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Experimental Investigation to Evaluate the Performance, Emission and Combustion Characteristics of Diesel Engine with Mahua Oil Biodiesel

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Abstract: - Nowadays the crude oil is depleting at a fast rate and cannot be produced in short duration of time as it is non-renewable source of energy,therefore it is high time to study & research over and to act towards the sustainable use of our natural resources like petroleum products.Biodiesel is a renewable alternative fuel created from vegetable oils, animal fats, and greases through a chemical process. The chemical process involves reaction of natural oils with an alcohol, and then refining the mixture to create molecules which can be easily burned in a diesel engine.In the present study,biodiesel extracted from mahua oil was taken & the evaluation of the performance, emission and combustion characteristics of a compression ignition engine fuelled with different blends of biodiesel extracted from mahua oil biodiesel was done. The c.i. engine was single cylinder, four stroke, water cooled, and naturally aspirated direct injection (DI) diesel locomotive.
The performance, emission and combustion characteristics of the engine fuelled with mahua oil biodiesel and diesel blends was investigated and compared with that of standard diesel. The experimental results confirm that the Brake thermal efficiency(BTE), Brake specific fuel consumption(BSFC), exhaust gas temperature are the function of biodiesel blend and load. For similar operating conditions, a particular blend gave better engine performance and reduced emissions compared to other blends in comparison to standard diesel. The brake thermal efficiency of mahua biodiesel blends is higher than that of diesel at all load conditions. Results showed that biodiesel obtained from Mahua oil can be used as a great and sustainable substitute for fossil fuels.

***Keywords*:** *Biodiesel, Combustion, Performance, Emissions, Mahua Oil, Load, BSFC,BTE.*

I. INTRODUCTION

As per the excessive and dependant use, it is believed that crude oil and petroleum products will become very scarce and costly to find and produce. Although fuel economy of engines is greatly improved, increase in the number of automobiles alone explains that there will be a great demand for fuel in the near future. Alternative fuel technology, availability, and use must and will become more common in the coming decades. Another reason providing motivation for the development of alternative fuels for the IC-engine is concerned over the emission problems of gasoline engines. Combined with other air polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. A third reason for alternative fuel development is the fact that a huge percentage of crude oil must be imported from other countries which control the larger oil fields.

. Biodiesel is produced from the transestrification reaction of vegetables oil or animal fats with alcohol in presence of a catalyst. As per scientist’s recommendation, pure biodiesel can not used for conventional engines. Therefore Engine modifications are required to use pure bio-diesel which is an expensive affair. Henceforth, bio-diesels are generally mixed/blended with petroleum diesel at predetermined percentages to create a proper biodiesel blend. But the performance of the engine varies with the amount of concentration of bio-diesel used.

Engine’s Vibration,power/torque,Fuel Consumption and Emission are some of the standard parameters which determines the quality and performance of the fuel used. Fuel price and consumption determine the economy of using the fuel. Poor fuel performance will lead to frequent maintenance and more often replacement of the engine. Hence, over the years,finding an optimum Blend of bio-diesel and petro-diesel which gives the best operating characteristics has been a requirement.

II. EXPERIMENTAL WORK

For the present study a single cylinder, four stroke diesel engine, Kirloskar, Model TV1, connected to eddy current type dynamometer for loading, smoke meter to measure smoke and five gas analyzer for exhaust gas evaluation, is employed. It is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for Pθ−PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The setup has stand- alone panel box consisting of air box, fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator Rotameters are provided for cooling water and calorimeter water flow measurement. The setup enables study of engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency etc.

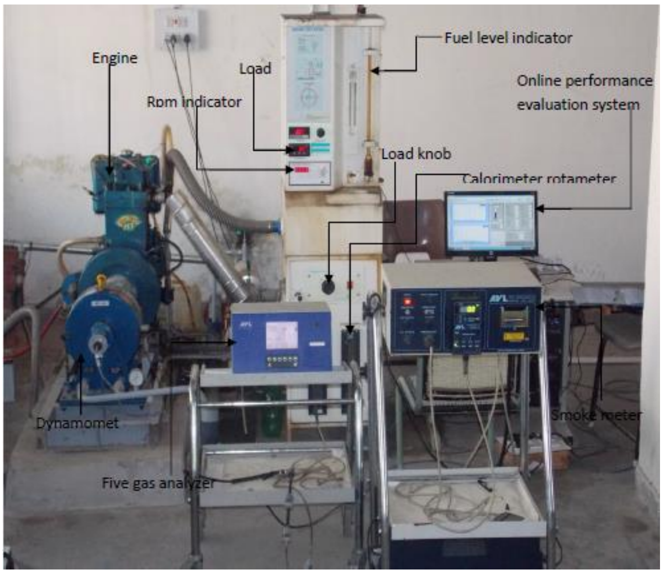

Fig. 1 Engine Setup

The engine was fuelled with pure diesel and mixtures containing 10%, 20%, 30%, and 50% of Mahua oil biodiesel. Relative effects of engine operation, emission characteristics and combustion characteristics of the different blends of Mahua oil biodiesel with that of diesel under variable loads (0%, 25%, 50%, 75% and 100%) at a constant velocity of 1500 RPM are measured. The main specifications of engine are shown in Table1.

Table 1: Specifications of Test Engine

Product	Engine test setup 1 cylinder, 4 stroke, Diesel Engine.
Maximum Power	5.2kW @1500rpm
Bore × Stroke	87.5 × 110
Compression Ratio	17.5:1
No of Cylinder	1
Dynamometer	Type Eddy Current
Software	EnginesoftLV
Pump	Type Monoblock
Fuel tank capacity	15 litres

III. RESULTS AND DISCUSSIONS

Figure 2 shows that the variation of brake thermal efficiency (BTE) with load for different blends. It has been observed that the brake thermal efficiency for all test fuel is 85 increasing with the increase in applied load. It happens due to a reduction in heat loss and increase in power developed with increase in load. Blend B30 and diesel has been shown the BTE of 33.75% and 34.57% respectively. Hence B20 gave the little difference in efficiency among all test fuel, which is about 0.82% less than the diesel. Initially, efficiency was found to be increased with increased blend ratios up to B30 and after that it got a decrease as shown in figure 2. The decrease in brake thermal efficiency for higher blends may be due to the combined effect of its lower heating value and increase in fuel consumption. In spite of this increasing viscosity may be the other reason for decreasing efficiency with higher blend ratio fuel, thereby, poor spray and poor atomization occurred due to which charge was not properly burned.

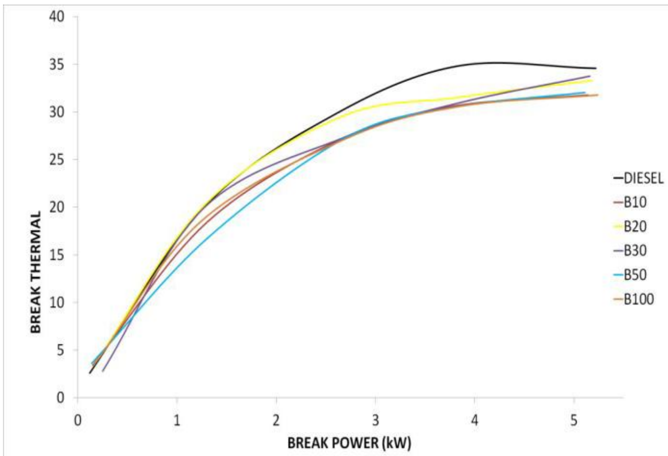

Fig. 2 Variation of Brake power with BT Efficiency

The variation of brake specific fuel consumption with regard to load is given in figure 3. B30 has given lowest brake specific fuel consumption to all other blends and diesel at full load condition. Diesel and B30 has been read 0.25 kg/kWh and 0.25 kg/kWh of BSFC respectively, at full load which is more or less same as diesel. For a higher percentage of biodiesel blends BSFC are found to be increased. B30 has minimal value of fuel consumption among B10, B20, B50 and B100 at and above 100% load.

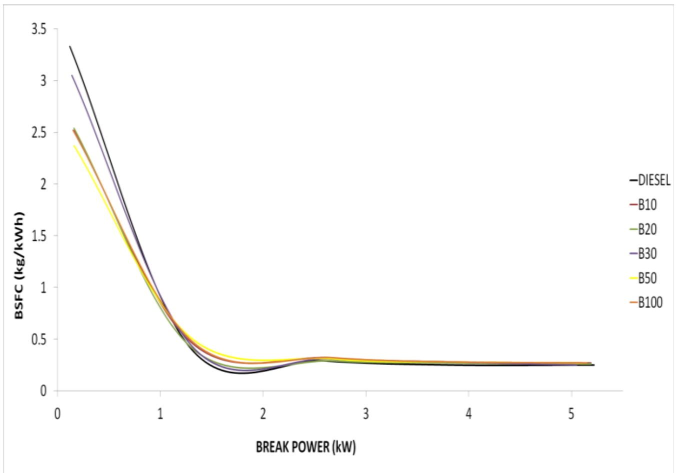

Fig. 3 Variation of Brake power with BSFC

Figure 4 shows the variation of carbon monoxide emission of blends and diesel under various loads. The discharge of CO is found to be diminished with increasing load at the initial stage up to approximate 75% load after that it increases for B10 up to 0.2 (%V). But for B30 decrement of 0.2 (%V) of CO at stage of 75% to 100% load. This is because of more fuel accumulates at higher load to produce more power due to which higher temperature achieved in the fumes. This increased temperature helps in the oxidation of CO on account that its value decreases. Blend B10, B20, B50 and B100 have been given equal amount of CO to that of diesel at full load stage, because for B10 due to the inefficient inherited oxygen of biodiesel CO could not oxidized to CO_2, and for B50 increased viscosity and high non volatility of biodiesel caused poor spray, atomization and burning of CO into CO_2.

Variation of unburned hydrocarbon can be seen in figure 5. Significant reduction in HC emission has been found with decreasing the blend ratio of biodiesel in fuel. Blends B10, B20, B30, B50, B100 and diesel are given 36.5ppm, 34.8ppm, 30.2ppm, 23ppm, 23.2 and 27.4ppm of HC emission on an intermediate basis. Hence B50 and B100 has been given lowest HC compare to all test fuels due to optimum level of oxygen and viscosity of fuel.

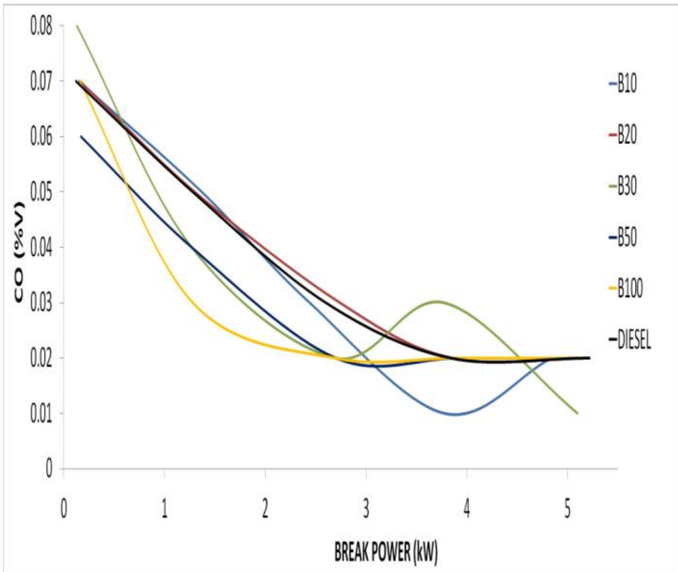

Fig. 4 CO (%V) Vs BP (KW) emission

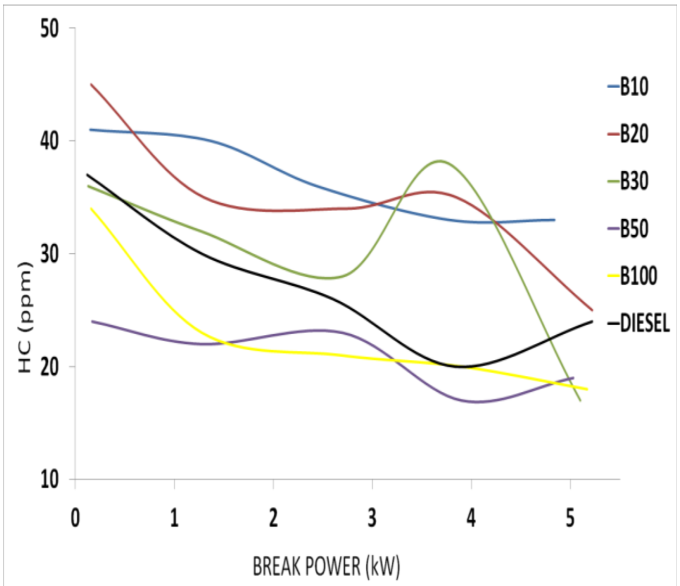

Fig. 5 Unburned HC Vs BP

Variations of NOx emission with loads for different blends are presented in figure 6. The NOx emission is found to be increased with growth in shipment due to less heat rejection at higher load. That is the way all test fuels shows highest value of discharge at full load condition. Blends B10, B20, B30, B50, B100 and diesel show 549ppm, 743ppm, 608ppm, 704ppm, 669ppm and 730ppm respectively at full load condition. it can be concluded that B20 exhibiting proper complete combustion compare to others fuels.

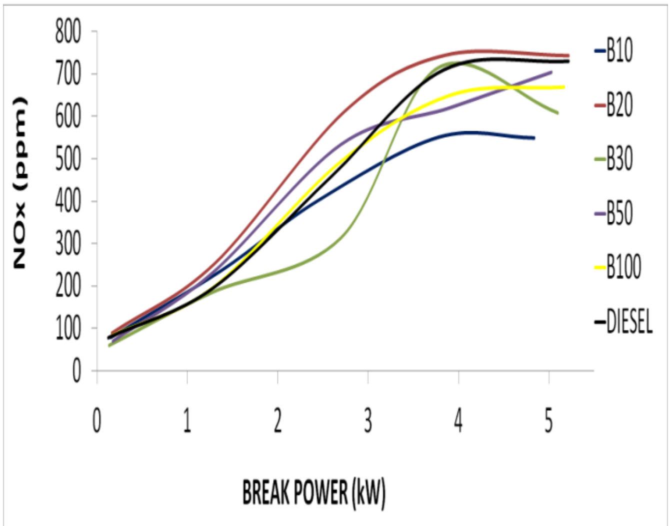

Fig. 6 NOx Vs BP

Percent of CO2 in exhaust is the direct indication of complete combustion of fuel in combustion chamber. Figure 7 shows the variation of CO2 under varying load for different biodiesel blends. All test fuels show increasing trends, CO2 emission with increase in shipment due to increase in accumulation of fuel. Blends B10, B20, B30, B50, B100 and diesel shows 3.6%, 4%, 3.7%, 4,2%, 3.7% and 4.5% of CO2 respectively at full load condition. Only B50 has been shown higher CO2 emission compare to diesel due to the significant issue of higher cetane number compare to other test fuel. Other blends have been presented the lower value of CO2 than diesel. It can also be cleared from exhaust gas temperature vs. load curves in which B50 has been shown higher temperature than other blends.

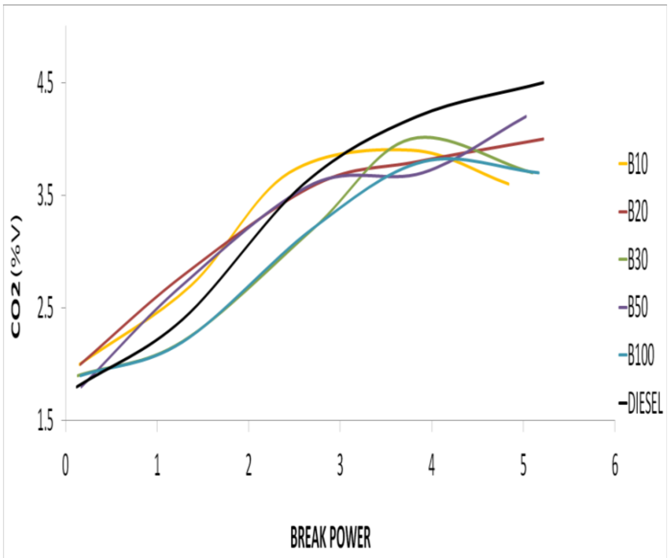

Fig. 7 CO2 Vs BP

Figure 8 shows the variation of incylinder pressure with crank angle for blends B10, B20, B30, B50 and B100 in comparison of baseline data obtained from standard diesel. Pressure rise has been found to be comparable with diesel for higher biodiesel blends fuel.

Moreover, low biodiesel blends such as B10 and B20 show delayed pressure rise with respect to standard diesel at full load due to longer physical ignition delay period because of the higher boiling point range of biodiesel compare to diesel. It can as well be visualized in figure 8 that all test fuel has shown decreases in ignition delay with increase in shipment.

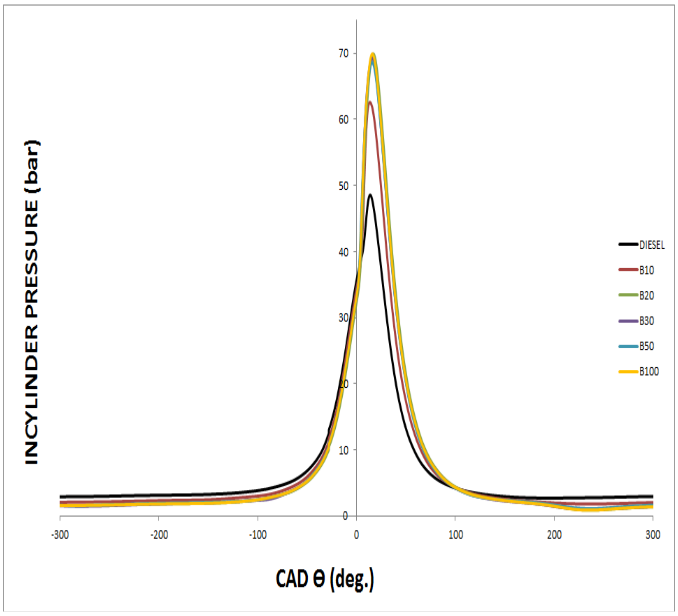

Fig. 8 Incylinder pressure vs. crank angle

This was passed due to increase in gaseous state temperature at high load operation, therefore reduction in the physical ignition delay period was held. In all cases higher biodiesel blends as B100 and B50 has been shown higher incylinder peak pressure compare to diesel and other low biodiesel blends. Two elements are mostly responsible for that first presence of inherited oxygen molecules in biodiesel helps in combustion and the second is the lower viscosity of mineral diesel which ensures adequate air-fuel blending.

Figure 9 shows the heat release rate for biodiesel blends in comparison of standard diesel at different engine operating conditions. After burning of fuel, fluctuation of heat release rate occurs. However, at B100 shows highest rate of heat release compare to diesel and other biodiesel blends, because of the higher cetane number and higher oxygen capacity of biodiesel that improves the burning quality of fuel and helps in firing at higher charge per units. Moreover B10, B20 and B50 have been established a corresponding rate of heat release with diesel. This is because, in low blends the concentration of biodiesel is low, that is way fuel does not cause a significant force on certain number, but it touches the air fuel mixture formation due to changes in viscosity and evaporation properties of the fuel. That is way lower blends showed a less charge per unit of heat release than B100.

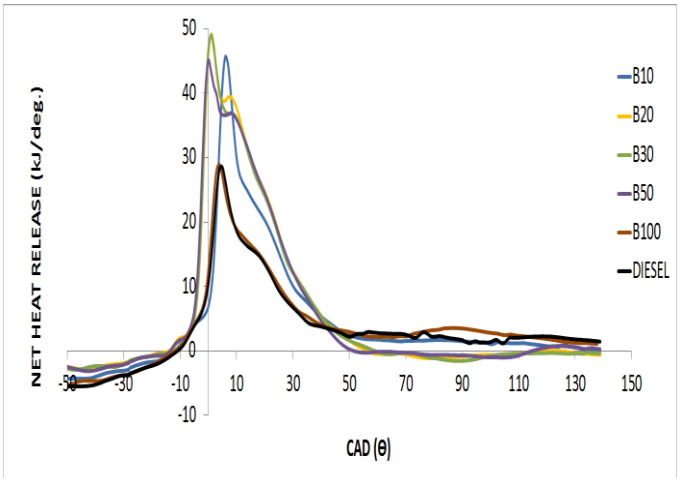

Fig. 9 Heat release rate vs. crank angle

IV. CONCLUSIONS

- The brake thermal efficiency of mahua biodiesel blends is higher than that of diesel at all load conditions.
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- CO 2 emissions were lesser in comparison to diesel.The smoke density and NOx of biodiesel blends were always higher than the standard diesel
- The CO emissions at different loads were found to be equal compared to diesel.
- B50 and B100 has been given lowest HC compare to all test fuels due to optimum level of oxygen and viscosity of fuel. B30 has minimal value of fuel consumption among B10, B20, B50 and B100 at and above 100% load.
- blend B30 of mahua oil biodiesel gave the better overall performance among all other blends in comparison to diesel.Blend B30 gave reduced CO, HC, NOx and CO2 emissions with high value smoke which indicates better combustion of fuel, which can be considered as acceptable results in overall performance with biodiesel without any modification of engine.
- Incylinder Pressure rise has been found to be comparable with diesel for higher biodiesel blends fuel. In all cases higher biodiesel blends as B100 and B50 has been shown higher incylinder peak pressure compare to diesel and other low biodiesel blendsl.
- B100 shows highest rate of heat release compare to diesel because in low blends the concentration of biodiesel is low

REFERENCE

[1] Demirbas A. (2005) "Biodiesel production from vegetable oils via catalytic and noncatalytic supercritical methanol transesterification methods". Prog Energy Combus Sci;31:466–87.

[2] Sree, R, SeshuBabu, N, Sai Prasad, P.S, &Lingaiah, N.(2008) "Transesterification of edible and non-edible oils over basic solid Mg/Zr catalysts". Fuel Processing Technology2009;90(1),152–157

[3] Kittiphoom Suppalakpanya1, Sukritthira Ratanawilai, Ruamporn Nikhom, and Chakrit Tongurai, (2011) "Production of ethyl ester from crude palm oil by two-step reaction using continuous microwave system." Songklanakarin Journal of Science and Technology 2011; 33(1):79-86.

[4] Man Kee Lam, Keat Teong Lee (2010) "Renewable and sustainable bioenergies production from palm oil mill effluent:Win–win strategies toward better environmental protection" Biotechnology Advances 29 (2011);124–141

[5] Xiaoling miao,Rongxiu Li,Hongyan Yao (2009) "Effective acid-catalyzed transesterification for biodiesel production" Energy Conversion and Management(2009); 50(10):2680-2684.

[6] Prafulla D Patil, Shuguang Deng (2009) "Optimization of biodiesel production from edible and non-edible vegetable oils" Fuel 88 (7);1302-1306

[7] Vyas, P. Amish, N. Subrahmanyam and A.P. Patel, (2009) "Production of biodiesel through transesterification of Jatropha oil using KNO_3/ AL_2O_3 solid catalyst." Fuel, 2011; 88, 625-628.

[8] Singh S.P.and Singh Dipti (2010)"Biodiesel production through the use of different sources and characterization of oils and their esters as the substitute of diesel" Renewable and Sustainable Energy Reviews 14(1);200-216

[9] P.C. Mazo and L.A. Rios, (2010) "Esterification and transesterification assisted by microwaves of crude palm oil." Homogeneous catalysis. Latin American Applied Research 2010; 40:337-342.