

# Experimental Investigation of Engine Characteristics of Diesel Engine using Neem Biodiesel with Methanol Blending

Akshay Kumar<sup>1</sup>, Prof. Harischandra Astagi<sup>2</sup>, Dr. Prashant G. Kamble<sup>3</sup>

<sup>1</sup>M.Tech Scholar in Thermal Power Engineering, Department of Mechanical Engineering, PDA College of Engineering, Kalaburagi-585102 VTU Belagavi, INDIA

<sup>2</sup>Assistant Professor in Department of Mechanical Engineering, PDA College of Engineering, Kalaburagi-585102, INDIA

<sup>3</sup>Professor in Department of Industrial & Production Engineering, PDA College of Engineering, Kalaburagi-585102, INDIA

\*\*\*

**Abstract** - The performance of compression Ignition Engine depends on various parameters. The fuel injection pressure is one of the most important parameter. This research is carried out to find the optimum fuel injection pressure in order to improve the performance of CI Engine. By varying Injection pressure the performance parameters like brake thermal efficiency, Specific fuel consumption, Brake power also varies. In this present work experimental investigation of method to improve performance of DI engine using neem biodiesel, methanol by varying parameters. A single cylinder water-cooled four stroke diesel engine was used. The neem is blended with methanol and diesel in the proportions of B20, B40, B60, B80, B100, B20M5, B20M10, B40M5, and B40M10 with different injection pressure 180 bars, 200bar. The performance of DI engine using neem biodiesel, methanol blends are evaluated by operating the engine at different load conditions. B40M5 and B40M10 shows best results Brake thermal efficiency, specific fuel consumption, NOx and HC.

**Key Words:** Biodiesel, Emission.

## 1. INTRODUCTION

In the modern world, the demand for the fossil fuels is increasing day by day due to modernization and mechanization. Demand for electricity and enormous increase in the number of automobiles has resulted in greater demand for fossil fuels. The increasing demand for the petroleum based fuels has led to oil crises in the recent times.

Fossil fuels are still being created today by underground heat and pressure; they are being consumed more rapidly than they are being created. Insufficient quantities or unreasonable price of petroleum fuels deeply concerns us whereas the renewable energy is a promising alternative solution because it is clean and environmentally safe. Due to petroleum fuel, Pollution and accelerating energy consumption have already affected equilibrium of the earth's landmasses and biodiversity.

Since petroleum diesel and gasoline consist of blends of hundreds of different chemicals of varying hydrocarbon chains, many of these are hazardous and toxic. Carbon

monoxide (produced when combustion is inefficient or incomplete), nitrogen oxides (produced when combustion occurs at very high temperatures), sulfur oxides (produced when elemental sulfur is present in the fuel), and particulates that are generally produced during combustion are other specific emissions of concern. So it is time to search for its alternative fuels. There are several alternative sources of fuel like vegetable oils, biogas, biomass, primary alcohols which are all renewable in nature. Among these fuels, vegetable oils appear to have an exceptional importance as they are renewable and widely available, biodegradable, non-toxic and environment friendly. The alternative fuel that much closer to diesel engine is 'biodiesel'.

Neem comprises mainly of triglycerides and large amounts of triterpenoid compounds. It contains four significant saturated fatty acids, of which two are palmitic acid and two are stearic acid. It also contains polyunsaturated fatty acids such as oleic acid and linoleic acids the renewable or alternate fuels to replace the petroleum based fuels for transport vehicles.

**Table - 1:** Properties of Neem biodiesel, Methanol, Pure Diesel

Fuel properties	Diesel	Neem biodiesel	Methanol
Fuel density (gm/cc)	0.830	0.850	0.789
Calorific value (kJ/kg)	42500	36496	20100
Flash point, °C	74	178	12
Viscosity, cst	3.6	38.16	6.8

## 2. MATERIAL AND METHODS:

The neem oil used in this study was purchased from the market in Nagpur. The chemicals methanol, potassium hydroxide, sulphuric acid were purchased from local. All the chemicals used were analytical reagent grades. Distilled water from local supplier is used for the hydrolysis process.

Thus, different methods of biodiesel production are being developed. The conventional method of producing biodiesel via transesterification as have been seen earlier focusses. The pre-treatment process to this step involves subjecting the oil to acid esterification which converts all the free fatty acids to its corresponding fatty acid methyl esters form. The disadvantage with this method is that when there is insufficient acid value reduction via acid catalysed esterification, there occurs significant soap formation which acts as a hindrance in the efficient separation or removal of the biodiesel.

Thus, an alternative approach to biodiesel production is proposed via the method of acid hydrolysis. In this case, focus is on breaking all the triglyceride esters into their corresponding free fatty acids i.e., acid value is to be increased. It is then followed by acid esterification for the production of fatty acid methyl esters (biodiesel).

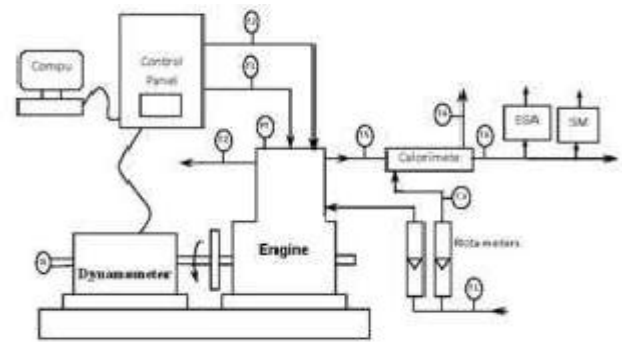
**2.1 ACID HYDROLYSIS**

50 ml of the oil sample is taken into the flask and heated upto 40°C. A standard mixture of 0.5N sulphuric acid is prepared. 100ml of the 0.5N sulphuric acid solution is added to the oil sample in flask once it reaches 40°C. Heating and stirring is continued for about 2 hours at atmospheric pressure. After completion of this reaction, the mixture is poured into a separating funnel for separating the water, glycerol and sulphuric acid. The top layer is the acid hydrolysed oil. Thus, it is centrifuged to remove presence of any residual water, sulphuric acid or glycerine. A maximum FFA of 82 % is achieved with this method.

**3. EXPERIMENTAL SET-UP**

The experiment set up consists of single cylinder watercooled four stroke diesel engine conducted to eddy current dynamometer for variable loading at a constant speed 1500 rpm. The engine is connected to a exhaust gas analyzer emission such as carbon monoxide (CO), carbon dioxide(CO<sub>2</sub>), oxide of nitrogen (NOX) were measured by exhaust gas analyzer. The experiments were carried out by using various blends of neem (B20,B40,b60,b80,B100) with diesel at different load conditions on the engine keeping all the independent variables same.

The variable tests are conducted for 0, 1, 2, 3, 4, and 5 kW at a constant speed of 1500 rpm with different injection pressure of 180 bars and 200 bars and Observations were recorded.



**Fig 1: Experimental Set Up**

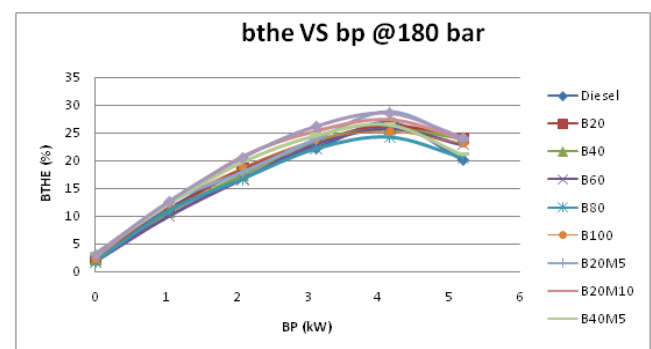
**ENGINE SPECIFICATION**

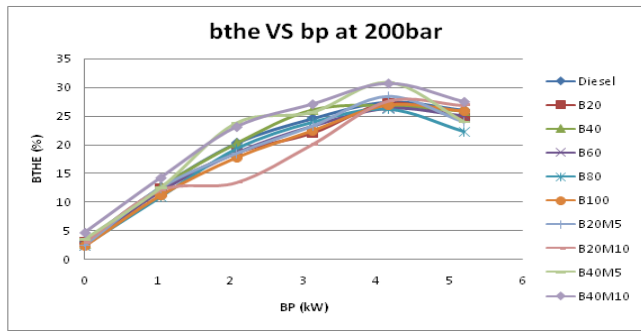
**Table 2: Technical Specifications of the Kirloskar Diesel Engine**

Parameters	Specifications
Manufacturer	Kirloskar Oil Engine Ltd., India
Model	TV – SR II, naturally Aspirated
Engine	Single cylinder, DI, water-cooled, four strokes
Bore/Stroke	87.5 mm/110 mm
Compression ratio	17.5:1
Speed	1500 r/min, constant
Rated Power	5.2 kw
Injection pressure	240 bar/230 BTDC
Type sensor	Piezo electric
Response time	4 micro seconds
Make and model	Neptune equipment’s, India, OPAX200 II/DX200P
Crank angle sensor	1 – degree crank angle

**4. RESULTS AND DISCUSSION**

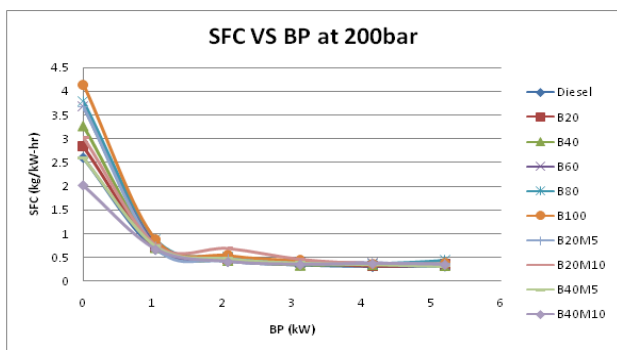
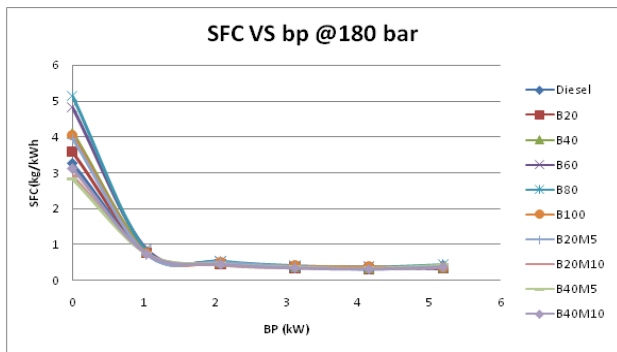
**4.1 PERFORMANCE CHARACTERISTICS**





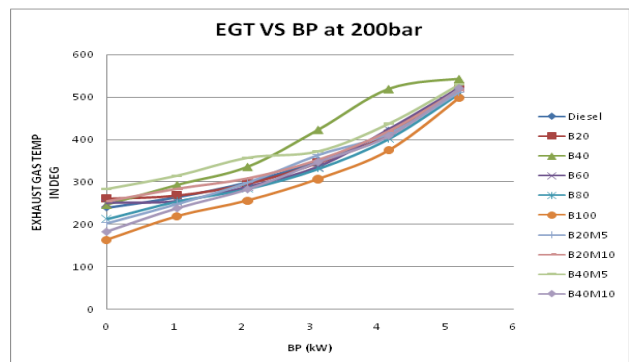
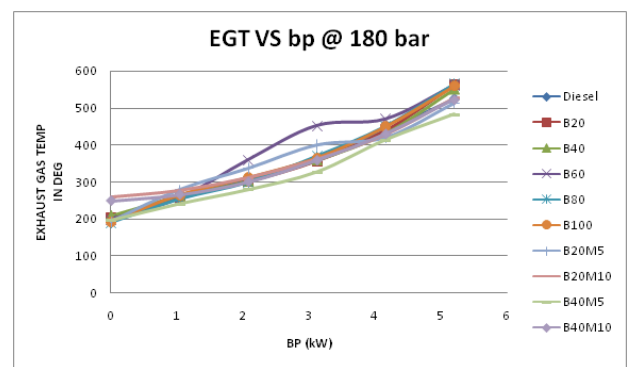
**Fig 2:** Variation of brake thermal efficiency with bp for pressure 180 bar and 200 bars

Fig.2. shows the comparison of brake thermal efficiency with brake power for pressure 180 bars and 200 bars for different blends of Neem biodiesel, Methanol and diesel. As the load on the engine increases, brake thermal efficiency increase because it is the function of brake power and brake power increases as the load on the engine increases. The maximum brake thermal efficiency without EGR at 180 bars and 200 bars of neem oil and methanol blend at B40M10 is 24.14% and 27.55%, against diesel which is 20.13% and 26.13% because of better spray characteristics in the combustion chamber. The decrease in B80 brake thermal efficiency for higher blends may be due to the combined effect of its lower heating value, low calorific value, and increase in fuel consumption. The bthe of Neem and Methanol blends were higher than that of diesel. For B40M10 gives better performance with respect to other blends.



**Fig 3:** Variation of specific fuel consumption with brake power for pressure 180 bar and 200 bars

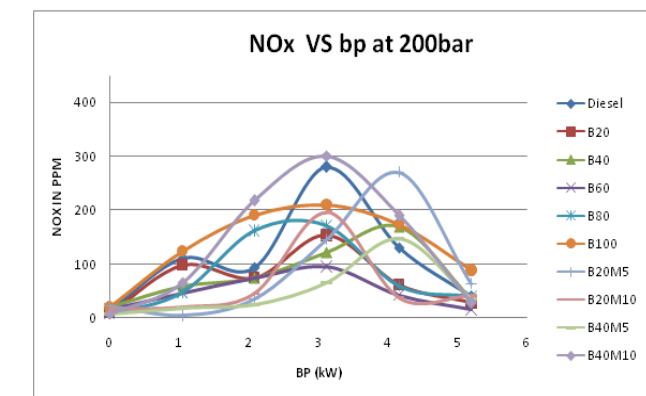
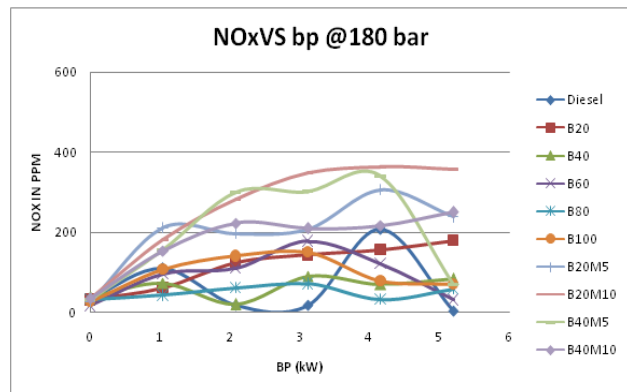
Fig.3. shows the comparison of specific fuel consumption with brake power for 180 bar and 200 bars for different blends of Neem oil, Methanol and diesel. Specific fuel consumption at 180 bars pressure under full load for biodiesel is 0.34 kg/kw-hr and for diesel is 0.42 kg/kW-hr and 200 bars pressure under full load was found to be same value for both Neem, Methanol blend and diesel and 0.32 kg/kW-hr, due to its lower heating value, greater density and hence higher bulk modulus. B40M5 has low SFC at higher load in 200 bars it's because of fuel consumption is less compared to other blends because of its high latent heat vaporization. B80 blend shows highest fuel consumption in 200 bars. As compared to all the blends B40M5 is the best blend for low fuel consumption.



**Fig 4:** Variation of exhaust gas temperature with bp for pressure 180 bar and 200 bars

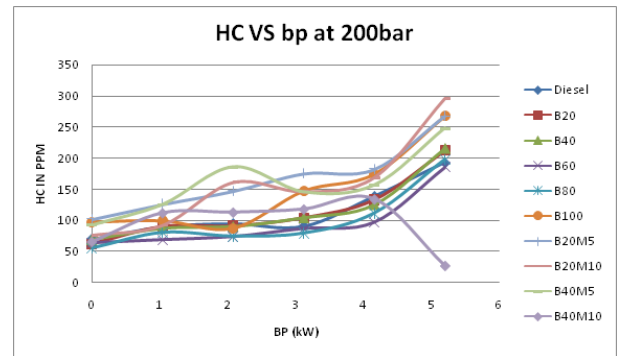
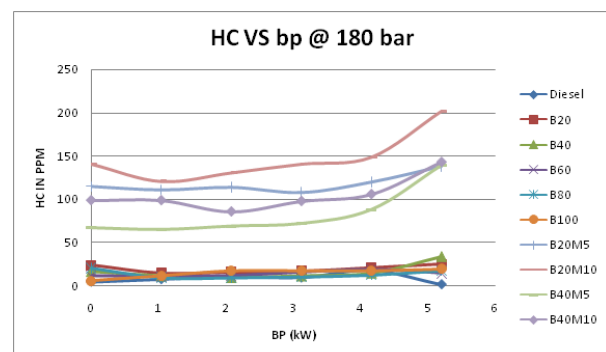
Fig. 4 shows the comparison of exhaust gas temperature with brake power for 180 bar and 200 bars for different blends of Neem oil, Methanol and diesel. The exhaust gas temperature for all fuels tested increases with increase in the brake power. Exhaust gas temperature of all blends is higher as compared to diesel. The maximum EGT occurs at full load. From fig 3 show the Maximum EGT of B20 is 561.25°C against 525.38 °C for that of diesel on normal engine in both the graphs. B40M5 at 180 bar and B100 at 200 bar shows the low EGT value because by increasing percentage of Neem biodiesel in diesel decrease the EGT. It is observed that, at full load the exhaust gas temperature is high for both pressures.

## 4.2. EMISSION CHARACTERISTICS



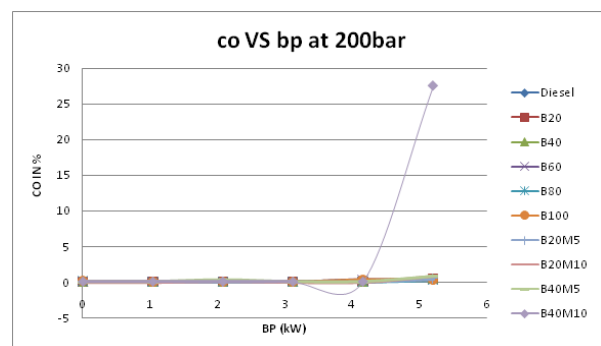
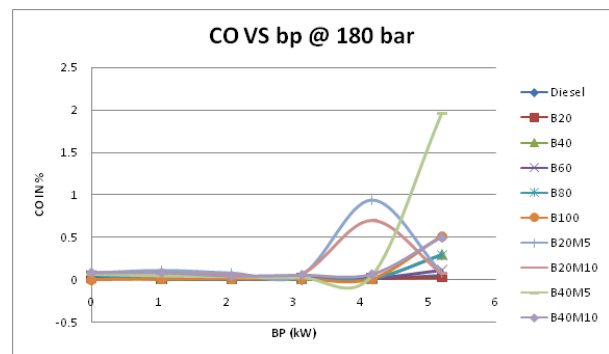
**Fig 5:** Variation of Oxides of Nitrogen with Brake Power at 180 and 200 bars.

The change in NO<sub>x</sub> emissions at dissimilar engine load and varied injection pressures are displayed in fig. 5. NO<sub>x</sub> is formed by a combination of nitrogen and oxygen from the air under heat and pressure. The increased engine heat and pressure give you more NO<sub>x</sub>. The main reason for higher NO<sub>x</sub> production is the temperature and duration of the combustion flame due to a burning of mixed fuel and air. Due to increase in applied load on the engine, emission of NO<sub>x</sub> rate increases. This increased NO emission for B40M10 for both 180 and 200 bars might be owing to more O<sub>2</sub> atoms presence in the biodiesel and improved atomization of biodiesel by the high injection pressure resulting in high NO<sub>x</sub> emissions



**Fig: 6.** Variation of unbrunt hydrocarbon with bp for pressure 180 bar and 200 bars.

Fig.6. shows the variation of Unbrunt Hydrocarbon with brake power for pressure 180 bars and 200 bars for different blends of Neem oil, Methanol and diesel. HC emissions decrease with increase in percentage of blend. Since the Neem biodiesel blended with Methanol and diesel, it promotes combustion and results in reduction in HC emissions it is observed that for B40M10 emission of HC is less than that of the diesel at 200 bar as shown in the graph. The maximum HC of B40M10 is 27.55 ppm in 200 bars against 193 ppm for that of diesel. B40M10 blend gives lower emission with respect to other blends, due to the higher cetane number of biodiesel results decrease in HC shorter ignition delay.



**Fig:7.** Variation of carbon monoxide with brake power for pressure 180 bar and 200 bars.

Fig.7. shows comparison of CO with brake power for pressure 180 bar and 200 bars for different blends of Neem



oil, Methanol and diesel. The CO emissions mainly depends upon the strength of the mixture, availability of oxygen and viscosity of fuel. CO emission of diesel is higher in 180 bars and lower in 200 bars than that of the all the blends, expect the blend B20 which has a lower value in both graphs. The decrease in carbon monoxide emission for biodiesel is due to more oxygen molecule present in the fuel and more atomization of fuel as compared to that of diesel. The maximum CO pure biodiesel is 0.05% volume against 0.03% volume pure diesel for pressure 180 bar. The maximum CO B20 is 0.49% volume against 0.52% volume pure diesel for pressure 200 bars. B20 blends give lower emission with respect to other blends.

## 5. CONCLUSIONS

- Neem biodiesel, Methanol blended with diesel can be directly used in diesel engine without any engine modification.
- Brake thermal efficiency is high at 200 bar when compared to 180 bar, B40M10 is highest brake thermal efficiency.
- specific fuel consumption is low at 200 bar when compared to 180 bar because of its high latent heat of vaporization .B80 shows highest fuel consumption while B40M5 shows lowest fuel consumption compared to all, hence B40M5 is the best suitable.
- B40M10 has the highest NO<sub>x</sub> emission at both 180 and 200 bars because of increased temperature and duration of combustion flame. B60 shows the best results compared all other blends at both 180 and 200 bars.
- Unburnt Hydrocarbons (UBHC) which were high in both case of 180 and 200 bars, in that B40M10 has lowest emission compared to all.
- B60 shows the less emission next to B40M10 in both 180 and 200 bars for CO, NO<sub>x</sub>, HC emissions.
- Properties of 40% biodiesel blended with 5% and 10% of Methanol shows the best results compared to all other blends.
- Hence B40M10 and B40M5 blends can be used as an alternate fuel for diesel engine without any major modification.

## REFERENCES

- [1] N.Prabhu Kishore, N. Alekhya, P Bridjesh, "Experimental Investigation by varying Fuel Injection Pressure on CI Engine".2016
- [2] L. Karikalan, S. Baskar, S. Venugopal "Analysing the influence of varied fuel injection pressure on diesel engine fueled with Karanja biodiesel". 2019
- [3] M.C.Navindagi, Maheswar Dutta, experiment conducted on comparative performance analysis of castor and cottonseed oil as alternative fuel in CI engine. (NCRAME 2011)
- [4] Banashankari Nimbale, Dr. M. C. Navindgi, "Experimental Investigation of methods to improve performance of DI engine using Pongamia biodiesel by varying parameters", 2018
- [5] B. Karunanithi, Kelmy Thomas Maria " Biodiesel production from cotton seed oil –an alternate approach".2015
- [6] Study paper on the oil crises.
- [7] Mehmet Celik, "Examining combustion and emission characteristics of cotton methyl ester to which manganese additive material was added".2017