

Experimental Study of Brake Power on Emission for Different Blending Ratio of Neem Biodiesel in Dual Cylinder Diesel Engine

¹H. A. Shah, ²B. S. Patil, ³A. J. Patel

Assistant Professor

¹Mechanical Engineering Department, C G Patel Institute of Technology, Bardoli, Surat, Gujarat, India

²Mechanical Engineering Department, Shroff S R Rotary Institute of Chemical Technology, Vataria, Bharuch, Gujarat, India

³Mechanical Engineering Department, S N Patel Institute of Technology & RC, Umrakh, Surat, Gujarat, India

¹hirensah29@hotmail.com, ²bhupendrapatil.mech@gmail.com, ³aniljpatel705@gmail.com

Abstract— Non-edible filtered neem oil based mono esters (biodiesel) produced and blended with diesel were tested for their use as substitute fuels of diesel engines in terms of emission. The major objective of the present investigation is to experimentally access the emission performance of biodiesel and find the optimum blending ratio in a dual cylinder diesel engine used in generating sets and the agricultural applications in India. Diesel; neat biodiesel from neem and their blends (10, 20 and 30 percentage by volume) were used for conducting tests at varying loads. It is observed that thirty percentage neem with diesel blend gives the better emission test (in terms of carbon monoxide, carbon dioxide, hydrocarbon, smoke density) than other blend ratios of neem biodiesel. The higher fuel consumption of neem biodiesel is due to higher flash point and viscosity than petroleum diesel. The higher the flash point of the biodiesel, the better atomization process will be performed. Thirty percentage blends of bio-diesel (bio-diesel produced from non- edible sources like neem) have been found to comply with all specification of diesel fuel. The cetane number, flash point and lubricity of the blended fuel are observed to be better than commercial diesel fuel.

Index Terms—Neem Biodiesel, Transesterification, Emission Test

I. INTRODUCTION

Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Fuels derived from renewable biological resources for use in diesel engines are known as biodiesel. Biodiesel is environmentally friendly liquid fuel similar to petrol-diesel in combustion properties. Increasing environmental concern, diminishing petroleum reserves and agriculture based economy of our country are the driving forces to promote biodiesel as an alternate fuel. Biodiesel derived from vegetable oil and animal fats is being used in USA and Europe to reduce air pollution, to reduce dependence on fossil fuel. In USA and Europe, their surplus edible oils like soybean oil, sunflower oil and rapeseed oil are being used as feed stock for the production of biodiesel. Since India is net importer of vegetable oils, edible oils cannot be used for production of biodiesel. Blending, cracking/ pyrolysis, emulsification or transesterification of vegetable oils may overcome these problems. Heating and blending of vegetable oils may reduce the viscosity and improve volatility of vegetable oils but its molecular structure remains unchanged. Hence, polyunsaturated character remains. Blending of vegetable oils with diesel, however, reduces the viscosity drastically and the fuel handling system of the engine can handle vegetable oil-diesel blends without any problems [1], [5]. On the basis of experimental investigations, it is found that converting vegetable oils into simple esters is an effective way to overcome all the problems associated with the vegetable oils [4]. Previous studies have shown that there is a substantial reduction of CO, unburned hydrocarbons and particulate matter emission, when they are used in conventional diesel engines. Biodiesel is alkyl (e.g. Methyl, Ethyl) ester of fatty acids made from a wide range of vegetable oils, animal fat and used cooking oil via the transesterification process. Moreover, biodiesel has been used not only as an alternative for fossil diesel [1], [2]. Biodiesel is alkyl (e.g. Methyl, Ethyl) ester of fatty acids made from a wide range of vegetable oils, animal fat and used cooking oil via the transesterification process [3]. Additionally, the cetane number of the blend is low, making it difficult to burn by the compression ignition technology employed in diesel engines. As a result, a number of studies have been carried out to improve the solubility of ethanol in diesel, as well as to improve the cetane number of the [7]. India has the potential to be a leading world producer of biodiesel, as biodiesel can be harvested and sourced from non-edible oils like jatropha curcas, pongamia pinnata, neem (azadirachta indica), mahua, castor, linseed, kusum (schleichera trijuga), etc. Some of these oils produced even now are not being properly utilized. Out of these plants, India is focusing on jatropha curcas and pongamia pinnata, which can grow in arid and wastelands. Oil content in the jatropha and pongamia seed is around 30 to 40 percentage. India has about 80 to 100 million hectares of wasteland, which can be used for jatropha and pongamia plantation [6]. It is an untapped source in India. Implementation of biodiesel in India will lead to many advantages like green cover to wasteland, support to agriculture and rural economy and reduction in dependence on imported crude oil and reduction in air pollution [8]. However, long term engine test results showed that durability problems were encountered with vegetable oils because of deposit formation, carbon buildup and lubricating oil contamination. Thus, it was concluded that vegetable oils must either be chemically altered or blended with diesel fuel to prevent premature engine failure [4].

II. THE PROCESS OF MAKING BIODIESEL

The transesterification process is the reaction of a triglyceride (fat/oil) with an alcohol to form esters and glycerol. A triglyceride has a glycerine molecule as its base with three long chain fatty acids attached. The characteristics of the fat are

determined by the nature of the fatty acids attached to the glycerine. The nature of the fatty acids can, in turn, affect the characteristics of the biodiesel. Vegetable oils have to undergo the process of transesterification to be usable in internal combustion engines. Biodiesel is the product of the process of transesterification.

TABLE I
PROPERTIES OF NEEM BIODIESEL

Characteristics	Specific gravity @ 15 °C (Kg/m ³)	Net calorific (heating value) (MJ/Kg)	Cetane Number	Kinematic viscosity @ 40 °C (Cp)
Diesel	0.8396	44.421	54.6	4.84
NB10	0.8498	41.621	57.8	5.01
NB20	0.8601	38.737	59	5.52
NB30	0.8784	37.187	62.7	5.82

Biodiesel is renewable and can be produced from agriculture and plant resources. Biodiesel is commonly produced by the transesterification of the vegetable oil feedstock. There are several methods for carrying out this transesterification reaction including the common batch process, supercritical processes, ultrasonic methods, and even microwave methods. Chemically, transesterified fatty acid (biodiesel) comprises a mix of mono-alkyl esters of long chain fatty acids. The most common form uses methanol (converted to sodium methoxide) to produce methyl esters as it is the cheapest alcohol available, though ethanol can be used to produce an ethyl ester biodiesel and higher alcohols such as isopropanol and butanol have also been used. Using alcohols of higher molecular weights improves the cold flow properties of the resulting ester at the cost of a less efficient transesterification reaction. A liquid transesterification production process is used to convert the base oil to the desired esters. Any free fatty acids (FFAs) in the base oil are either converted to soap, or removed from the process, or they are esterified (yielding more biodiesel) using an acidic catalyst. After this processing, unlike straight vegetable oil, biodiesel has combustion properties very similar to those of petroleum diesel and can replace it in most current uses. A by-product of the transesterification process is the production of glycerol. For every one tone of biodiesel that is manufactured, 100 kg of glycerol are produced.

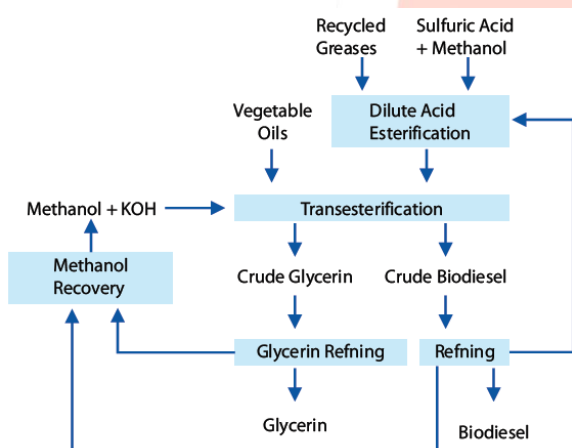


Fig. 1 Transesterification process



Fig. 2 Experimental Setup

III. EXPERIMENTAL SETUP

Engine was connected with an electrical dynamometer to measure the power output. The engine was instrumented to measure the parameter like fuel consumption, load, and speed of engine, cooling water temperature, inlet air & exhaust gas temperature with smoke density. The engine test was carried out with the load variation from no load to the maximum load conditions. At each operating stage the observations of various parameters were taken.

Apparatus Specification:

Engine – Multi cylinder vertical water cooled self-governed diesel engine developing 10 HP at 1500 rpm with compression ratio 16:1, Lubricating oil -20w/40 and Lubricating oil quantity required are 7 Litres. Dynamometer 6 KVA capacity alternator coupled to the engine with load arrangement.

Measurement:

- Calibrated burette for fuel intake measurement.
- Orifice meter – Fitted to the air inlet tank with water manometer for air intake measurement.
- Multichannel digital temperature measurement at various points.
- Exhaust gas calorimeter to measure heat carried away by exhaust gas.
- Measure the water flow rate of engine jacket and calorimeter

At each operating condition, the dynamometer load, speed, fuel consumption and temperatures were recorded after allowing time for the engine to stabilise.

IV. RESULT & DISCUSSION

Fig. 3 and observation table no. two show that as the load increased on the engine smoke density goes on increased continuously. NB 10 has maximum smoke density with the increase in load as compare to diesel and NB 30.

TABLE II

EMISSION TEST RESULTS FOR DIESEL

Load	Smoke density	CO	CO ₂	O ₂	HC
KW	%	%	%	%	ppm
0	12.4	0.09	2.1	20.89	42
1.49	13.1	0.08	2.8	20.89	48
2.76	20.9	0.07	3.2	20.90	52
4.05	35.6	0.06	3.5	20.90	66
5.17	41.5	0.07	4.4	20.90	81

TABLE III

EMISSION TEST RESULTS FOR NB10

Load	Smoke density	CO	CO ₂	O ₂	HC
KW	%	%	%	%	ppm
0	7.0	0.07	2.0	20.89	39
1.49	13.5	0.08	2.6	20.89	62
2.76	24.2	0.08	3.4	20.89	73
4.05	36.0	0.06	3.8	20.98	56
5.17	48.0	0.06	4.6	20.89	60

TABLE IV

EMISSION TEST RESULTS FOR NB20

Load	Smoke density	CO	CO ₂	O ₂	HC
KW	%	%	%	%	ppm
0	8.8	0.09	2.3	20.91	40
1.49	12.4	0.08	2.5	20.89	72
2.76	24.2	0.07	3.2	20.89	73
4.05	35.0	0.07	3.7	20.90	60
5.17	47.7	0.05	4.6	20.90	76

TABLE V

EMISSION TEST RESULTS FOR NB 30

Load	Smoke density	CO	CO ₂	O ₂	HC
kw	%	%	%	%	ppm
0	10.6	0.08	2.3	20.91	43
1.49	11.2	0.07	2.5	20.90	70
2.76	23.9	0.06	3.2	20.90	68
4.05	33.4	0.06	3.5	20.90	70
5.17	46.7	0.05	4.2	20.90	72

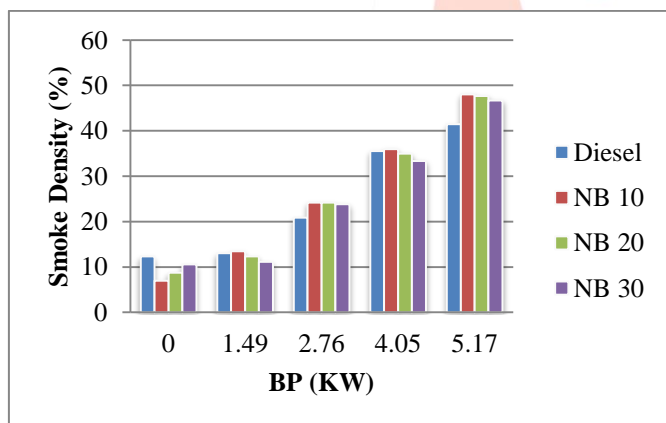


Fig. 3 Variation in Smoke Density (%) Vs BP (KW)

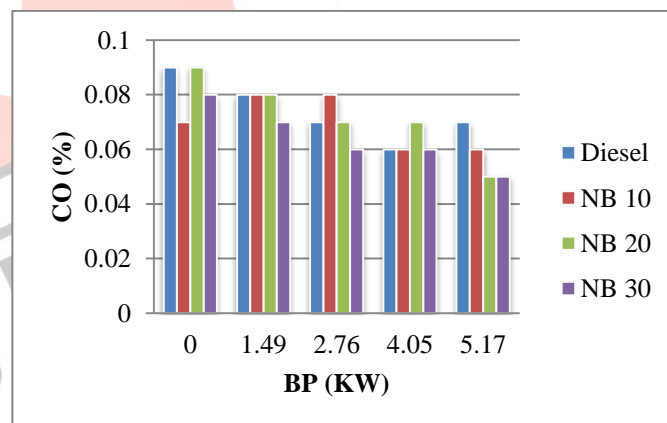


Fig. 4 Variation in CO (%) Vs BP (KW)

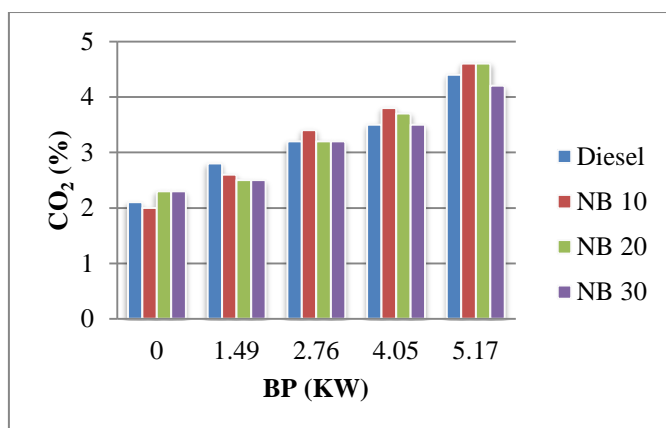
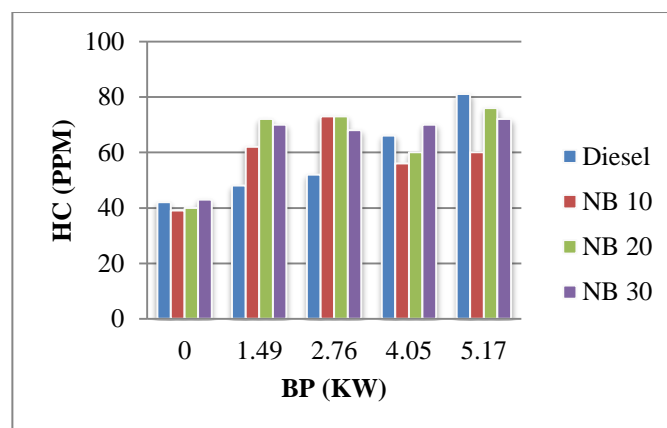
Fig. 5 Variation in CO₂ (%) Vs BP (KW)

Fig. 6 Variation in HC (PPM) Vs BP (KW)

Fig. 4 and table no. three show that carbon monoxide decreased with increases in blending ratio and load. NB 20 and NB 30 produced minimum carbon monoxide emissions at high load but when load decreases there is a constant relation between all blending ratios. It is clear that at zero loads diesel and NB 20 produced maximum CO emission.

Fig. 5 and table no four show that carbon dioxide increased with increases blending ratio at same load conditions and also increasing with higher load conditions. NB 30 produced minimum carbon dioxide emissions as compare to other blends and diesel at all load conditions.

Fig. 6 and table no. five show that HC emissions increased with increases blending ratio at same load conditions and also increase with higher load conditions as compared to diesel. NB 10 produced minimum HC emissions as compare to other blends and diesel at all load conditions.

V. CONCLUSION

The following conclusions could be arrived, based on the experimental results:

- Engine works smoothly on bio-diesel with performance comparable to diesel operation. Heat of combustion of all the blends was found to be lower than that of diesel fuel alone. However, the heating value of the blends containing lower than 20 percentages were not much different from that of conventional diesel.
- N10 gives the smoke density, HC and carbon dioxide higher value than other blend ratios. 30 percentage blends of bio-diesel (bio-diesel produced from non- edible sources like neem) have been found to comply with all specification of diesel fuel. The cetane number, flash point and lubricity of the blended fuel are observed to be better than commercial diesel fuel.
- The viscosity of biodiesel is higher and reported to result into gum formation on injector, cylinder liner etc. However blends of up to 20 percentages should not give any problem. It is also observed that neem biodiesel has higher fuel consumption than that of petroleum diesel. The higher fuel consumption of neem biodiesel is due to higher flash point and viscosity than petroleum diesel. The higher the flash point of the biodiesel, the better atomization process will be performed.
- The neem biodiesel produces marginally lower output characteristics, low performance in terms of torque, effective power and thermal efficiency than petroleum diesel.

ACKNOWLEDGMENT

The authors would like to acknowledge the support for experimental data collection to laboratory assistants, laboratory in-charge Professor D. C. Gosai and Principal Dr. R. G. Kapadia of SVM Institute of Technology, Bharuch, Gujarat, India. Special thanks to Professor A. J. Modi from Government engineering college, Bhuj, Gujarat, India.

ABBREVIATION

BP	Brake power
SFC	Specific Fuel Consumption
RPM	Revolution per minute
NB10	Blend of 10% neem biodiesel with 90% of petroleum diesel
NB20	Blend of 20% neem biodiesel with 80% of petroleum diesel
NB30	Blend of 30% neem biodiesel with 70% of petroleum diesel

REFERENCES

- [1] L. M.Das and P.K.Sahoo "Combustion analysis of Jatropha, Karanja and Polanga based biodiesel as fuel in diesel engine" Fuel, vol.88, pp.994-999,[2009].
- [2] L.M.Das,P.K.sahoo,M.K.G.Babu,P.Arora,V.P.Singh,N.R.Kumar and T.S.Varayani"Comparative evaluation of performance and emission characteristics of Jatropha, Karanja and Polanga based biodiesel as fuel in tractor engine" Fuel vol.88, pp.1698-1707, [2009].
- [3] Poonam Singh and Anoop Singh "production of liquid bio fuels from renewable resources"Production in energy combustion science, vol.37, pp 52-68,[2011].
- [4] G. Prabhakar Rao and K. Hema Chandra Reddy T.Venkateswara Rao, "Experimental investigation of pongamia, jatropha and neem methyl esters as biodiesel on C.I. Engine", " jordan journal of mechanical and industrial engineeringl, vol. 2, pp. 117-122, june,[2008].
- [5] Saroj K. Padhi and R. K. singh, "Non-edible oils as the potential source for the production of biodiesel in India: A review", Journal of Chemical and Pharmaceutical Research, vol. 2, pp. 39-49, [2011].
- [6] Modi A.J. and Gosai D.C "Experimental Study on Thermal Barrier Coated (TBC) Diesel Engine Performance with blends of diesel and Palm biodiesel",SAE International,01-1519-[2010].
- [7] Saurabh Srivastava, A. Rehman, Savita Dixit, Atul Lanjewar and S. P. Chincholkar, "Biodiesel as an alternative fuel for Pollution Control in diesel engine," Asian J. Exp. Sci., vol. 19, pp. 13-22, [2005].
- [8] Modi A.J. and Gosai D.C., "Experimental analysis of performance of Bio-fuels (Jatropha & Palm Bio-diesel) on Thermal Barrier Coated (TBC) Diesel Engine", Presented at The 3rd International conference of Advances in Mechanical Engineering (ICAME - 2010), January 4-6,[2010]