

Assessment of C.I Engine Performance and Pollutants with Dissimilar Biodiesel Blends

L.Karikalan^{1*}, M.Chandrasekaran², S.Venugopal³ and S.Jacob⁴

^{1,3,4}Department of Automobile Engineering, VELS Institute of Science, Technology & Advanced Studies (VISTAS), Chennai, Tamil Nadu, India,

²Department of Mechanical Engineering, VELS Institute of Science, Technology & Advanced Studies (VISTAS),
Chennai, Tamil Nadu, India,

Abstract— Performance and pollutant parameters of selective biodiesel such as neem, linseed, polanga and tobacco and were compared in this study with diesel. The test has been completed on a direct injection, water cooled, single cylinder, diesel engine at steady-state conditions. During this test, brake thermal efficiency, specific fuel consumption and toxic pollutants were measured. The experimental results indicated that biodiesel generally give more BSFC and lower BTE relative to diesel, owing to the calorific value of the biodiesel. The pollutant toxic emission analyses showed that biodiesel gives lower NO_x emissions and higher hydrocarbon and smoke emissions when compared to diesel. But O₂ content in the biodiesel lessens the CO emission. Hence, it was clearly showed that the various biodiesel can be effectively run and provide better performance and also reduced pollutants without any engine alteration.

Keywords— Fuel, Diesel, Biodiesel, Emission, Performance

I. INTRODUCTION

Energy and long term availability of energy is playing a crucial role in all countries economic growth. Energy is the important phenomenon for society since which is used in many applications. It has obtained from various sources and in different forms. Due to rising demands on energy, researchers have started to focus on bio-fuels for the past few decades. Bio-fuels are the energy source that is resulting from various sources such as animal fats and plants. Biodiesels are meeting the technical properties of the diesel fuel due to its molecular similarities [1-3]. Since biodiesel produced from plants, it contains oxygen within its molecules to make cleaner and burning bio fuel than petroleum based fuels. Biodiesel production in the country reduces the imported petroleum dependency. The major advantage of the biodiesel is biodegradability, renewability, portability, low sulfur and aromatic content and higher combustion efficiency. It has considerable potential to use an alternate fuel for conventional diesel engine. It is a toxic free, biodegradable, and sulfur free fuel, since it is acquired from renewable feed stocks [4-7]. The major advantages of biodiesel fuels are renewability, biodegradability, ease of availability, liquid nature portability, lower sulfur and aromatic content, higher heat content and the better lubricating properties. Oxygen content of biodiesel is 11% which leads complete combustion and better auto ignition process. The major demerits of the biodiesel are cold weather freezing, less calorific value and degradation of bio fuel when it is used for longer periods in under storage. From the above reasons, found that the biodiesel can be utilized in diesel engines with few alterations in the fuel or in the engine [8-10].

II. MATERIALS AND METHODS

Transesterification is an operative method to diminish the viscosity of the plant oils. Through the practice of transesterification, triglycerides of plant oil respond with methanol in the existence of NaOH compound and yields glycerol and plant oil ester. Experimentations were conceded using B20 blends of neem, linseed, polanga and tobacco methyl ester in the diesel engine. All the trials were steered at the continual speed of 1500 rpm and the standard injection timing. During the experiments the BTE, Specific Fuel consumption and HC, CO, NO_x and smoke discharges were recorded. Engine tests were conducted with B20 methyl ester blends at rated speed and standard injection to get the performance, pollutant factors of the C.I engine.

III. BIODIESEL PROPERTIES

Biodiesel properties vary depending on chemical composition and fatty acid. The fuel possessions such as density, viscosity, cetane number, calorific value, flash point, cloud point and pour point are the most important properties of the fuel. Among these properties viscosity, calorific value carries a dynamic part in the fuel because it may affect the injection nozzle as well as combustion characteristics.

TABLE I: BIODIESEL PROPERTIES

Fuel Name	Density at 40°C (kg/m ³)	Viscosity at 40°C (mm ² /s)	Cetane number	Calorific value (MJ/kg)	Flash Point (°C)	Cloud point (°C)	Pour point (°C)
Diesel	815 - 840	1.4 - 5.6	45 -54	41.5 - 45.9	50 - 97	-10	-19 to 5
Neem	910 - 965	20.6-8.4	50	33.6 - 39.4	35	-	-
Linseed	864 - 950	16.1 -36.5	28 -36	37.6 - 39.8	107	1.7	-4 to -17
Tobacco	860 - 888	3.6 -4.2	49 -51	38.4 - 39.8	151- 164	-	-13
Polanga	888 - 912	4.1 - 5.3	57	39.2 - 41.3	150-171	13.1-14	4.2

IV. EXPERIMENTAL SETUP

In the present work, research were steered on a water cooled, stationary, single-cylinder, vertical, 4 stroke DI diesel engine with a compression ratio of 17.5:1, induced 5.2 kW power at 1500 rpm. The engine is completely furnished with measurements for all functioning parameters. The procedure entails the apparatus and systems for carry out the chosen testing. The engine specifications are detailed in the table.2 and the investigational set-up is displayed in the figure.1.

TABLE II: SPECTIFICATION OF ENGINE

Model/Make	SV1, KIRLOSKAR
Engine Speed	1500 rpm
Rating Power	5.2 KW
Bore x Stroke	87.5mm x 110mm
Compression Ratio	17.5:1
Cooling Method	Water

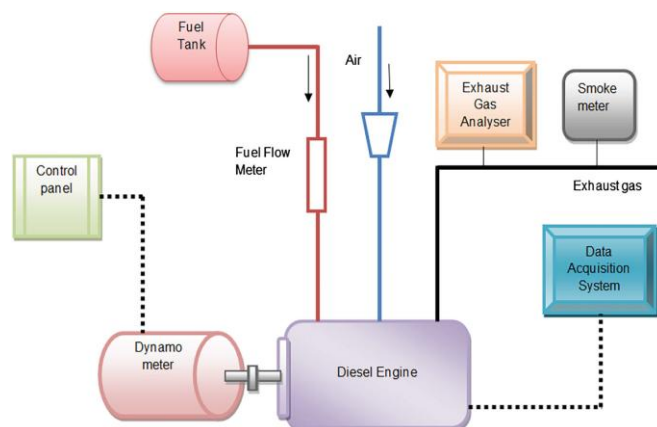


Fig.1. Experimental Set- up

Research engine attached to an alternator and eddy current dynamometer. Fuel flow measurement of is achieved by using a manometer and stop watch arrangement. Intake charge temperature, cooling water, and exhaust gases are measured by thermocouples. Smoke meter is utilized to define the smoke thickness of the engine discharges. An exhaust gas analyzer is utilized to size the exhaust discharges (CO, HC, CO₂ and NO_x).

V. RESULTS AND DISCUSSION

A. Performance Characteristics

a) Brake Thermal Efficiency

It shows the capability of the burning system to receive the experimental fuel and indicates that how efficient the energy in the fuel was transformed to mechanical work. The improvement of BTE is owing to the enhancement of the burning process on account of enlarged O_2 content in the fuel. The engine yields relatively equal brake thermal efficiency values for the biodiesel which can be credited to the encouraged burning owing to the O_2 content of the biodiesel and additional lubricity in the biodiesel. Therefore BTE of diesel engine improves at higher engine loads, higher biodiesel blends.

b) Brake Specific Fuel Consumption

BSFC depends upon the relationship between the calorific value and the quantity of fuel injected. Owing to lower energy content of the biodiesel, there is an growing movement in BSFC for neem, linseed, polanga and tobacco biodiesel. BSFC rises expressively when the engine is operated with the biodiesel owing to high density low heating value, and viscosity of biodiesel leads to poor atomization of biodiesel.

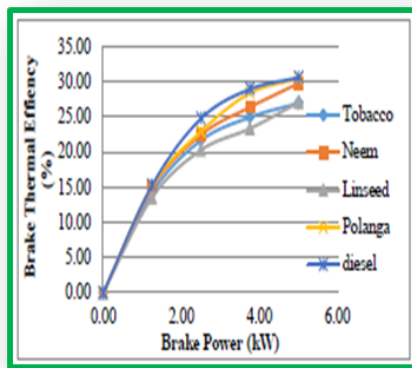


Fig.2 BTE vs. Brake Power

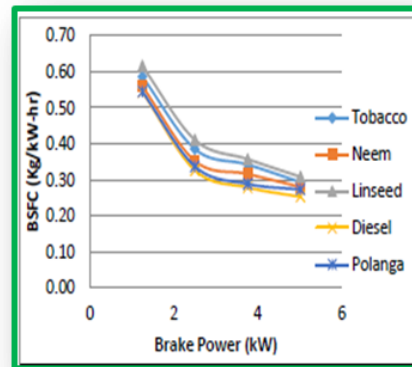


Fig.3 BSFC vs. Brake Power

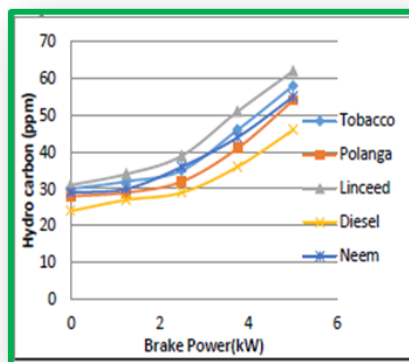


Fig.4 HC vs. Brake Power

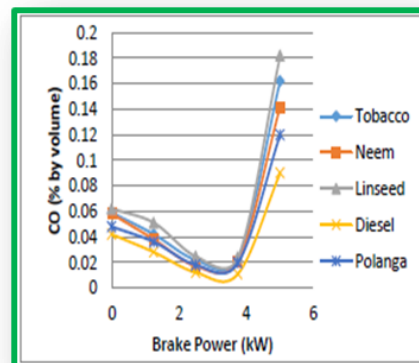


Fig.5 CO vs. Brake Power

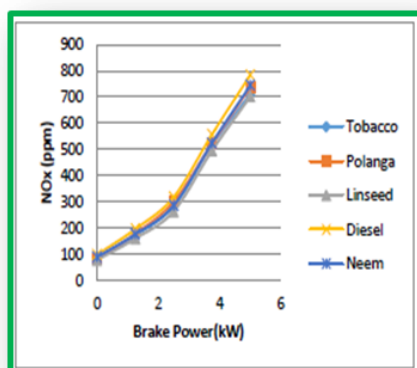


Fig.6 NO_x vs. Brake Power

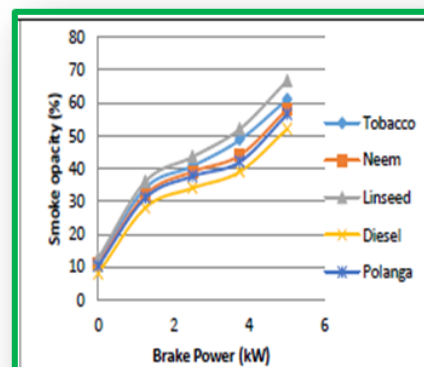


Fig.7 Smoke vs. Brake Power

B. Emission Characteristics

c) Hydro Carbon

Hydrocarbon pollutant is the outcome of imperfect burning. Deprived mixture establishment and inferior air entrainment are the causes for high HC emissions. The level of hydrocarbon emission decreases, if the combustion takes place efficiently. It has proved that the HC emission straight away depends on the magnitude of burning. The fuel spray would be estimated to effect on hydro carbon emission with biodiesel fuels. The high viscosity of biodiesel clues to poor burning owing to larger droplet size when fuel is injected.

d) Carbon Monoxide

Carbon monoxide is a poisonous gas and an midway product in the burning of a diesel fuel that will be emitted at rich fuel-air mixtures from combustion of fuels containing hydrocarbon and as a outcome of imperfect combustion. Therefore, carbon monoxide emission depends on the air/fuel ratio. Rich burning process consistently yields carbon monoxide, and it increases linearly with the deviance from the stoichiometry air fuel mixture. Even though carbon monoxide emission mainly depends on oxygen content in the fuel air mixture, it increases for biodiesel due to poor combustion as compared to diesel.

e) Oxides of Nitrogen

The resident temperature, absorptions of nitrogen and oxygen particles and time offered for the oxygen–nitrogen responses are the significant factors for NO_x creation. Enlarged O₂ levels amplified the extreme temperature through the burning, which augmented NO_x pollutant. It is recognized that the NO_x creation is extremely reliant on the temperature, which is owing to higher initiation energy required for the intricate reactions and these responses are resolute by the equivalence ratio, O₂ absorption and burning temperature as well.

f) Smoke Opactiy

Smoke rises with upsurge in brake power. Since higher turbulence and temperature in the burning chamber and oxidation of soot elements takes place competently foremost to lessening in smoke. The smoke pollutant was marginally high for biodiesel owing to high viscosity, bigger fuel droplet size and improper air and fuel mingling rate. Smoke pollutant displayed the similar trend as HC pollutant owing to the existence of O₂ atoms in the methyl ester, which permits more complete burning even in areas of burning chamber with fuel-rich dispersal flames.

VI. CONCLUSIONS

In this work, performance and pollutant features of selective B20 biodiesel blend such as polanga, neem, tobacco and linseed oils have been compared with the diesel. The results proved that the polanga biodiesel gives closer values of performance and pollutant features as equated to diesel due to its closer values of properties particularly calorific value, density, viscosity and cetane number. So polanga biodiesel may be straight away utilized in the unmodified CI engine.

REFERENCES

- [1] Karikalan, L., Chandrasekaran, M. and Sudhagar, K., 2013. Comparative studies on vegetable oil usage in CI engines as an alternative to diesel fuel. *IREME Journal*, 7(4), pp.705-715.
- [2] Sharma, A., Singh, D., Vivekanandhan, C., Singh, Y., Mustefae, I., Assefa, S. and Tilahun, S., 2018. Experimental Investigations on the Influence of Fuel Pressure on Single Cylinder CI Engine Fuelled with Different Polanga Biodiesel Blends. *Journal of Aerospace Engineering & Technology*, 8(2), pp.58-66.
- [3] Ansari, N.A., Sharma, A. and Singh, Y., 2018. Performance and emission analysis of a diesel engine implementing polanga biodiesel and optimization using Taguchi method. *Process Safety and Environmental Protection*, 120, pp.146-154.
- [4] Karikalan, L. and Chandrasekaran, M., 2013. Investigation on emission characteristics of CI Engine using vegetable oil with SCR technique. *International Journal of Renewable Energy Research (IJRER)*, 3(4), pp.969-975.
- [5] Tunio, M.M., Luhur, M.R., Ali, Z.M. and Daher, U., 2018. Performance and Emission Analysis of a Diesel Engine Using Linseed Biodiesel Blends. *Engineering, Technology & Applied Science Research*, 8(3), pp.2958-2962.
- [6] Kumar, C.R., Saravanan, S. and Gopal, P., 2017. Investigation of combustion, performance and emission characters of compression ignition engine fuelled with diesel blends of linseed and cottonseed oil. *Progress in Industrial Ecology, an International Journal*, 11(3), pp.207-218.
- [7] Karikalan, L. and Chandrasekaran, M., 2015. Karanja Oil Biodiesel: A potential substitution for diesel fuel in diesel engine without alteration. *ARNP Journal of Engineering and Applied Sciences*, 10(1).
- [8] Karikalan, L. and Chandrasekaran, M., 2015. Effect of varying fuel injection pressure of Selective Vegetable oil biodiesel on CI engine performance and pollutants. *International Journal of ChemTech Research*, 8(12), pp.312-318.
- [9] Ashraful, A.M., Masjuki, H.H., Kalam, M.A., Fattah, I.R., Imtenan, S., Shahir, S.A. and Mobarak, H.M., 2014. Production and comparison of fuel properties, engine performance, and emission characteristics of biodiesel from various non-edible vegetable oils: a review. *Energy Conversion and Management*, 80, pp.202-228.
- [10] Karikalan, L., Chandrasekaran, M. and Sudhagar, K., 2014. A review on waste cooking oil (WCO) based biodiesel and its combustion, performance and emission characteristics. *Poll Res*, 33(1), pp.99-107.