engines, Methyl Tertiary Butyl Ether ,Performance and Emissions, Thermal Efficiency

I. INTRODUCTION

Due to shortage of petroleum diesel fuel and its increasing cost an alternate source of fuel for diesel is very much needed. It has been found that vegetable oils hold special promise in this regard, since they can be produced from the plants grown in rural areas. Vegetable oil from crops such as soybean, peanut, sunflower, jatropha, mahua, neem, rape, coconut, karanja, cotton, mustard, linseed and castor have been tried in many parts of the world, which lack petroleum reserves as fuels for compression ignition engines. The long chain hydrocarbon structure, vegetable oils have good ignition characteristics, however they cause serious problems such as carbon deposits buildup, poor durability, high density, high viscosity, lower calorific value, more molecular weight and poor combustion. These problems lead to poor thermal efficiency, while using vegetable oil in the diesel engine. We can rectify these problems by transesterification process.

From these above mentioned oils, the performance and emission characteristics of mahua and Pongamia oils are studied experimentally and it will be compared with base diesel fuel characteristics. Further, the Methyl tertiary butyl ether is added with diesel and mahua and pongamia methyl esters to study the effect of mtbe on mahua and pongamia methyl esters. The performance and emissions characteristics of mahua and Pongamia methyl esters with adding the Methyl tertiary butyl ether are studied.

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II. TRANSESTERIFICATION

Transesterification is the process of using an alcohol (e.g. methanol or ethanol) in the presence of catalyst such as sodium hydroxide (NaOH) or potassium hydroxide (KOH), which chemically breaks the molecule of the raw oil into methyl or ethyl esters with glycerol as a by-product, which reduces the high viscosity of oils. This method also reduces the molecular weight of the oil to 1/3 of its original value, and reduces the viscosity, and increase the volatility and Cetane number to levels comparable to diesel fuel

III. EXPERIMENTAL SETUP

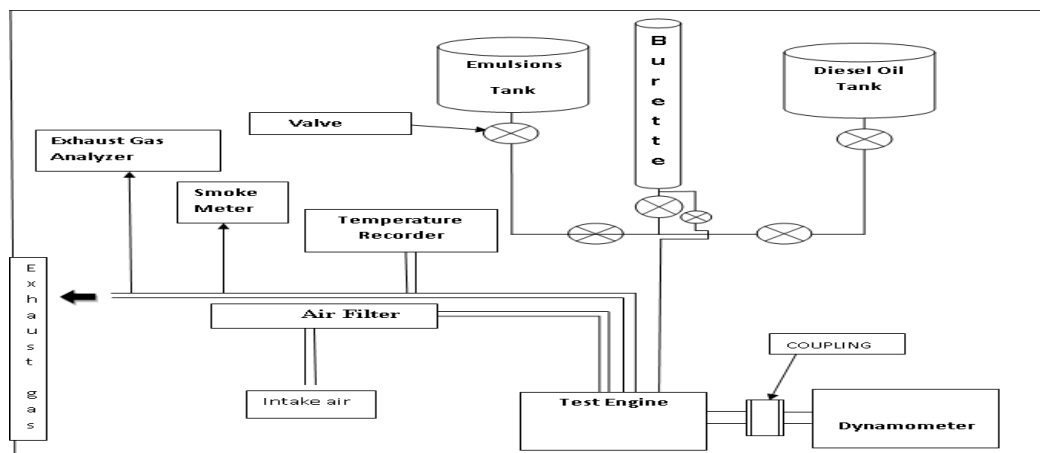
The present work is carried out to study the performance and emission characteristics of a small direct injection (DI) type compression ignition engine using the emulsified fuel. According to the problem statement water-in-diesel oil (W/O) emulsion is prepared in a variable speed, motor driven stirrer in the presence of emulsifying agents. Then these emulsified fuels are used in DI type diesel engine by a fuel burette. A prony brake dynamometer is connected with this engine to determine the engine performance with varying engine speed. A gas analyzer and smoke meter are used with this diesel engine to determine the emission characteristics of the engine.

III.A. Experimental Set-up Overview

The schematic diagram of the engine test rig used is shown in Figure. The engine is fully equipped with measurements of all operating parameters. The arrangement requires the following systems and apparatus for carrying out the desired experiment.

- (1) Diesel engine
- (2) Prony brake dynamometer
- (3) Exhaust gas analyzer
- (4) Smoke meter
- (5) Mixer machine
- (6) Bomb calorimeter

The test rig used for the present study has been developed in the dynamometer laboratory of the Madras Institute of Technology, Chennai. The test engine and prony brake dynamometer are mounted on channels which are embedded on concrete foundation. A smoke meter is used to determine the smoke density of the engine exhaust. A gas analyzer is used to measure the exhaust gas composition. The exhaust gas temperatures are measured with the help of K type thermocouple. The photograph of the test rig on which experiment was carried out has shown in Figure.



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III.B. SPECIFICATIONS OF THE APPARATUSES

In the test rig there are several instruments/equipments have been used for the purpose of the experiment. Brief Specification, the calibration procedure and working principle of all the instruments used for conducting the experiment are given below.

III.B.a. Diesel Engine

The engine used in test rig is a single cylinder, four stroke, water-cooled, direct injection type, diesel engine. To reduce the temperature of the cylinders and the lubricant, the cooling system of the engine is connected to a cooling-water tower by means of a cooling-water pipe line. The specifications of the engine are listed in Table

III.B.b. ENGINE SPECIFICATION

Engine used : Single Cylinder
Bore : 78 mm
Stroke : 110 mm
Cooling : Water Cooling
Rated Speed : 1500 rpm
POWER : 5 BHP
SFC : 245 g/ kw.hr
Compression Ratio: 16.5 : 1
Lubrication Oil : HD type 3 as per IS:496-1982
Rating at 1500 rpm : 3.7 Kw.

III.C. SMOKE METER

Smoke meter is used to determine the smoke density of the engine exhaust. The AVL 437 Smoke meter has been designed for simple one man operation either from alongside a vehicle for either free acceleration or steady state test procedures. Control is via a compact and rugged handset with a digital L.C.D. display. Any out of range parameters are automatically flagged to the operator. The brief specifications of the smoke meter are given below:

Type:AVL 437 Smoke meter
Make :AVL India Pvt. Ltd.
Measuring range:0 to 100 HSU (Hart ridge Smoke Unit)

IV. PROPERTIES OF FUELS

Property	Diesel	Diesel with 1% mtbe	Diesel with 2% mtbe	Diesel with 3% mtbe
Calorific value (MJ/Kg)	43	42.5	42.2	42
Sp.gravity	.8301	.8321	.8369	.8395

Table IV.A : Properties Of Diesel After Adding MTBE .

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Property	Mahua	Mahua with 1% mtbe	Mahua with 2% mtbe	Mahua with 3% mtbe
Calorific value (MJ/Kg)	40	39.6	39.3	39
Sp.gravity	.8411	.847	.85	.867

Table IV.B. Properties Of Mahua Methyl Ester After Adding MTBE

Property	Pongamia	Pongamia with 1% mtbe	Pongamia with 2% mtbe	Pongamia with 3% mtbe
Calorific value (MJ/Kg)	38	37.3	37.1	37
Sp.gravity	.842	.854	.86	.87

Table IV.C Properties Of pongamia Methyl Ester After Adding MTBE.

V. RESULTS AND DISCUSSIONS

Graphs:

V.A Performance Characteristics of Diesel Fuel with MTBE addition and pure Diesel.

Fig: 1BP Vs SFC

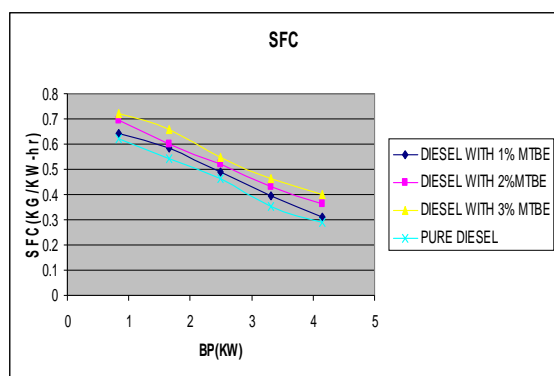


Fig: 2BP Vs TFC

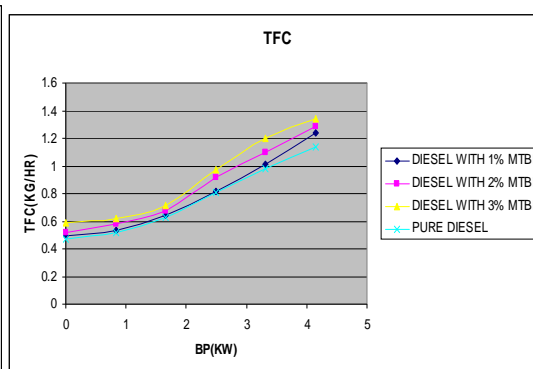
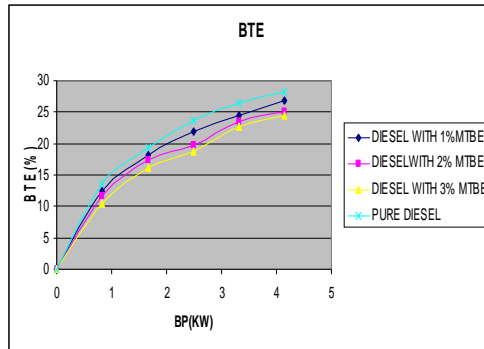


Fig: 3BP Vs BTE

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It is very clear from the above graphs that the brake thermal efficiency of diesel reduces with increase in the percentage of methyl tertiary butyl ether. However the brake thermal efficiency of diesel with 1% MTBE are closer to that of the pure diesel as compared to the blend of diesel with 2% and 3% MTBE.

V.B HC,CO,NO_x And Smoke Emission Characteristics Of Diesel Fuel and MTBE blended Diesel Fuel.

Fig:4 BP Vs HC

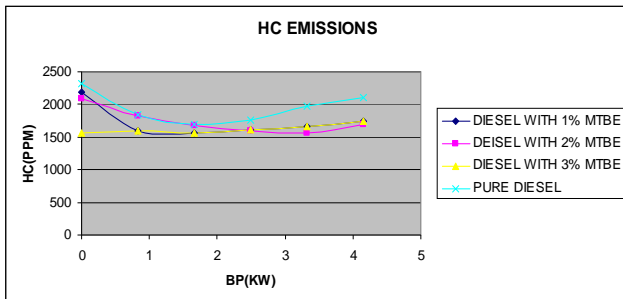


Fig:5 BP VS CO

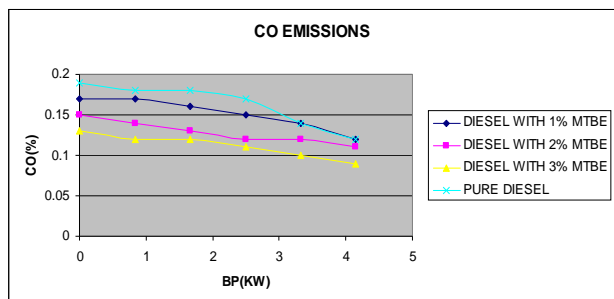


Fig:6 BP VS NO_x

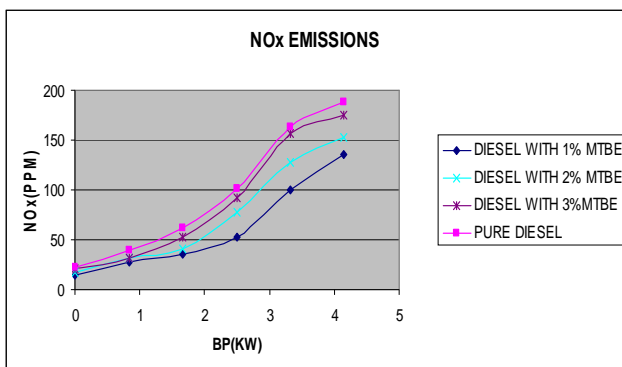
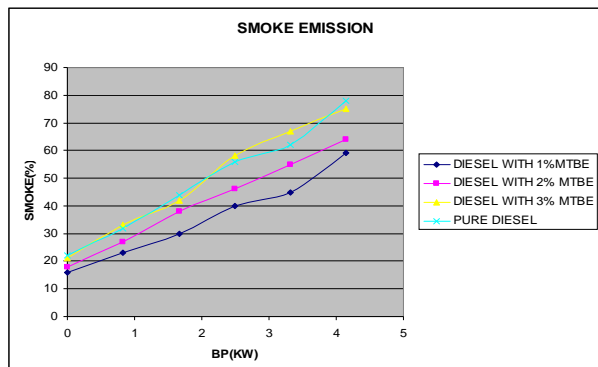


Fig:7 BP VS SMOKE



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It is very clear from the above graphs that the emission CO, HC, NO_x and smoke decreases with increase in the percentage of methyl tertiary butyl ether in diesel. This is because of the presence of oxygen content in the methyl tertiary butyl ether which converts CO into CO₂ and HC into H₂O. The presence of oxygen further increases diffusive combustion in the combustion chamber and higher flame temperature which reduces the smoke emission.

V.C Performance Characteristics and HC Emission of Mahua Methyl Ester and blended with Diesel.

Fig:8 BP VS SFC

Fig:9 BP VS TFC

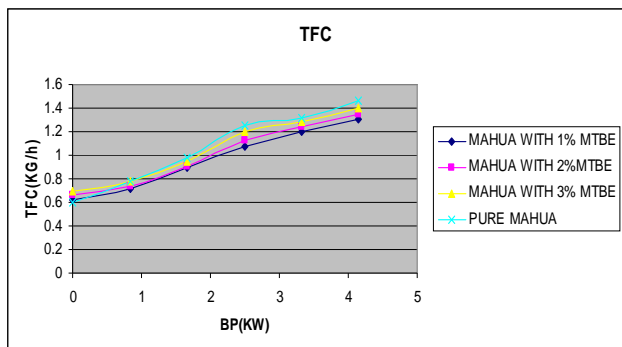
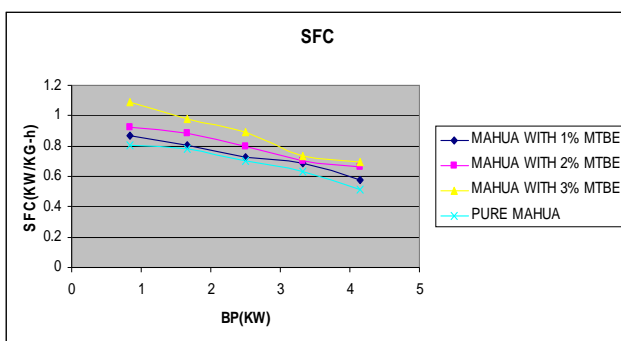
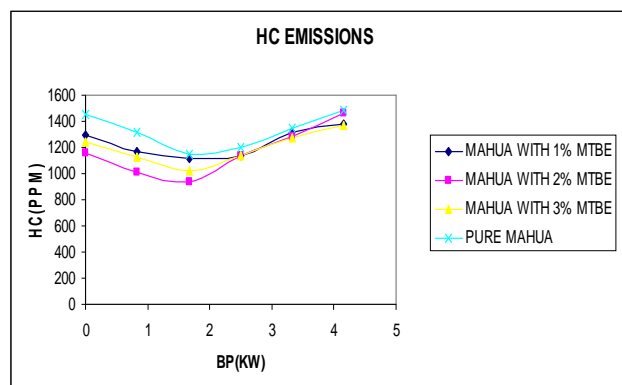
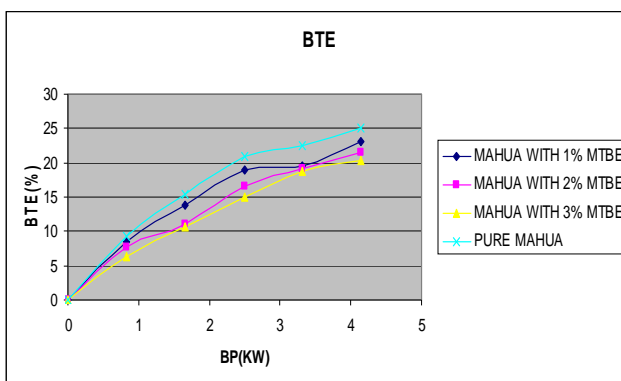


Fig:10 BP VS BTE

Fig:11 BP VS HC



It is very clear from the above graphs that the brake thermal efficiency of pure mahua reduces with increase in the percentage of methyl tertiary butyl ether. However the brake thermal efficiency of mahua with 1% MTBE are closer to that of the pure mahua as compared to the blend of mahua with 2% and 3% MTBE. In addition the hydrocarbon emission reduces with the increase of the percentage of the MTBE in Mahua.

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V.D NO_x,CO,Smoke Emission characteristics Of Mahua Methyl Esters and Diesel Blended mahua

Fig:12 BP VS NO_x

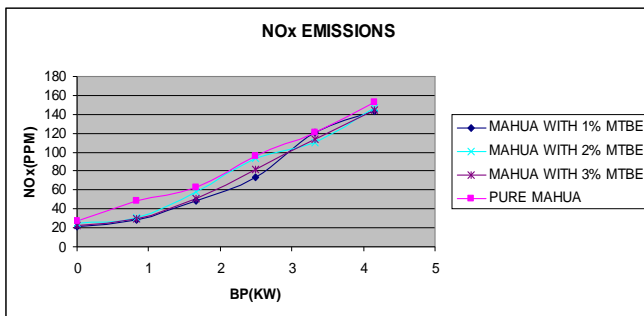


Fig:13 BP VS CO

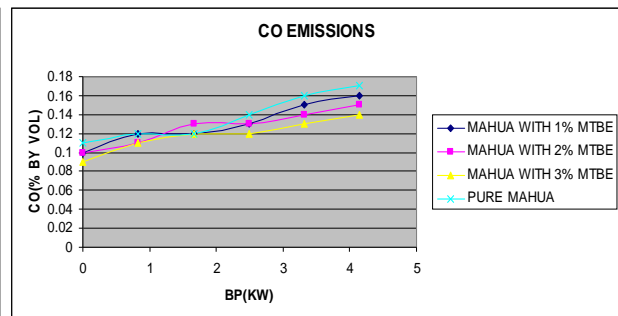
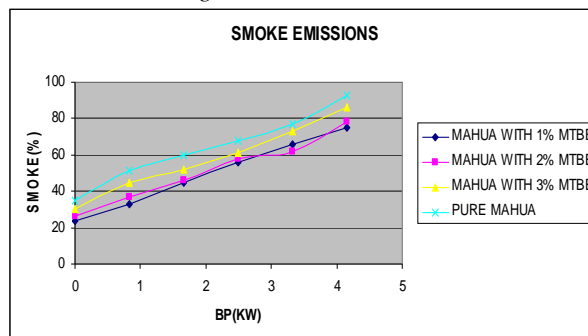


Fig:14 BP VS SMOKE



It is very clear from the above graphs that the emission CO, NO_x and smoke decreases with increase in the percentage of methyl tertiary butyl ether in mahua. This is because of the presence of oxygen content in the methyl tertiary butyl ether which converts CO into CO₂. The presence of oxygen further increases diffusive combustion in the combustion chamber and higher flame temperature which reduces the smoke emission.

V.E Performance Characteristics Pure Pongamia Methyl Ester and Diesel Blended.

Fig:15 BP VS SFC

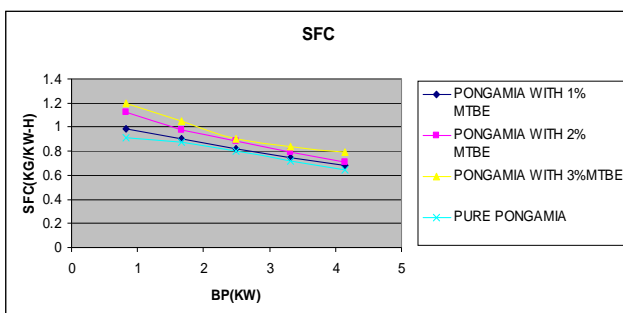


Fig:16 BP VS TFC

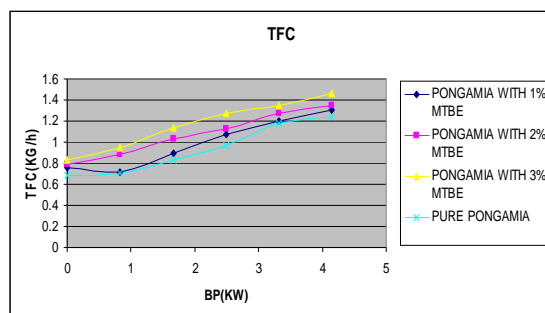
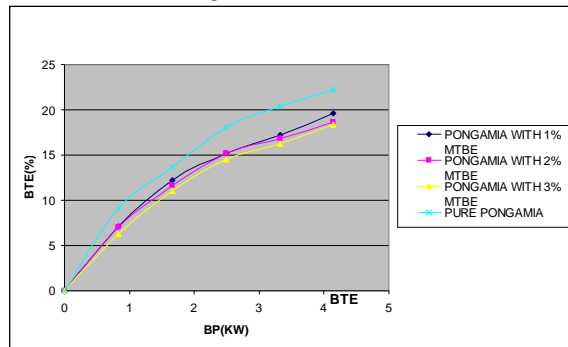


Fig:17 BP VS BTE



It is very clear from the above graphs that the brake thermal efficiency of pure pongamia reduces with increase in the percentage of methyl tertiary butyl ether. However the brake thermal efficiency of pongamia with 1% MTBE are closer to that of the pure pongamia as compared to the blend of mahua with 2% and 3% MTBE.

V.F HC,CO,NO_x,Smoke Emissions Characteristics with Pongamia and MTBE mixture.

Fig:18 BP VS HC

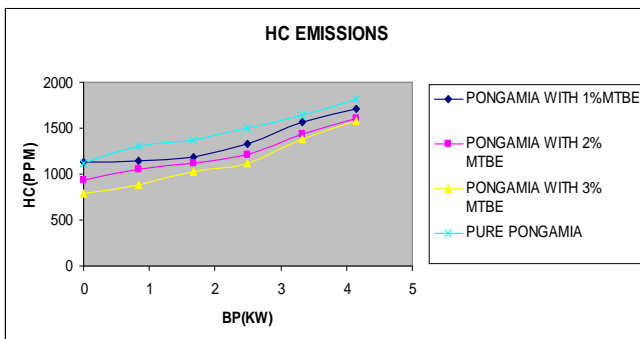


Fig:19 BP VS NO_x

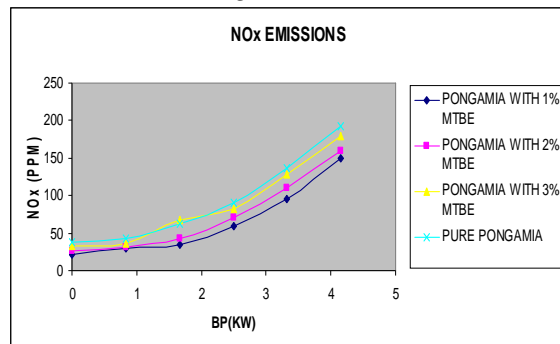


Fig:20 BP VS CO

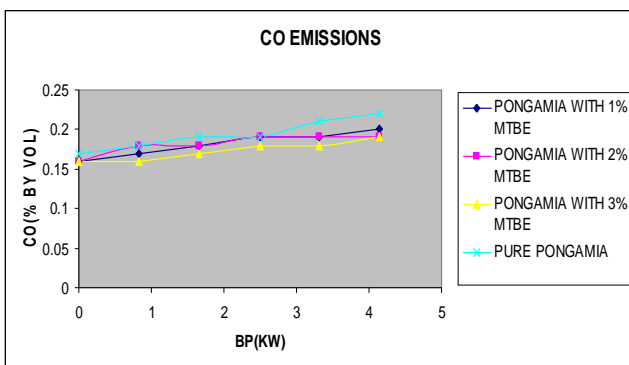
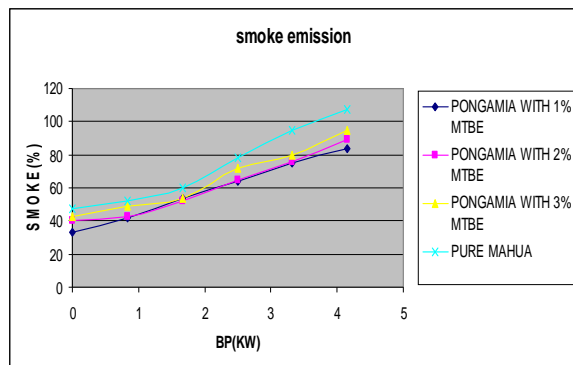


Fig:21 BP VS SMOKE



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VI. CONCLUSION

Based on the results of this experiment, the following conclusions are drawn:

1. After blending the Methyl tertiary butyl ether with diesel, it is found that the calorific value is reduced by 4%..
2. When the percentage of methyl tertiary butyl ether is increased, it is found the emissions characteristics are good and reduced a lot.
3. Higher percentage of methyl tertiary butyl ether did not show good blending with fuel.
4. In case of diesel with methyl tertiary butyl ether, it is found that the performance though is not efficient as compared to diesel fuel but the emission characteristics are good. The HC, CO and NO_x are reduced well about when adding 3% MTBE.
5. Well in the case of mahua with methyl tertiary butyl ether, it shows lesser performance than mahua but emissions are far than mahua and diesel.
6. The emissions after adding methyl tertiary butyl ether, shows lesser than mahua and than diesel when compared.
7. Pongamia with methyl tertiary butyl ether shows far better emissions results than diesel and mahua.
8. The blending of methyl tertiary butyl ether with pongamia reduces emission when compared to diesel and mahua

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