Performance and Emission Analysis of Mahua Biodiesel Blends with Diesel Oil using Single Cylinder Diesel Engine

Avinasha P. S, Krishnamurthy K. N, Akash Deep B. N

Abstract— ***Now a day's world facing fuel problems because of increasing automobiles, power plants and factories, Increasing of this automobiles, power plants produce the more emissions like CO, HC and NOx. So we need alternative source, in this direction lot of work is going on to find out a suitable alternative to the diesel oil. Biodiesel is one of the main solutions to the global energy crisis. In this present work studied the performances and emission characteristics of Mahua Bio-diesel. The blends of Mahua methyl ester and Diesel in the proportion B10, B25, B50, B75and B100 were prepared analyzed and their performance and emissions characteristics compared with performance and emission characteristics of diesel. In engine performance and Emission test obtained the thermal efficiency, Mechanical efficiency, fuel consumption and indicated thermal efficiency for different blends and also obtain the emissions like CO, HC, NOx and*** CO_2***. The results are compared with pure diesel.***

Index Terms— ***Mahua oil, Mahua bio-diesel, Diesel oil, Engine performance and engine emissions.***

I. INTRODUCTION

The fuel requirements are increasing day by days so cost is also more and fuel oil is expected to reach peak next few years, it produces more Emissions, for that we need alternative fuel sources like bio-diesel is substitute for diesel. Bio-diesel has more attention as an alternative fuel for diesel because of renewable source and it can reduce the emissions [1] [2]. The main characteristics of biodiesel are that its use doesn't require any modifications to the existing diesel engine. However, the biodiesel has near 10% lower energy and different physical properties than conventional diesel oil. This may cause small changes in engine performance and engine emissions. However, the biodiesel has higher cetane number, no aromatics and contains 10% to 11% oxygen by weight [3]. These properties of biodiesel reduce the emissions of carbon monoxide (CO), un-burnt hydrocarbons, particulate matter in the exhaust [4] [5]. Currently, the cost of biodiesel is higher than conventional diesel oil because edible grade vegetable oils are used as a source for the production of biodiesel. An effort has also made in the past to use non edible oils such as Jatropha curcas, Pongamia pinnata, Mahua, Neem, Castor etc. as a source for the production of biodiesel [6]. In this work an attempt will be made to reduce the cost of biodiesel by selecting low cost/low grade/non-traditional oil seeds such as Mahua Seed Oil. The Mahua oil is much cheaper rate because most of them are waste oils [1].

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II. MATERIAL AND METHODS

The Mahua bio-diesel be prepared by using three march transesterification processes because of their FFA level is more than 1%. In the first march, esterification result is carried out by adding up 15 ml CH_3OH to 100 ml Mahua oil and 0.5ml H_2SO_4. This reaction is carried at temperature range between 50^0c to 60^0c with reaction period of 60 minutes. In the second march 8ml methanol is added to the sample obtained from first march with 0.5 ml sulfuric acid with reaction instance of 60 minutes and the temperature range 50^0c to 60^0c. In third march transesterification retort was completed by adding 15ml of CH3OH to the trial gets from earlier march and 0.5gms of sodium hydroxide with retort instant of 60 minutes and temperature is 56^0c to 65^0c. Mahua bio-diesel blends were arranged by mixing B10, B25, B50, B75 and B100 respective bio-diesel with diesel oil on volume basis.

III. EXPERIMENTAL SETUP

The engine performance and emission test were conducted on single cylinder diesel engine, which developing power output 3.675 Kw at 1500 rpm speed. The engine specifications are given in table 3.1. First the engine was run with diesel and reading were recorded, then the biodiesel blends with diesel in different proportion like B10, B25, B50, B75, B100,was used and reading were recorded.

Figure 3.1 Kirloskar single cylinder 4-stroke diesel engines

Table3.1 Engine specification

Made	Kirloskar
Cycle's used	Diesel
Number of strokes	4
Number of cylinder	1
Bore diameter	80 mm
Stroke	100 mm
Cooling system	Water cooled
Lubrication	Forced method
Output	3.675 kW at 1500 rpm
Dynamometer	D.C Generator
Armature	Shunt
Voltage	220 V
Rated BP	3.675 Kw
Air box orifice diameter	25 mm
Current	13 A

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IV. RESULTS AND DISCUSSION

The basic engine performance measuring parameters are BTE, Mechanical efficiency, SFC has been obtained from different blends and results are compared with pure diesel.

4.1 Effect of BP on BSFC

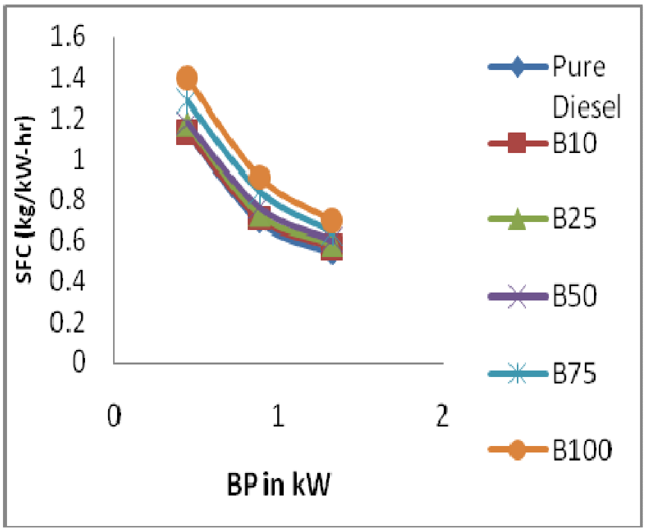

Figure 4.1 Effect of BP on specific fuel consumption when diesel engine has run on B10, B25, B50, B75, B100 and Diesel.

Figure 4.1 shows the variation of BP on SFC when diesel engine has run on B10, B25, B50, B75 and B100 respectively. The figure shows that with increases in the Brake power on the engine SFC has decreased. It is observed that Mahua biodiesel blends B10, B25 have specific fuel consumption close to diesel. SFC increased with increases in percentage of biodiesel blends. Mahua biodiesel heating value is lower so SFC for B100 is more than all blends.

4.2 Effect of BP on Brake Thermal Efficiency

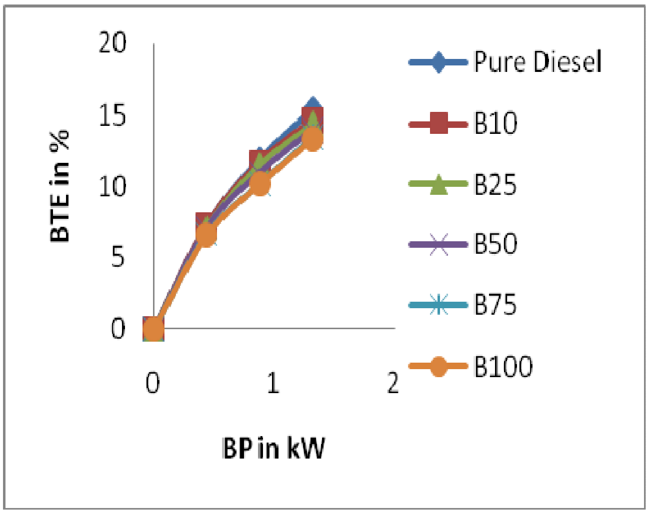

Figure 4.2 Effect of BP on Brake thermal efficiency when diesel engine has run on B10, B25, B50, B75, B100 and Diesel.

Figure 4.2 shows the variation of brake thermal efficiency with brake power, when diesel engine runs by different blends of Mahua Biodiesel with diesel. From figure4.2 it is clear that the B10 has near to thermal efficiency as diesel. B10 curve almost nearer to the diesel line. The obtained result shows that BTE increases with increases BP for all blends of biodiesel and diesel.

4.3 Effect of BP on Mechanical Efficiency

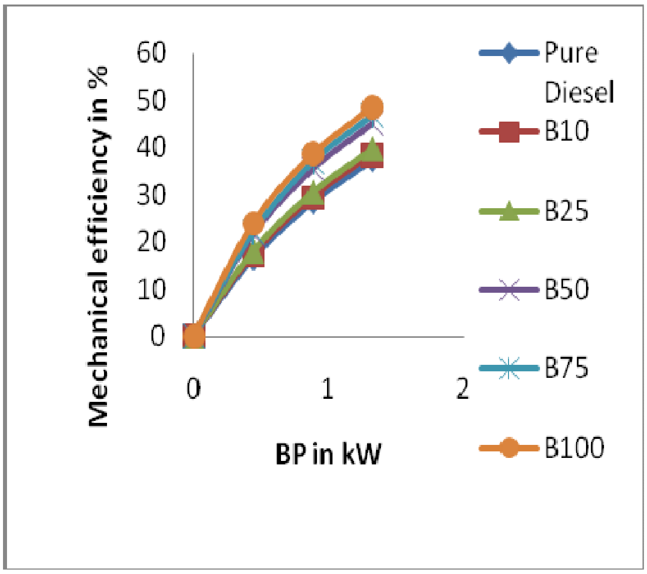

Figure 4.3 Effect of BP on Mechanical efficiency when diesel engine has run on B10, B25, B50, B75, B100 and Diesel.

Figure4.3 shows variation of mechanical efficiency with brake power for diesel and blends of B10, B25, B50, B75 and B100 of Mahua methyl esters at 180 bar injection pressure. The obtained results show that mechanical efficiency increases with increase in BP for all blends of biodiesel and diesel. From analyzing graph it shows that Mechanical efficiency of B100 is more than the all blends and diesel. B10 and B25 mechanical efficiency is very close with the diesel are shown in figure.

4.4 Effect of BP on CO emission

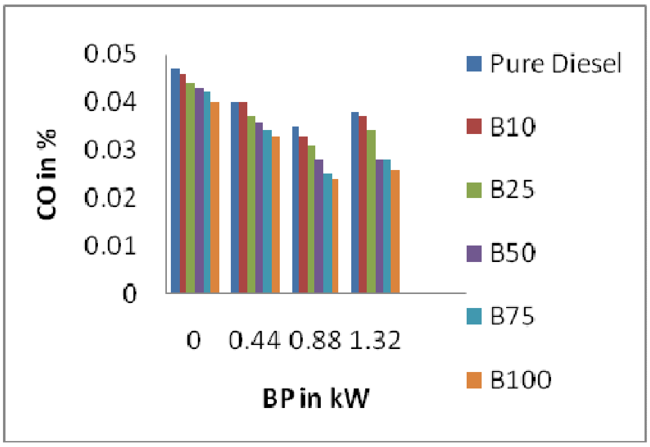

Figure 4.4 Effect of BP on CO emission when diesel engine has run on B10, B25, B50, B75, B100 and Diesel.

Figure4.4 shows the effect of BP on CO emission when diesel engine runs on B10, B25, B50, B75, B100 and diesel. Figure4.4 shows that CO emission decreases with increasing BP and decreases with increase in percentage of ester. CO emission decreases with load starting from no load for all fuels. The high emission at no load is because lower cylinder temperature. Load increases cylinder temperature increases. This gives reduction of CO and further increase in power

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results in higher emission of CO as shown in figure. The CO emission decreases with increasing percentage of blends.

4.5 Effect of BP on CO2 emission

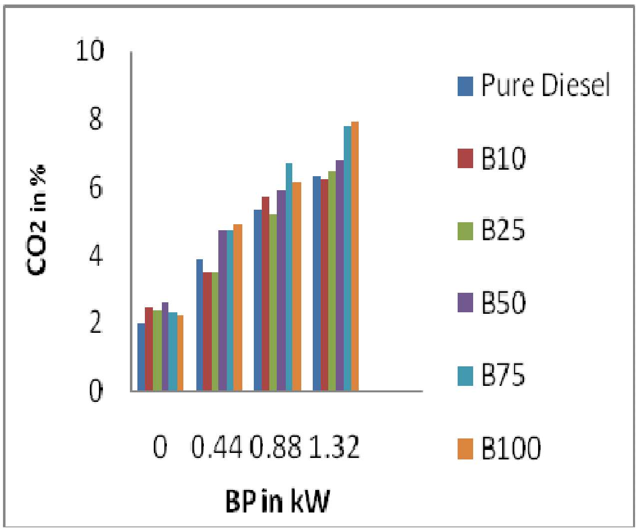

Figure 4.5 Effect of BP on CO2 emission when diesel engine has run on B10, B25, B50, B75, B100 and Diesel.

The figure4.5 shows the variation of CO2 emission with BP when diesel engine runs on B10, B25, B50, B75, B100 and diesel. The carbon dioxide is gradually increases with increasing the BP for all blends. The lower percentage of Mahua methyl ester blends emits less amount of CO2 in comparison with diesel. Blend B25 emits very low emission shown in figure. By using higher content Mahua biodiesel blends it increases the CO2 emission was noted because of incomplete combustion.

4.6 Effect of BP on unburned hydrocarbon (HC) emission

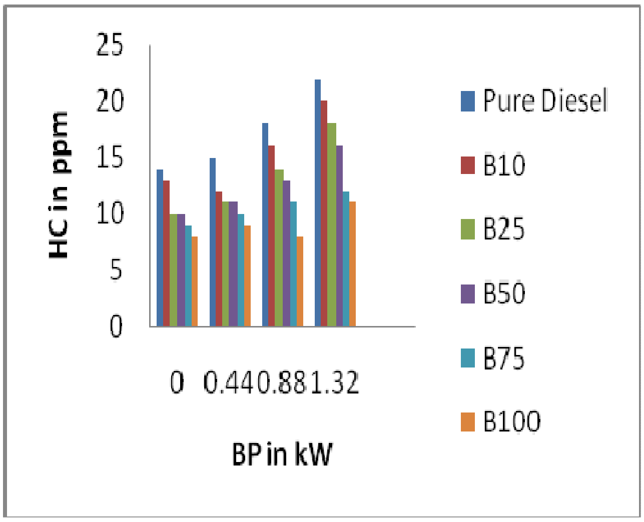

Figure 4.6 Effect of BP on HC emission when diesel engine has run on B10, B25, B50, B75, B100 and Diesel.

Figure4.6 shows the effect of BP on HC emission when diesel engine has run on B10, B25, B50, B75, B100 and diesel. Figure4.6 sows that HC emission increases with increasing BP and decreases with increase in percentage of ester. B100 has minimum HC emission at all loads. B10 has maximum HC emission than all blends but lower than pure diesel.

4.7 Effect of BP on NOx emission

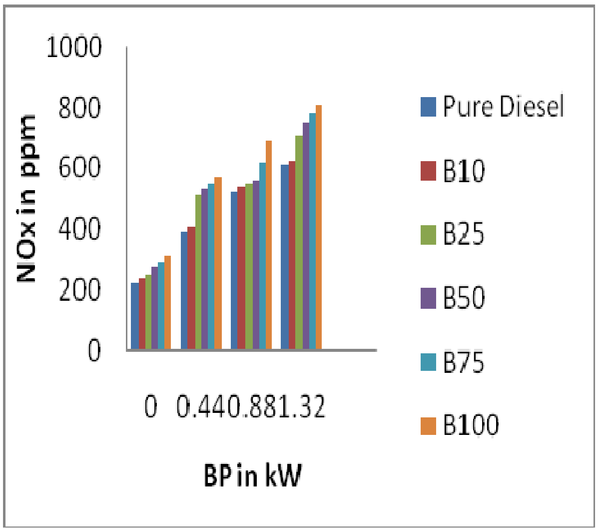

Figure 4.7 Effect of BP on NOx emission when diesel engine has run on B10, B25, B50, B75, B100 and Diesel.

Figure4.7 shows the effect of BP on NOx emission when diesel engine has run on B10, B25, B50, B75, B100 and diesel. Figure4.7 shows that NOx emission increases with increase in the percentage of ester. B10 and B25 have minimum NOx emission at no load. The primary reason of higher NOx emission of Mahua oil biodiesel fuel is contributed towards inbuilt oxygen. B10, B25 fuel shows lower NOx emission compared to B100. With increase in Mahua methyl ester percentage in blend the oxygen content increase and hence higher blend shows higher NOx emission compared to diesel.

V. CONCLUSION

The following conclusions obtained from the present work.

- Mahua oil can be successfully converted into methyl ester by using transesterification process.
- Transesterification process reduces the viscosity of the Mahua oil and it improves the properties like viscosity, flash point, fire point of the Mahua methyl ester.
- Smooth running of engine is observed with esterified Mahua oil compared with that of diesel.
- Brake thermal efficiency of B25 is nearer to diesel.
- Specific fuel consumption of B10, B25 is close with the diesel.
- Minimum emission of CO compare with diesel.
- Highest HC emissions for diesel, B10 at no load, B100 has minimum HC emission at all loads.
- From this study it is conclude that the B10, B25 gives optimum performance where B100 gives the lower emission of HC and CO.
- Present experimental work shows the Mahua methyl ester give the good engine performance and less emission.
- Finally concluding B25 could be used as a viable alternative fuel to operate single cylinder diesel engine with injection pressure at 180 bars.

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