IJARSE
ISSN: 2319-8354

Performance and Emissions analysis of Diesel Blended with Nahar Biodiesel in VCR Compression Ignition Engine

Mr.R.G.Biradar[1], Dr. C. L. Prabhune[2], Mrs. Supriya Bobade[3]

1 Research Scholar, JJTU, Vidyanagari Dist Jhunjhunu, Churela, Rajsthan

2. Mechanical Engg. department, Zeal College of Engg, Pune, Maharashtra, India.

3. Indian Biodiesel Corporation, Baramati, Maharashtra, India.

ABSTRACT

Biomass derived vegetable oils are quite promising alternative fuels for agricultural diesel engines. Use of vegetable oils in diesel engines leads to slightly inferior performance and higher smoke emissions due to their high viscosity. The performance of vegetable oils can be improved by modifying them through the transesterification process. In the present work, the performance of single cylinder water-cooled diesel engine using blends of diesel blended with Nahar biodiesel as fuel was evaluated for its performance and exhaust emissions. The fuel properties of biodiesel such as kinematic viscosity, calorific value, flash point, carbon residue and specific gravity were found. Results indicated that B18 has closer performance as compared to plain diesel fuel. Emissions of CO, HC, CO_2 and O_2 are reduced as compared to pure diesel and NOx emissions are increased as compared to pure diesel. *For Nahar biodiesel and its blended fuels, the exhaust gas temperature increased with increase in power and amount of biodiesel. But, diesel blends showed reasonable efficiency, lower smoke, CO_2, CO and HC.*

Key words: Nahar Biodiesel, Engine, Performance, Emissions

I INTRODUCTION

The biomass energy is by far the largest renewable energy source, representing 10.4% of the world's total primary energy supply or 77.4% of global energy supply. Although several oil bearing trees like Karanja, Mahua, Polang, Kusum, Neem, Simarauba, Sal, Linseed, Castor, Baigaba, Jatropha Curcas etc. are native to India, systematic propagation and processing of these seeds is very important in view of large scale commercial production of bio-fuels. Nahar biofuel is chosen for the present work of experimental investigation of performance and emission characteristic on VCE diesel engine.

Present study reports on the use of nahar oil (Mesua ferrea Linn.) as a potential source of biodiesel. Nahar oil is a medium- sized to large evergreen tree with short trunk, found in the Himalayas from Nepal eastwards, in North-Eastern India, Deccan Peninsula and the Andaman Islands, ascending to an altitude of 1500m. It is estimated that 5500 tons of mesua seeds are annually available from Lakhimpur and sibsagar districts of Assam. Nahar oil (mol wt 900) mainly contains mesuol ($C_{23}H_{22}O_5$) and mesuone ($C_{29}H_{42}O_4$). Every litre of nahar oil requires 500 ml of methanol (density 0.8, mol wt 32) to achieve satisfactory esterification.

II LITERATURE REVIEW

Rakopoulos et al. studied to evaluate and compared the use of a wide variety of vegetables oils or biodiesels of various origins containing cottonseed as substitute to conventional diesel fuel at blend ratios of 10/90 and 20/80 in a direct injection diesel engine. Results showed that the smoke density was significantly reduced with the use of biodiesel blends as compared to that of the neat diesel fuel, the emissions were slightly decreased with the use of biodiesel blends.

Peterson CL et al. suggested that the transesterification process has been proven worldwide as an effective means of biodiesel production and reduction in viscosity of vegetable oil. Temperatures, catalyst type, concentration ratio of alcohol to fuel and stirring speed rate have been observed to influence the transesterification process to a greater extent.

Wagner et al. conducted 200 h engine tests with soybean oil ester fuel on John Deere (4239T Model) engine. It was reported that the engine performance with methyl, ethyl and butyl esters was nearly the same as that with diesel fuel. There was no difference in thermal efficiency resulting from the use of the various fuels to power the engine. The esters showed a slight power loss and increased fuel consumption, which was attributed to the lower gross heating values. Engine wear was normal. There was, however, an increased carbon deposition on the pistons with the methyl and butyl esters. Emissions of oxides of nitrogen were significantly higher for the esters. They concluded that the esters could be used on a short-term basis, and that further testing to be done for determining long-term ester fuel effects.

S. Sundarapandian and G. Devaradjane et al. Shows experimental work done and evaluate the performance characteristics, combustion parameters and emissions of vegetable oil esters like Jatropha, Mahua and Neem Oil esters. From the results, it is found that the heat release and work done are reduced by about 4% for Jatropha, 5% for Mahua and 8% for Neem oil esters when compared to diesel. From the investigation, it is concluded that the performance of vegetable oil esters are good. Thus the developed model is highly compatible for simulation work with bio diesel as an alternative fuel.

C. Srinidhi et al. performed an experiment analysis of performance parameter (such as brake power, break specific fuel consumption, brake thermal efficiency and Exhaust Gas temperature) and emission characteristics (NO_x, HC, CO. etc.) is obtained for various bio diesel and diesel blends and compared with ordinary diesel at various loads on a modified variable compression ratio CI engine. The results of the investigation shows that the performance and emission characteristics of the engine fuelled with Honne oil methyl ester – diesel blends is comparable to the ordinary diesel.

Bawane et al. performed experimental work to obtain the operating and emission characteristics of Undi Oil Biodiesel on Variable Compression Ratio (VCR) engine run on various blends of biodiesel, compression ratios and load conditions. From the comparison of results, it is inferred that the engine performance is improved with significant reduction in emissions for the chosen oils without any engine modification.

 IJARSE
ISSN: 2319-8354

1. Transesterification reaction:

The main components of animal fats and vegetable oils are Triglycerides. The vegetable oil or animal fat is subjected to a chemical reaction called Transesterification to produce biodiesel. The fatty acid triglycerides are esters of fatty acids and the chemical divides up of the heavy molecules and forming simpler esters is termed as Transesterification. These triglycerides are reacted with alcohol (Methyl, Ethyl, or others) in the presence of a catalyst under a restricted temperature for a given length of time. The final products are Alkyl esters and Glycerin. The Alkyl esters are having positive properties as fuels for use in CI engines, are the main product and the Glycerin, is a by-product

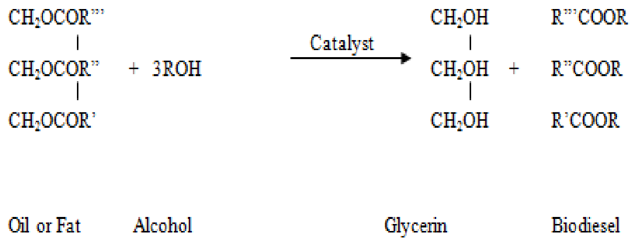

Fig. 01 Transesterification reaction

1. Filtering: The vegetable oil is first filtered to remove solid particles from it. It is to be warmed up a bit first to get it to run freely; 35°C should be enough. A Cartridge filter is used for the same.

2. Removing the Water: First the oil is heated to remove the water content. Vegetable oil may contain water, which can slow down the reaction and causes saponification (soap formation). Then the temperature is raised to 100°C, holding it and allows water contents to boil off. Run the agitator to avoid steam pockets forming below the oil and exploding, splashing hot oil puddles out from the bottom. When boiling slows, the temperature is raised to 130°C for 10 minutes and allow cool to it.

With the help of transesterification process various blends of biodiesel are prepared. The biodiesel blended with diesel by volume as B06 (6% biodiesel and 94% diesel fuel), B12 (12% biodiesel and 88% diesel fuel), B18 (18% biodiesel and 82% diesel fuel), B12 (12% biodiesel and 88% diesel fuel), B18 (18% biodiesel and 82% diesel fuel), B24 (24% biodiesel and 76% diesel fuel), B30 (30% biodiesel and 70% diesel fuel), B36 (36% biodiesel and 64% diesel fuel). Then the samples were proceeding for their property testing.

Fig. 02 Blends of Hybrid biodiesel

IJARSE
ISSN: 2319-8354

The physico-chemical properties of Hybrid biodiesel i.e. equal mixture of cotton-seed and Eucalyptus oil biodiesel is given in the Table 1. The specific gravity, Kinematic Viscosity, Flash Point, Cloud Point, Pour point, Cetane index and color are comparable with that of diesel fuel.

Properties	Diesel	Nahar oil
Specific gravity	0.860	0.952
Kinematic viscosity, cst$^{40°C}$	2.2894	20.589
Flash point, ºC	83	--
Cloud point, ºC	-1	8
Pour point, ºC	-6	--
Cetane index	52.4	--
Color	Light	Brown

Table 01 Tested Properties of Hybrid Biodiesel

IV EXPERIMENTAL SET UP

The engine was started and allowed to run for 15-20 minutes to get stabilized using pure diesel fuel and baseline data for B00 was generated. Compression ratio was set at 18:1 and performance parameters were noted using I.C. engine software. The exhaust gas emission parameters like HC, NOx, CO_2, CO were recorded by pelting the probe of AVL gas analyser in the exhaust pipe. For noting the value of smoke (opacity) the exhaust gas was directed to AVL smoke meter and the opacity was recorded.

Then the load on the engine was further increased from 0 kg, 3 kg, 6 kg, 9 kg, 12 kg and 15kg while keeping the fuel injector triggering pressure and fuel injection advance angle unchanged. The engine was run for sufficient time duration to ensure that the diesel fuel phase is over and the engine has started running with biodiesel as fuel. The entire process was repeated while engine running with different blends of hybrid biodiesel i.e. B06, B12, B18, B24, B30 and B36 as a fuel and various performance and emission parameters were noted.

Sr. No	Description	Specification
1	Make	Rocket Engineering Model VRC-1
2	Bore	80 mm
3	Stroke	110 mm
4	Swept Volume	553 mm
5	RPM	1500
6	Brake Horse Power	5 HP
7	Compression Ratio	17.5 : 1
8	Fuel Oil	High Speed Diesel

IJARSE
ISSN: 2319-8354

9	Coefficient of Discharge	0.65
10	Water Flow Transmitter	0 to 10 lit./min.
11	Air Flow Transmitter	0 to 250 wc
12	Piezo Sensor	0 to 5000 psi with low noise cable
13	Software	Labview

Table 2 Test Engine specifications

Fig. 02 Engine Test Rig

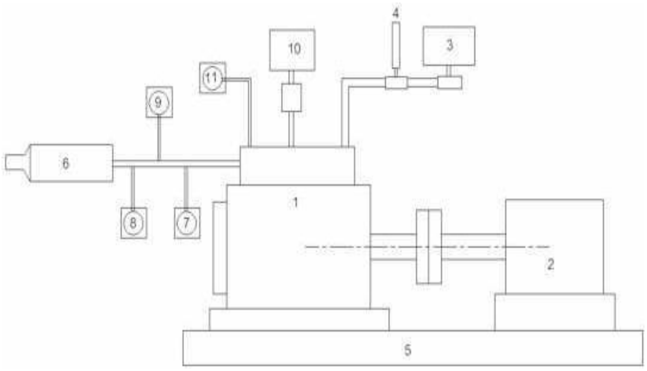

Fig. 03 Experimental Engine Setup Arrangements

1. Test Engine 2. Hydraulic Dynamometer
5. Fuel Tank 4. Fuel Burette
6. Test Bed 6. Silencer
7. Smoke Meter 8. HC/CO/NOx/CO_2/O_2 Analyzer
8. Exhaust Temp Indicator 09. Air Flow Meter

IJARSE
ISSN: 2319-8354

10. Stop Watch

V RESULTS AND DISCUSSION

5.1 Engine performance Analysis

The engine performance parameters such as BP, SFC, Brake Thermal Efficiency, and BMEP obtained with B00, B06, B12, B18, B24, B30, and B36, are discussed in the following sections.

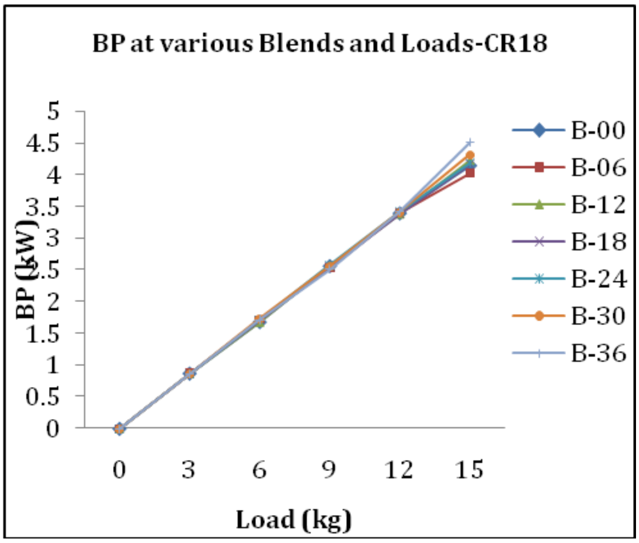

Fig. 04 Load vs Brake Power

It can be said from FIG.04, the Brake Power of B30 is increased by 2.06% and B36 is improved by 3.01% as compared to pure diesel (B00).

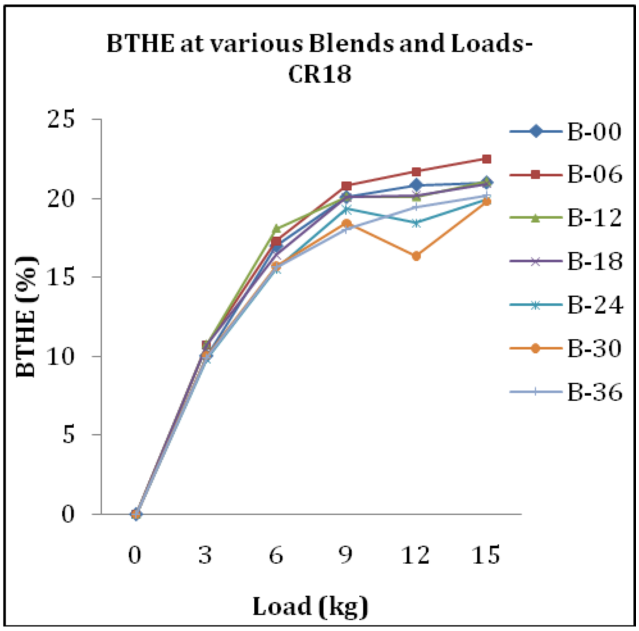

Fig. 05 Load vs BTHE

It can be said from FIG.05, the Brake Thermal Efficiency of B06 increased by 4.48% and B12 is improved by 1.24% as compared to pure diesel (B00).

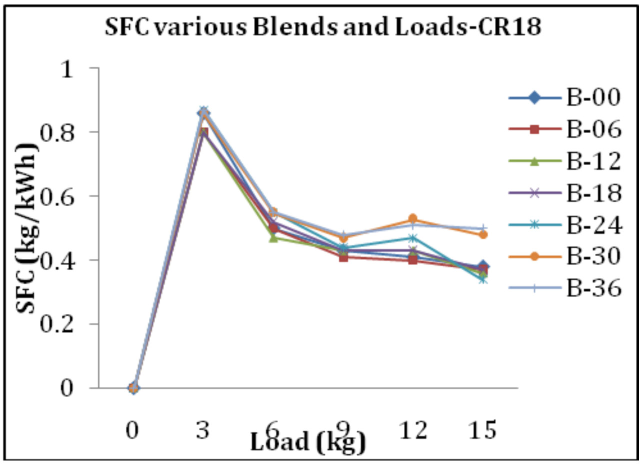

Fig. 06 Load vs SFC

It is observed from above graph, the SFC of B06 is reduced by 3.88%, SFC of B12 is reduced by 3.49% and SFC of B18 is reduced by 1.16% as compared to pure diesel (B00).

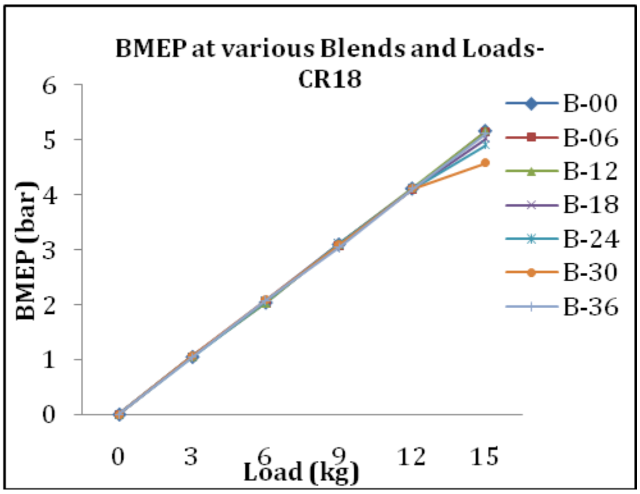

Fig. 07 Load vs BMEP

It is observed from above graph, the BMEP of B06 is increased by 0.06% as compared to pure diesel (B00).

5.2 Exhaust Emissions Performance Analysis-

The performance parameters such as CO, CO_2, HC (ppm), Nox, O_2 obtained with B00, B20, B37, and B43 and B100 and are discussed in the following sections.

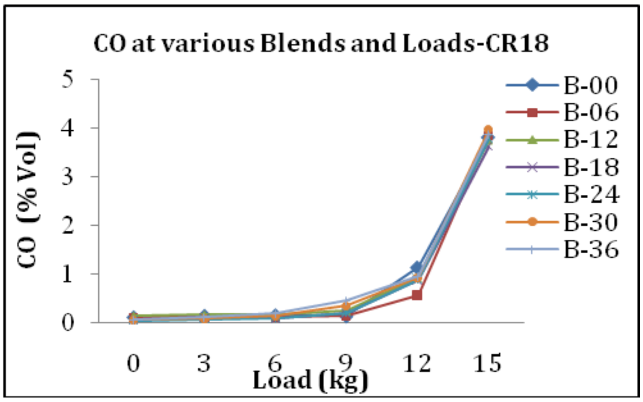

Fig. 08 Load vs Carbon Monoxide

From above graph, the CO of B06, B12, B18 and B24 is reduced by 10.74%, 1.30%, 8.89% and 6.11%, respectively as compared to pure diesel (B00). For B30 and B36 CO emissions have increased by 1.85% and 3.70% respectively.

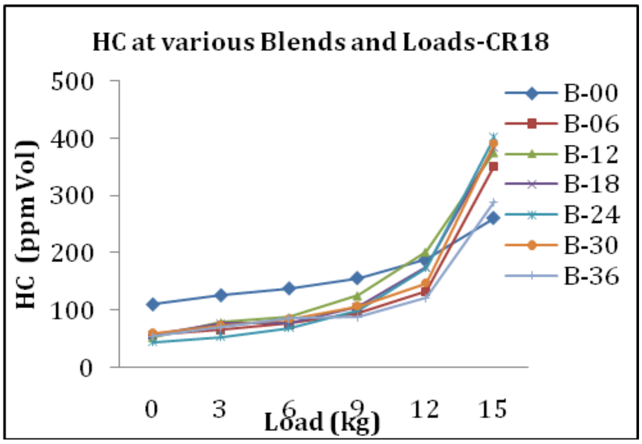

Fig. 09 Load vs HC

From above graph, the HC of B06, B12, B18, B24, B30 and B36 is reduced by 21.02%, 6.19%, 10.36%, 14.11%, 12.08% and 27.82%, respectively as compared to pure diesel (B00).

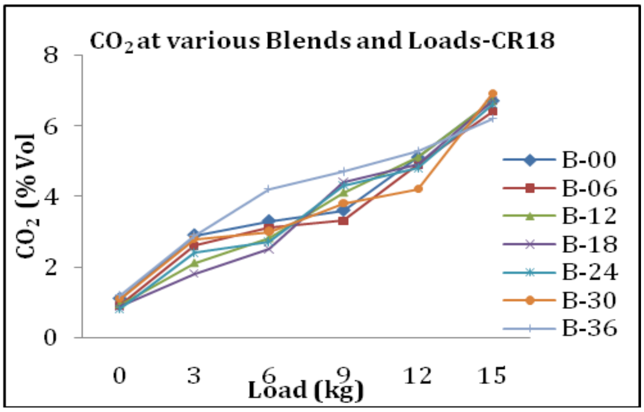

Fig. 10 Load vs Carbon dioxide

From above graph, the CO_2 of B06, B12, B18, B24 and B30 is reduced by 6.46%, 4.32%, 6.74%, 4.85% and 3.96% respectively as compared to pure diesel (B00). For B36 CO_2 emissions have increased by 7.93%.

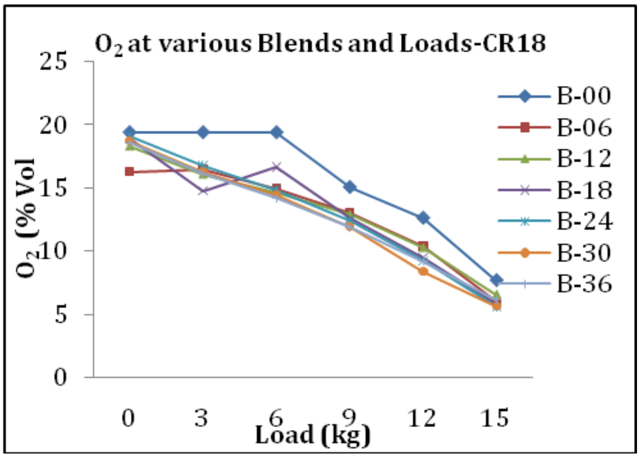

Fig. 11 Load vs Oxygen

From above graph, the O_2 of B06, B12, B18, B24, B30 and B36 is reduced by 17.60%, 15.74%, 16.60%, 16.56%, 19.50% and 18.80%, respectively as compared to pure diesel (B00).

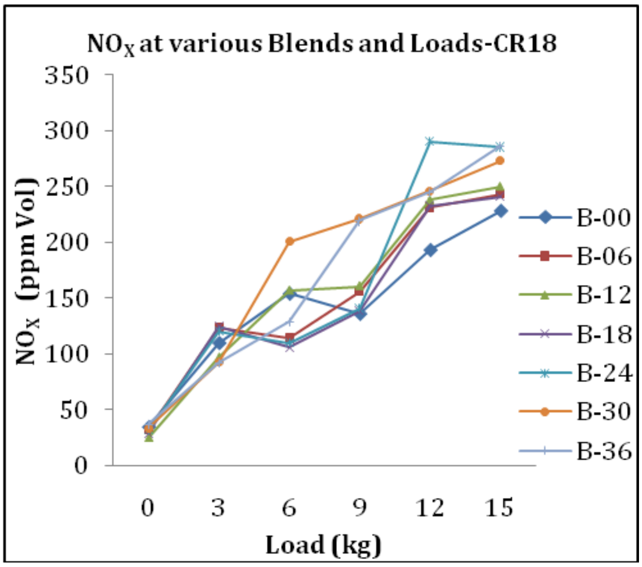

Fig. 12 Load vs Nitrogen Oxide

From above graph, the NO_X of B06, B12, B18, B24, B30 and B36 is increased by 5.14%, 8.41%, 1.99%, 14.25%, 24.77% and 17.76%, respectively as compared to pure diesel (B00).

VI CONCLUSION

The Experimental work carried out in this study, and the conclusions made from above discussions are as follow

[1.] The Brake Power of B30 is increased by 2.06% and B36 is improved by 3.01% as compared to pure diesel (B00).

[2.] The Brake Thermal Efficiency of B06 increased by 4.48% and B12 is improved by 1.24% as compared to pure diesel (B00).

[3.] The SFC of B06 is reduced by 3.88%, SFC of B12 is reduced by 3.49% and SFC of B18 is reduced by 1.16% as compared to pure diesel (B00).

[4.] The BMEP of B06 is increased by 0.06% as compared to pure diesel (B00).

[5.] The CO of B06, B12, B18 and B24 is reduced by 10.74%, 1.30%, 8.89% and 6.11%, respectively as compared to pure diesel (B00). For B30 and B36 CO emissions have increased by 1.85% and 3.70% respectively.

[6.] The HC of B06, B12, B18, B24, B30 and B36 is reduced by 21.02%, 6.19%, 10.36%, 14.11%, 12.08% and 27.82%, respectively as compared to pure diesel (B00).

[7.] The CO_2 of B06, B12, B18, B24 and B30 is reduced by 6.46%, 4.32%, 6.74%, 4.85% and 3.96% respectively as compared to pure diesel (B00). For B36 CO_2 emissions have increased by 7.93%.

[8.] The O_2 of B06, B12, B18, B24, B30 and B36 is reduced by 17.60%, 15.74%, 16.60%, 16.56%, 19.50% and 18.80%, respectively as compared to pure diesel (B00).

[9.] The NO_X of B06, B12, B18, B24, B30 and B36 is increased by 5.14%, 8.41%, 1.99%, 14.25%, 24.77% and 17.76%, respectively as compared to pure diesel (B00).

[10.] From the results it can be concluded that all blends are showing similar performance as compared to plain diesel fuel. Emissions of CO, HC, CO_2 and O_2 are reduced as compared to pure diesel and NOx emissions are increased as compared to pure diesel.

REFERENCES

1. Rakopoulos C.D, Antonpoulos K.A, Hountalas D.T, Giakoumis E.G, (2006),comparative performance and emission study of direct injection diesel engine using blends of diesel fuel with vegetable oils or biodiesel of various origins. Energy conservation and management; 47:32, pp.71-87.

2. Peterson CL, Reece DL, Hammond DL, Cruz R, Thompson JA, (1992), Comparison of ethyl and methyl esters of vegetable oils as diesel fuel substitute. Proceeding of Alternate Energy Conference, ASAE pp.99-110.

3. Wagner LE, Clark SJ, Scrock MD. Effects of soybean oil esters on the performance, lubricating oil and wear of diesel engines. SAE 1984: paper no. 841385.

4. S.Sundarapandian, G.Devaradjane, 2007, "Performance and Emission Analysis of Bio Diesel Operated CI Engine "Journal of Engineering, computing and Architecture, ISSN 1934-7197, volume 1, Issue 2, 2007.

5. C. Srinidhi,S. V. Channapattana, J.A. hole, A.A.Pawar, P.G.Kamble " Investigation On Performance and Emission Characteristics Of C.I. Engine Fuelled With Honne Oil Methyl Ester" International Journal of Engineering Science Invention , Volume 3 Issue , May 2014, PP.59-66.

6. Rahul Krishnaji Bawane, SV Chanapattana, Abhay A Pawar, " Performance Test of CI Engine fueled with Undi Oil Biodiesel under Variation in Blend Proportion, Compression Ratio & Engine Load" International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 8, August 2014.