INTERNATIONAL JOURNAL ON OCCUPATIONAL HEALTH & SAFETY, FIRE & ENVIRONMENT – ALLIED SCIENCE
ISSN 2349-977X

VOL. 1 ISSUE 1 JULY-SEPT,2014 (014-016)

Available online at www.ohsfejournal.com

Study on Emission Index of Jatropha Based Bio Diesel

Akbar Ziauddin[a]*, Dharani Kumar K[a], Prasenjit Mondal[a]

[a] *University of Petroleum and Energy Studies, Dehradum, 248007, India*

ARTICLE INFO

Article history:
Received 01 June 14
Received in revised form 15 July 14
Accepted 00 February 21 July 14

Keywords:
Internal Combustion Engine
Bio diesel
Particulate matter

ABSTRACT

In the current scenario world petroleum reserve is getting depleted and there is an urgent need to find an alternative fuel, which has similar characteristics of conventional fuels. Jatropha based bio diesel is an alternative, which can be easily produced and made commercial. Also, bio diesel can be directly used on internal combustion engine (ICE) without any modification. Study on the different cultivation methods of Jatropha Curcas plant and production methods in India have been explained in detail. The emissions of CO, PM (particulate matter), CO_2 and SO_x are less as compared to diesel. However, NO_x emissions are high in bio diesel. The aim of this work is to find an optimum blend, which has least NO_x emissions, and to find the emission index of bio diesel. The blends chosen for the experiment included B20, B40, B60, B80 and B100. The optimum blend with least NO_x emission was found to be B20 but the NO_x emissions are still high compared to diesel. The emission index of NO_x of all blends was calculated. The Emission Index value showed that blends B20 – B40 can be used on diesel engine without any engine modification and also with a minimum emission of NO_x. Bio diesel is environment friendly and a better alternative to diesel.

1. Introduction

In today's scenario of depleting petroleum reserves, there is an urgent need to find an alternative fuel to meet the demands. India ranks sixth in the world in terms of energy demand. The economy of India is projected to grow 8-9 percent over the next two decades and there will be a substantial increase in demand for oil to manage transportation and to meet various other energy needs. While India has significant reserves of coal, it is relatively poor in oil and gas resources.

If the corrective measures are not taken in time, the India's maximum revenue will be wasted out in the import of petroleum products. Therefore, attempt needs to be made to reduce dependence on imports and seek better alternatives. Among bio fuels, jatropha-diesel blends have gained much popularity as it does not require any modification in the diesel engine and emissions rates are less compared to conventional diesel. Jatropha Curcass seeds are non-edible and do not compete with the food market. Jatropha seeds have triglyceride which is transesterified to methyl or ethyl esters and glycerol is obtained as a by-product. Transesterification process converts the vegetable oil into a non-toxic and biodegradable renewable fuel. Also, the by-product glycerol can be used for other pharmaceutical, cosmetics and many other sectors. They are also used in making inks, candy, liquid soap etc. The by product of the process is profitable and there is no waste in the whole bio diesel process. Bio diesels have improved characteristics like reduced molecular weights as compared to diesel. Most bio diesels can be easily fed on internal combustion engine (IC) without any modification. The combustion can be optimized by adjusting the injection timing. There may be some drawbacks on the availability on large scale and related consequences on

* *Corresponding author.* Tel.: 91-9634525401.
E-mail address: nsiddiqui57@gmail.com

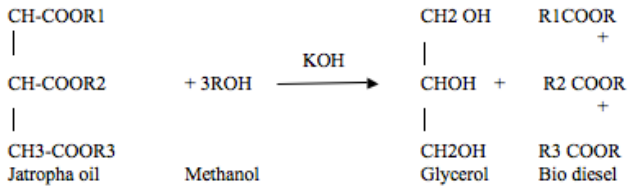
Peer review under responsibility of Dr. Akula Ramakrishna.

Hosted by International Journal on Occupational Health & Safety, Fire & Environment. – Allied Scicence.

the agricultural sector, but can be improved and enhanced with further research and technologies. Overall biodiesels have more potential and use over conventional diesel. This project is a study on the emission rates of different blends of Jatropha Curcass based biodiesel and ways to find optimum blend of jatropha oil to make environment friendly fuel.

2. Materials and Methods

The experiment to produce bio diesel was carried out in the university Biodiesel lab. Jatropha seeds contain triglycerides and in the process of transesetrification, the triglycerides get converted to ethyl or methyl esters and glycerol. The process uses catalyst and it is known as Base Catalyzed Trans esterification. The overall transesterification reaction is given by 3 consecutive and reversible equations as below: The first step is the conversion of triglycerides to diglycerides, then the conversion of diglycerides to monoglycerides, and of monoglycerides to glycerol, giving one methyl ester molecule per mole of glyceride at each step.
The overall reaction is as follows:



Emission Study:

Emission study was done by testing the sample diesel and bio diesel blends in the diesel engine. The blends used for testing were B20, B40, B60, B80 and B100.The engine was started by cranking it with hand. The engine attains a constant speed in a less time as it is constant speed engine. Fuel was filled in the fuel tank and flows automatically to the calibrated tube. This tube helps in calculating the time taken for the consumption of 50 ml of the fuel. Electrical loading is applied and gets power from the engine. Sensors are attached and gives the following temperature readings

T1 = Air inlet temperature

T2 = Water outlet temperature

T3 = Exhaust temperature

T4 = Lubricant oil temperature

The inlet temperature can be considered as ambient temperature, which is approximately 19° C. Tachometer is used to measure the rpm (revolutions per minute) of the engine at a particular load. The pipe of the gas analyser is connected to the smoke outlet manifold. The emission readings are obtained from the smoke meter and gas analyser. Three sets of readings are taken to take the average value of the three.
The readings obtained are tabulated in the table below and a graph was plotted to compare the emission rates.

Table 1 – Emission Values from Diesel Engine.

Fuel	RPM	Time Taken (sec)	Exhaust gas temperature ℃	Water temperature ℃	Emission parameters				
					CO (% vol)	HC (ppm)	CO2 (% vol)	NOx (ppm)	Smoke (%capacity)
Diesel	1030	1.28	320	29	0.04	52	5.00	595	63.4
B20	1024	1.34	269	32	0.01	6	1.30	737	9.9
B40	1004	1.34	290	32	0.04	7	12	775	11.7
B60	1024	1.34	301	32	0.02	4	1.10	785	11.6
B80	1000	1.34	300	32	0.02	11	8.1	848	9.9
B100	1002	1.34	269	30	0.03	7	10.87	832	11

Emission Index Calculation:

The emission index was calculated for NOx of all the test fuels. The calculation helped in finding out the blends, which releases less NOx. The calculation was done as follows:

TOTAL EMISSIONS $= \sum CO2 + CO + NOx + HC$

Emission index is thus calculated as follows

$$\text{EI NOx} = \frac{NOx}{Total\ emissions}$$

3. Results and Discussions

The experiment showed that at 100 % load, the blends B20, B40, B60, B80 and B100 showed least emissions of CO, CO2 and HC than conventional diesel. The plots of emissions and blends are shown in the figure 6, 7, 8, 9 and 10.

The main advantage of these blends is that they can be directly used into the diesel engine as a primary fuel without any addition. The emission index of NOx of all blends is calculated. The emission index EI value showed that blends B20 and B40 can be used on diesel engine without any engine modifications and also with minimum emission of NOx.

NOx emissions were high in all the bio diesel blends due to higher oxygen content and presence of unsaturated compounds. The main source of NOx emissions are due to oxidation of atmospheric nitrogen at higher temperatures. The high temperature peak zones lead to uncontrolled combustion and forms NOx in the cylinder areas. The addition of bio diesel in the diesel leads to increase of oxygen content in the combustion chamber. The results show that at 100 % load, the NOx emissions of all blends are higher than diesel.

For B20, B40, B60, B80 and B100, the NOx emission values are 737 (ppm), 775 (ppm), 785 (ppm), 848 (ppm) and 832(ppm) respectively at full load. The NOx emission of diesel at 100 % load was 595 (ppm) and the least among all. This is possibly due to lower calorific value and higher density of bio diesel. Jatropha bio diesel is environment friendly and better alternative to diesel.

The emission index was calculated for diesel and bio diesel blends. Emission index is a single value, which denotes the emission of NOx per cumulative emissions of all pollutants. EI NOx calculated for diesel, B20, B40, B60, B80 and B100 were 0.0116, 0.053, 0.00639, 0.0654, 0.010 and 0.00757 respectively. B40 showed the least value of 0.00639. This shows

that individual NOx emissions does not affect the EI NOx value as it is a cumulative value of all the pollutants and depends on other emissions too. This result in the fact that blends B20 to B40 can be commercialized and optimized further to reduce NOx emissions. B20 to B40 blends show the minimum NOx emissions and can be used on diesel engines without or with slight modifications. The EI NOx of diesel showed a value of 0.0116 is higher than B20 and B40 and proved to be a better alternative to diesel. A plot between EI NOx and blends has been plotted. The comparison shows the minimum and maximum EI NOX values of all the blends and diesel.

The values obtained after calculating the emission index is as follows

Table 2 – Emission Index Values.

Fuel	Diesel	B20	B40	B60	B80	B100
EI NOx	0.0116	0.053	0.00639	0.0654	0.010	0.00757

The emission index values showed the bio diesel blends with least NOx emissions and also the range within which the fuel can be optimized. The range obtained was B20 to B40 and within these ranges; the NOx emissions are minimum and also other emissions.

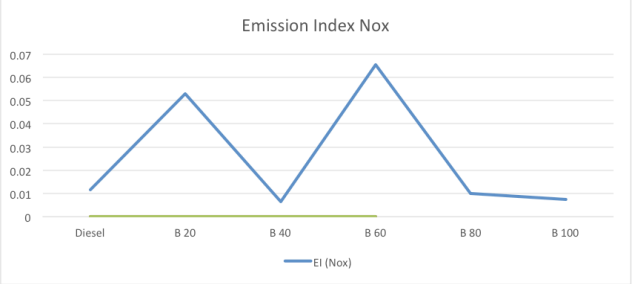


Fig. 1 Emission Index NOx.

From the pictorial representation we can conclude that the Emission Index NOx generated by B40 is comparatively very less. So it can serve as the best ecofriendly substitute for the diesel.

4. Conclusion

The aim of the project was to find the optimum blend of Jatropha based bio diesel with least emissions of NOx. The emission study was done and compared with diesel fuel. For blends of bio diesel B20, B40, B60, B80 and B100, the values of NOx emissions were 737 (ppm), 775 (ppm), 785 (ppm), 848 (ppm) and 832 (ppm) respectively. The diesel fuel had the minimum NOx emission of 595 (ppm) compared to all other blends of Jatropha based bio diesel. The blend with minimum NOx emission among Jatropha biodiesel blends was B20. To further optimize the blends, emission index of NOx was calculated. This showed that B20 to B40 blends can be used in the commercial scale and also with minimum environmental effects. A possible suggestion for the usage of other blends in a diesel engine is that, by coupling the engine with Exhaust Gas Recirculation (EGR) systems or with the help of a Catalytic Converter that can drastically reduce the emissions as well as increase the engine efficiency.

REFERENCES

- W.M.J. Achtena, L. V. (2008). Jatropha Bio-Diesel Production And Use. *Biomass and Bioenergy* , 1063-1084.
- Emil Akbar, Z. Y. (2009). Characteristic and Composition of Jatropha Curcas Oil Seed from Malaysia and its Potential as Biodiesel Feedstock Feedstock. *European Journal of Scientific Research , 29 (3)* (ISSN 1450-216X), 396-403.
- Pramanik, K. (2003). Properties and use of jatropha curcas oil and diesel fuel blends in compression ignition engine. *Renewable Energy , 28* (2), 239-248.
- R.K .singh, S. .. (2009). Characterization of jatropha oil for the preparation of Biodiesel. *Natural Product Radiance , l 8(2)*, 127-132.
- Leon M. Payawan Jr, 1. J. (2010). Transesterification of Oil Extract from Locally-Cultivated Jatropha curcas using a Heterogeneous Base Catalyst and Determination of its Properties as a Viable Biodiesel. *Philippine Journal of Science , 3139 (1)* (0031 – 7683), 105-116.
- P. Shinoja, S. R. (2010). An Economic Assessment along the Jatropha-based Biodiesel Value Chain in India. *Agricultural Economics Research Review , 23*, 393-404.
- P. Suresh Kumar1, F. A. (2013). The Performance and NOX Emissions of a IDI diesel Engine at Distinct EGR Rates Fuelled With JB100, JB80, JB60, JB40, JB20 & Diesel. *International Journal of Engineering Science and Technology (IJEST , 5* (0975-5462), 519-526.
- Jinlin Xuea, b. T. (2011). Effect of biodiesel on engine performances and emissions . *Elsevier,Renewable and Sustainable Energy Reviews* , 1098–1116.
- Guide, T. P. (2008). *Characterization of Engine Performance with Biodiesel Fuels.* Thesis, Leigh University.
- Performance of jatropha oil blends in a diesel engine. (n.d.).
- F.K. Forson, E. O.-D. (2004). Performance of jatropha oil blends in a diesel engine. *Elsevier, Renewable Energy* , 1135–1145.
- Dr. M.sPunia, E. D. *Cultivation and use of jatropha for bio-diesel production in india.* Haryana: National oilseeds and vegetable oils development board Ministry of agriculture, govt of india.
- V. Eyring, H. W. (2005). Emissions from international shipping for the last 50 years. *Journal of Geophysical Research: Atmospheres (1984–2012) , 110* (D17).
- A. Petzold!, J. S. (1998). Carbonaceous aerosol in jet engine exhaust: emission characteristics and implications for heterogeneous chemical reactions. *Atmospheric Environment 33*.
- H.Y. Tong a, W. H. (2011). On-Road Motor Vehicle Emissions and Fuel Consumption in Urban Driving. *Journal of the Air & Waste Management Association*.
- Sayangdev Naha, S. K. (2004). Fuel effects on NOx emissions in partially premixed flames. *Elsevier*.