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Performance Analysis and Investigation of Emissions of C.I. Diesel Engine Using Neem Oil as Blending Agent: Review

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Abstract*:* The depletion of world petroleum reserves and the increased environmental concern have stimulated the search of alternative fuel which is to be environment friendly. Bio-fuels have the potential to become alternative fuel for fossil fuels. Biodiesel is a fuel comprised of mono alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. Biodiesel is reliable, renewable, biodegradable and regarded as a clean alternative fuel to reduce exhaust emissions. Vegetable oil like Neem oil is considered as alternate fuels to diesel. This review has been taken up to identify the performance and emission characteristics of CI engine using Neem biodiesel.

Keywords: Neem oil, Biodiesel, Performance, Blends, Emissions

I.INTRODUCTION

Conventional energy sources such as oil, coal and natural gas have limited reserves that are expected not to last for an extended period. World primary demand is projected to increase by 1.5% per year from 2007 to 2030, from just over 12,000 million tonnes of oil equivalent to16800 million tones-as overall increase of 40%. As world reserves of fossil fuels and raw material are limited, it has stimulated active research interest in non petroleum and non polluting fuels. Diesel engines are the major source of power generation and transportation hence diesel is being used extensively, but due to the gradual impact of environmental pollution there is an urgent need for suitable alternate fuels for use in diesel engine without any modification. There are different kinds of vegetable oils and biodiesel have been tested in diesel engines its reducing characteristic for green house gas emissions. Its help on reducing a country's reliance on crude oil imports its supportive characteristic on agriculture by providing a new market for domestic crops, its effective lubricating property that eliminates the need of any lubricate additive and its wide acceptance by vehicle manufacturers can be listed as the most important advantages of biodiesel fuel. There are more than 350 oil bearing crops identified, among which only Jatropha, ongamia, sunflower, Soyabean, cottonseed, rapeseed, palm oil and peanut oil are considered as potential alternative fuels for diesel engines. The present study aims to investigate the use of neem oil blend with diesel as an alternate fuel for compression ignition engine.

A. Bio-diesel

Bio-diesel is fatty acid methyl or ethyl ester made from virgin or used vegetable oils (both edible & non-edible) and animal fats. The main commodity sources for bio- diesel in India can be non-edible oils obtained from plant species such as Jatropha Curcas, Karanj, Neem, Mahua etc. Bio-diesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a bio-diesel blend or can be used in its pure form. Just like petroleum diesel, bio-diesel operates in compression ignition engine; which essentially require very little or no engine modifications because bio-diesel has properties similar to petroleum diesel fuels. It can be stored just like the petroleum diesel fuel and hence does not require separate infrastructure. The use of bio-diesel in conventional diesel engines results in substantial reduction of un-burnt hydrocarbons, carbon monoxide and particulate matters. Bio-diesel is considered clean fuel since it has almost no sulphur, no aromatics and has about 10% built-in oxygen, which helps it to burn fully. Its higher cetane number improves the ignition quality even when blended in the petroleum diesel. It provides significant lubricity improvement over petroleum diesel fuel. Lubricity results of bio-diesel and petroleum diesel using industry test methods indicate that there is a marked improvement in lubricity when bio-diesel is added to conventional diesel fuel. Even bio-diesel level as low as 1% can provide up to 65% increase in lubricity in distillate fuels.). HC and CO emissions were also reported to be lower. Non-regulated emissions were also found to be lower.[1]

B. **Bio-diesel (Neem)**

A Neem tree can produce many thousands of flowers. In one flowering cycle, a mature tree may produce a large number of seeds. Neem trees start bearing harvestable seeds within 3-5 years, and full production may be started in 10 years, and this will continue up to 150-200 years of age. A mature Neem tree may produce 30-50 kg of fruit each year. By rough estimate India has nearly 20 million Neem trees. Indian Neem trees have a potentials to provide one million tonnes of fruits per year and 0.1 million tons of kernels per years (assuming 10% kernel yield). Neem seeds yield 40-60% oil. Neem is a golden tree that has gained world-wide importance owing to its multiple uses. Besides agro forestry, it is used in pest control, toiletries, cosmetics, pharmaceuticals, plant and animal nutrition and energy generation. Neem trees are considered to be a divine tree in India because of their numerous valuable uses. The commercial value of Neem has been known since Vedic times. Every part of Neem tree viz., leaf, flower, fruit, seed, kernel, seed oil, bark, wood, twig, root etc. has been in use and traded in various purpose.

Physical and chemical properties of neem oil, neem methylester and conventional diesel are presented in Table 1 The fuel properties of neem biodiesel were within the limits and comparable with the conventional diesel. Except calorific value, all other fuel properties of neem biodiesel were found to be higher as compared to diesel.[2]

Table 1: Properties of Neem Oils and its Ester

Properties	Diesel	Neem oil	Neem biodiesel
Density(kgm-3)	830	912–965	820–940
Viscosity(cSt)	4.7	20.5–48.5	3.2–10.7
Flashpoint(C)	60	214	120
Cetane number	45	31–51	48–53
Calorific value(MJkg-1)	42	32–40	39.6–40.2
Sulphur (ppm)	0.042	1990	473.8
Iodine value	----	65-80	----
Titre(C)	----	35-36	----
Fire point(C)	65	222	128
Pour point(C)	-16	10	2
Cloud point(C)	-12	19	9
Water content (%)	0.02	0.098	0.036

C. **Bio-Diesel in India**

About 400 wild species found in India produce non edible oils that can be converted to bio-diesel. A salient feature of India's bio fuel program is to only utilize wastelands, degraded forest, and non-forest lands for cultivation of oil seed plants. Of about 55 million ha of wastelands in India, about 32 million ha are suitable for biodiesel production. The available information about wasteland suitability for oil seed plantations is incomplete, and a proper wasteland mapping exercise should precede any major bio-diesel development program in India. The demand of diesel (H.S.D) is projected to grow from 39.81 Million Metric Tonne in 2001-02 to 52.32 MMT in 2006-07 @ 5.6% per annum. Our crude oil production as per the Tenth Plan working Group is estimated to hover around 33-34 MMT per annum even though there will be increase in gas production from 86 MMSCMD (2002-03) to 103 MMSCMD in (2006-07). The estimated bio-diesel requirements for blending with petro-diesel over the period of next 5 years.[1]

II. LITERATURE REVIEW

1. D. Subramaniam, A. Murugesan and A. Avinash [3]

Performance, emission, and combustion characteristics of methyl esters of Punnai, Neem, Waste Cooking Oil and their diesel blends in a C.I. engine was experimentally examined. For their study, Punnai oil methyl esters (POME), neem oil methyl esters (NOME), and Waste Cooking Oil Methyl Esters (WCOME) were prepared by tranesterification process. The Bio diesel-diesel blends were prepared by mixing 10%, 30%, 50%, and 70% of bio diesel with diesel. The effects of three methyl esters and their diesel blends on engine performance, combustion, and exhaust emissions were examined at different engine loads. Experimental results concluded that up to 30% of methyl esters did not affect the performance, combustion, and emissions characteristics. On the other hand, above B30 (30% Biodiesel with 70% diesel) a reduction in performance, combustion, and emission characteristics were clear from the study.

It was evident in the study that for all test fuels the brake thermal efficiency increased with increase in brake power. Among B10, B30, B50, B70, and B100 bio diesel, bio diesel blends up to B30 has a maximum brake thermal efficiency. With an increase in bio diesel blends the value of BSFC also increased.

CO, CO2, HC, NOx, and smoke are considered to be the major exhaust emissions from C.I. engines. The diesel engine produces lesser amount of CO and HC emissions than spark ignition engines. Moreover, in case of bio diesel fueled engines, presence of airborne oxygen as well as its presence in the molecules of bio-diesel aids nearly complete combustion of fuel. The NOx emission of diesel at maximum load was noted to be 960 ppm, whereas for B100 NOME it was noted to 890 ppm. This reduced NOx emission for B100 bio diesel when compared to diesel may be due to the reduced premixed combustion rate leading to lower NOx emissions for B100 bio diesel operation.

The experimental results proved that up to B30 blend of bio diesel-diesel blends, the performance and emission characteristics were not much affected. When the blend ratio increased, incomplete combustion takes place because of less time available for mixture formation, which leads to a reduction in the brake thermal efficiency of the engine as well as an increase in the emission level.

The combustion analysis revealed that the overall combustion characteristics of B30 bio diesel blends were closer to diesel than pure bio diesel. Overall, the methyl esters of waste cooking oil proved improvements in performance and emission characteristics than the methyl esters of Punnai and Neem due to its closer physical and thermo-chemical properties to neat diesel.

2. M C Navindgi, Dr. Maheswar Dutta, Dr. B. Sudheer Prem Kumar [4]

The diesel engine was modified in to LHR engine by means of partially stabilized zirconia (PSZ) coating. The basic concept of LHR engine is to suppress the heat rejection to the coolant so that the useful power output can be increased, which in turn results in improved thermal efficiency. However previous studies revealed that the thermal efficiency variation of LHR engine not only depends on the heat recovery system, but also depends on the engine configuration, operating condition and physical properties of the insulation material. The various combustion parameters such as cylinder pressure, rate of heat release, cumulative heat releases were analyzed.

The performance characteristics such as brake thermal efficiency, specific fuel consumption and specific energy consumption and various emission characteristics were compared. The maximum efficiency obtained in the case of LHR engine fueled with biodiesel was lower than the LHR engine operated with diesel fuel. However the efficiency of the LHR engine with biodiesel fuel is well within the expected limits. The exhaust gas temperature of LHR engine fueled with biodiesel was lower than LHR engine fueled with diesel throughout the operating condition. The low exhaust gas temperature indicates the heat release rate during the late combustion was comparatively lower than diesel fuel. The specific fuel consumption of LHR engine with biodiesel was higher than LHR engine fueled with diesel. The higher consumption of fuel was due to low calorific value and high viscosity. The specific energy consumption of LHR engine with biodiesel was higher than LHR engine fueled with diesel fuel. It was found that, CO and HC emissions for LHR engine with biodiesel was considerably lower than LHR engine fueled with diesel. The above comparative study clearly reveals the possibility of using the biodiesel in LHR direct injection diesel engine. The combustion, performance and emission characteristics show the suitability of biodiesel in LHR engine.

3. M. Ndana, B. Garba, L.G. Hassan and U.Z. Faruk [5]

Their work reports the results of the study of the effect of storage on the physico-chemical properties of biodiesel produced from Ricinus communis (Castor), Heavea brasiliensis (Rubber), Gossypium hirsutum (Cotton), Azadirachta indica (Neem), Glycin max (Soya bean), and Jatropha curcas (Jatropha oils) stored in an open air environment for a period of ten months. The peroxide value was found to be increasing with storage. However since peroxide value is an index of oxidation of vegetable oil or its derivatives, it is obvious that oxidation of biodiesel takes place at rapid rate due to inbuilt oxygen and unsaturated fatty acids. The acid value was found to be increasing significantly with storage period for the entire sample. The acid number increases as the fatty acid breaks down into shorter chain acids during oxidation. The variation of kinematic viscosity of all sample biodiesel over a period of 10 months was found to be increasing with storage period for all samples. The increase in viscosity was characterized by polymerization and sedimentation of biodiesel. The value of flash point was decreasing for all samples with storage period, making the fuel unsafe for use in ignition engines. The densities for the entire biodiesel sample were found to be increasing.

4. M C Navindgi, Dr. Maheswar Dutta and Dr. B. Sudheer Prem Kumar [6]

Here the effort has been made to determine the performance and emission characteristics of CNG and neem blends in CI engine. The maximum achievable neem biodiesel replacement by natural gas was found to vary with engine loads. The experiments are carried out for five different flow rates starting from minimum to maximum flow rate position. The engine showed very similar performance compared to diesel operation near up to 90% of rated load with up to 54% replacement of diesel by CNG being possible. The maximum flow rate position is one at which the engine starts knocking. Exhaust gas analysis showed that with higher diesel replacement the level of CO2 generation decreased and CO emission was found to increase. The late burning of the mixture with higher diesel replacement levels of CNG had caused more fuel to remain partially unburned increasing the formation of CO and decreasing the proportion of CO2. This would contribute to the reduction of efficiency at light loads. From the Comparison of results obtained with all above flow rate, CNG1 (4% CNG + 96% Neem oil), CNG3 (8% CNG + 92% Neem oil), CNG5 (12% CNG + 88% Neem oil) are found optimum. The following conclusions were drawn from their work:

1. The CNG fuelled engine produced more power and pressure cylinder than that of neem oil operation. The increase in brake thermal efficiency is attributed mainly due to the higher ignition delay, which allows more time for pre-flame reaction in CNG air mixture, which on initiation of combustion results in higher rate of heat release.
2. The neem-CNG operation produced lower emission of CO, CO2 for all operating conditions.
3. In the overall, the neem-CNG dual fuelled engines have a great possibility to be comparable to that of neem oil, since it has clearly advantages in reducing the emissions and cheaper price. Nevertheless, to reach the optimum performance, the CNG fuelled engine required some modification that may be studied further.

5. Lovekush Prasad and Dr. Alka Agrawal [7]

Experiments were conducted with different blends (B10&B20) of neem oil and diesel as various loads. The results showed that the brake thermal efficiency of diesel is slightly higher at all loads followed by blends of neem oil and diesel, it has been established that 20% of neem oil biodiesel can be use as a substitute for diesel without any engine modification thus neem oil as non-edible oil can be a good renewable raw material for biodiesel production. From the experimental analysis it was found that the blends of neem oil and diesel could be successfully used with acceptable performance up to a certain extent. Based on the result of this study properties of neem oil suggest that it cannot be used directly as CI engine fuel due to higher viscosity, density which will result in low volatility and poor atomization of oil during oil injection in combustion chamber causing incomplete combustion and carbon deposits in combustion chamber. Biodiesel blends produce lower brake thermal efficiency and higher brake specific fuel consumption then diesel because of low calorific value. The properties results of all blends show that blends up to 20% straight neem oil have value of viscosity and density equivalent to specified range for CI engine fuel, therefore it can be concluded that up to 20% blends can be used to run the CI engine at short term basis.

6. T. Venkateswara Rao , G. Prabhakar Rao , and K. Hema Chandra Reddy [8]

Experimental investigations have been carried out to examine properties, performance and emissions of different blends (B10, B20, and B40) of PME, JME and NME in comparison to diesel. Results indicated that B20 have closer performance to diesel and B100 had lower brake thermal efficiency mainly due to its high viscosity compared to diesel. However, its diesel blends showed reasonable efficiencies, lower smoke, CO and HC.

• Pongamia, Jatropha and Neem based methyl esters (biodiesel) can be directly used in diesel engines without any engine modifications.
• Brake thermal efficiency of B10, B20 and B40 blends are better than B100 but still inferior to diesel.
• Properties of different blends of biodiesel are very close to the diesel and B20 is giving good results.
• It is not advisable to use B100 in CI engines unless its properties are comparable with diesel fuel.
• Smoke, HC, CO emissions at different loads were found to be higher for diesel, compared to B10, B20, B40 blends.

7. Yogesh Tamboli, Dr. G. R. Selokar, Amitesh Paul and Jehan Zala [9]

The brake thermal efficiency was found reduced about 5% for Neem oil ester when compared to diesel. The brake specific fuel consumption is increased about Neem oil ester it is increased about 11% to 13% when compared to diesel fuel. The brake power is reduced about 12% for neem oil ester when compared to that of diesel. The carbon monoxide is reduced for Neem oil ester it is reduced about 16 % when compared to that of diesel. It is concluded that the carbon monoxide for vegetable oil ester is less when compared to diesel fuel. The concentration of hydrocarbon is decreased 15 % for Neem oil ester when compared to diesel fuel. The formation of nitric oxides is decreased about 3 % for Neem oil ester when compared to that of diesel fuel. The smoke level is decreased about ester 10 % for Neem oil ester when compared to diesel fuel. Thus multizone combustion model can be an efficient tool to calculate the effect of design and operating parameter. Hence it is concluded that in terms of performance characteristics and emission vegetable oil esters can be regarded as a potential substitute for diesel fuel.

- Neem based methyl esters (biodiesel) can be directly used in diesel engines without any engine modifications.
- Brake thermal efficiency of B10, B20 blends are better than B100 but still inferior to diesel.
- Properties of different blends of biodiesel are very close to the diesel and B20 is giving good results.
- It is not advisable to use B100 in CI engines unless its properties are comparable with diesel fuel.
- Smoke, HC, CO emissions at different loads were found to be higher for diesel, compared to B10, B20 blends.

8. Akshatha D.S, Manavendra.G and S.Kumarappa [10]

The main objective of this investigation was to study the use of neem (Azadirachtaindica) methyl esters in CI engine experimentally. Preparation of methyl esters were from non-edible oil using transestrification process. The use of neem oil biodiesel (neem oil methyl ester, NOME) blended with mineral diesel as substitute for conventional mineral diesel. The purpose of the investigation is to analyze the effects on diesel engine performance when fueled with the blends of biodiesel and diesel in various proportions on volume basis. Based on engine performance tests, it can be concluded that biodiesel blends can be used satisfactorily in the diesel engine without any major modifications in the hardware of the system.

The fuel consumption of the engine was somewhat higher at low loads and speeds on fuel blends due to lower gross heat of combustion and mass of fuel consumed increases with increasing injection pressure.

The BTE of Neem blends were lower than with diesel throughout the entire range showing the poor combustion characteristics of methyl ester due to high viscosity and poor volatility. When the injection pressure is increased to 250 bar the better mixing and proper utilization of air converted more heat into the useful work resulting in higher BTE of around 3.5%, with further increase in pressure to 290 bars, BTE tends to decrease.

The emissions of hydrocarbons (HC), carbon monoxide (CO) are considerably reduced for all biodiesel and additive blends, as injection pressure is increased the emissions goes on decreasing due to complete combustion of fuels.

Knocking was not observed for biodiesel blend at all operating conditions.

9. K. Anbumani and Ajit Pal Singh [11]

To study the feasibility of using two edible plant oils mustard (Brassica nigra, Family: Cruciferae) and neem (Azadirachta indica, Family: Meliaceae) as diesel substitute a comparative study on their combustion characteristics on a C.I. engine were made.

Butyl ester of mustard oil at 20% blend with diesel gave best performance in terms of low smoke intensity, emission of HC and NO_x, Cetane number, total fuel consumption, specific energy consumption, specific fuel consumption, brake thermal efficiency, and cylindrical peak pressure were almost equal when engine was run on pure diesel.

10. Vikas Kumar, Anuprasad SG and G.Mahesh Babu [12]

The fuel properties of biodiesel including flash point-and fire point were examined. The engine properties and pollutant emissions characteristics under different biodiesel percentages were also studied. The results shows that the biodiesel produced using neem oil could reduce Carbon monoxide and smoke emissions significantly while the Nitrogen oxide emission changed slightly. Thus, the ester of this oil can be used as environment friendly alternative fuel for diesel engine. Major Part of analysis is Performance characteristic in case of HC and at the same load for Diesel, B10, and B20 we found in decreasing state but in case of NOX found increasing for the same load. This is major drawback of using Bio-Diesel. During the experiment we found rate of fuel consumption lower for B20, B10. Overall to make environment greener we can use Bio-Diesel.

III.CONCLUSION

Good mixture formation and lower smoke emission are the key factors for good CI engine performance. These factors are highly influenced by viscosity, density, and volatility of the fuel. For bio-diesels, these factors are mainly decided by the effectiveness of the transesterification process. With properties close to diesel fuel, bio-diesel from Jatropha, pongamia pinnata and Neem seed oil can provide a useful substitute for diesel thereby promoting our economy. Biodiesel and diesel fuel blends may prove an alternative option as diesel fuel in the future because they are renewable resources and less polluting.

REFERENCES

[1] Dr. Tiwari, "Report of Committee on Development of Biofuel Planning commission of India", April 2003,

[2] Anindita Karmakar, Subrata Karmakar , Souti Mukherjee "Biodiesel production from neem towards feedstock diversification : Indian perspective", Renewable and Sustainable Energy Reviews 16 (2012) 1050- 1060

[3] D. Subramaniam, A. Murugesan, A. Avinash, "A comparative estimation of C.I. engine fuelled with methyl esters of punnai, neem and waste cooking oil", International Journal of Energy And Environment, Volume 4, Issue 5, 2013 pp.859-870.

[4] M C Navindgi, Dr. Maheswar Dutta, Dr. B. Sudheer Prem Kumar "Comparative Experimental Investigation of Combustion, Performance and Emission in a Single Cylinder Thermal Barrier Coated Diesel Engine using Diesel and Neem Biodiesel", International Journal of Engineering Research and Development, Volume 3, Issue 2 (August 2012), PP. 12-20.

[5] M. Ndana, B. Garba, L.G. Hassan and U.Z. Faruk, "Effect of Storage on Stability of Biodiesel Produced from Selected Seed Oils," Int. J. Pure Appl. Sci. Technol., 13(1) (2012), pp. 10-18.

[6] M C Navindgi, Dr. Maheswar Dutta and Dr. B. Sudheer Prem Kumar, "Experimental Investigation of Performance and Emission Characteristics of CI Engine Using CNG And Neem Oil Blend," International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.6, Pages : 01-04 (2013)

[7] Lovekush Prasad and Dr. Alka Agrawal, "Experimental Investigation of Performance of Diesel Engine Working On Diesel and Neem Oil Blends," IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE) ISSN: 2278-1684 Volume 1, Issue 4 (July-August 2012), PP 48-51.

[8] T. Venkateswara Rao , G. Prabhakar Rao , and K. Hema Chandra Reddy, "Experimental Investigation of Pongamia, Jatropha and Neem

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Methyl Esters as Biodiesel on C.I. Engine", Jordan Journal of Mechanical and Industrial Engineering, Volume 2, Number 2, Jun. 2008, ISSN 1995-6665, Pages 117 - 122

[9] Yogesh Tamboli, Dr. G. R. Selokar, Amitesh Paul and Jehan Zala, "Feasibility Testing of VCR Engine using various blend of Neem Oil", International Journal of Innovations in Engineering and Technology (IJIET), Vol. 2 Issue 3 June 2013, pp. 170-182.

[10] Akshatha D.S, Manavendra.G and S.Kumarappa, "Performance Evaluation of Neem Biodiesel on CI Engine with Diethyl Ether as Additive", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 8, August 2013, pp. 3729-3736

[11] K. Anbumani and Ajit Pal Singh, "Performance of Mustard and Neem Oil Blends With Diesel Fuel in C.I. Engine", ARPN Journal of Engineering and Applied Sciences, Vol. 5, No. 4, April 2010, pp.14-20.

[12] Vikas Kumar, Anuprasad SG And G.Mahesh Babu, "Production of Bio-Diesel to Neem oil and its performance and emission Analysis in two stroke Diesel Engine", International Journal of Engineering Science and Technology (IJEST), Vol. 5 No.02 February 2013, pp. 391-395.