EXPERIMENTAL INVESTIGATION ON PERFORMANCE AND EMISSION CHARACTERISTICS OF FOUR STROKE DIESEL ENGINE USING NERIUM OIL AS AN ALTERNATIVE FUEL

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Abstract

Increased environmental awareness and depletion of fossil petroleum resources are driving industry to develop alternative fuels that are environmentally more acceptable. Trans esterified vegetable oil derivatives called 'biodiesel' appear to be the most convenient way of utilizing bio-origin vegetable oils as substitute fuels in diesel engines In this project esterified Nerium oil is used as an alternate fuel. The experiments were conducted for studying the Performance, Emissions, Noise and Combustion characteristics of diesel engine with Nerium blends. The Nerium oil blends are in percentage of 20%, 40%, 60%, 80%, and W0% of Nerium oil to 80%, 60%, 40%, 20% & 0% of diesel. From this project it is concluded that among all nerium and diesel blends 20% of nerium and 80% of diesel blend gives better performance nearing the diesel.When comparing the emission characteristics HC, CO is reduced when compared to diesel, however NOx emission is slightly increased when compared to diesel. At present neither Nerium oil nor bio-diesel of Nerium oil is available in the market. Hence for our work, well grown Nerium seeds are collected from different parts of Tamil Nadu (India). Approximately 16 liters of oil is obtained from the 45 kgs of nerium seed. Then after proper filtration, esters of Nerium oil are prepared using the bio-diesel plant available in the department. Hence Nerium blend can be used in existing diesel engines without compromising the engine performance. It also describes the usage of non-edible oil to a greater extent.

Keywords Nerium oil, Ethanol, Engine performance, blends, Esterification

I. INTRODUCTION

Rapid depletion of conventional energy sources, along with increasing demand for energy is a matter of serious concern.Over 90% of today's energy demand is being met with fossil fuels, mainly petroleum products. Therefore energy crisis exists to a certain extent. The fact that problem based fuels will neither be available in sufficient quantities nor at reasonable price in future has revived interest in exploring alternative fuels for engines should be derived from indigenous sources and preferable renewable energy sources [1,2]. Since the first oil crises of the 1970's, various alternative fuels have been investigated with the goal of replacing conventional petroleum supplies. His initial interest was mainly one of the fuel supply security, but recently more attention has been focused on the use of renewable fuels in order to reduce the net production of CO_2 from the combustion sources. Almost all these vegetable oils have higher content of fatty acids which may affect the efficiency of the engine. Hence to offset these drawbacks, these oils are converted into esters by combing with alcohol, to eliminate the fatty acids [3].

India has the potential to be a leading global producer of biodiesel, as biodiesel can be produced from non-edible oils like Jatropha, Karanja neem, nerim. The industrial age is advent o developing countries and India is not on exception, developing at the rapid plau. And also biodiesel helps in promoting environmental health, energy security, support to agricultural sector and rural employment were helping in all ground development. While other energy Sowran are not capable of producing. Biodiesel is of pashiunder interest to the automobile industry and other areas in energy and environment. Because it significantly reduce particulate.

II. EXPERIMENTAL APPARATUS AND METHODS

A. Transesterification of Nerium Oil

To reduce the viscosity of the Nerium oil, trans-esterification method is adopted for the preparation of biodiesel. The procedure involved in this method is as follows: 1000 ml of nerium oil is taken in a three way flask. 12 grams of sodium hydroxide (NaOH) and 200 ml of methanol (CH_3OH) are taken in a beaker. The sodium hydroxide (NaOH) and the alcohol are thoroughly mixed until it is properly dissolved. The solution obtained is mixed with Nerium oil in three way flask and it is stirred properly. The methoxide solution with nerium oil is heated to 60°C and it is continuously stirred at constant rate for 1 hour by stirrer. The solution is poured down to the separating beaker and is allowed to settle for 4 hours. The glycerin settles at the bottom and the methyl ester floats at the top (coarse biodiesel). Methyl ester is separated from the glycerin. This coarse biodiesel is heated above 100°C and maintained for 10-15 minutes to remove the untreated methanol. Certain impurities like sodium hydroxide (NaOH) etc are still dissolved in the obtained coarse biodiesel. These impurities are cleaned up by washing with 350 ml of water for 1000 ml of coarse biodiesel. This cleaned biodiesel is the methyl ester of Nerium oil. This bio-diesel of Nerium oil is being used for the performance and emission analysis in a diesel engine.

B. Oil blends

Blending is the process of mixing oils in suitable proportions. Here blends are made from nerium oil by mixing it with 5% by volume of any material. It is denoted a N5 which means the mixture contains 5% volume of material and 95% volume of nerium oil, 10% volume of material and 90% volume of nerium oil, 15% volume of material and 85% volume of nerium oil, 20% volume of any material and 80 volume of nerium oil. This is done to improve the oil's combustion characteristics and reduce diesel consumption. The viscosity of blended oil is very close to diesel and has higher calorific value. The properties of these blends are intermediate between pure Biodiesel and diesel. Increase of oil percentage in the blend seems to increase the viscosity.

III. EXPERIMENTAL SETUP

The engine used for the investigation is kirloskar SV1, shown in fig. 1, single cylinder, four stroke, constant speed, vertical, water cooled, high speed compression ignition diesel engine. The kirloskar Engine is mounted on the ground. The test engine was directly coupled to an eddy current dynamometer with suitable switching and control facility for loading the engine. The liquid fuel flow rate was measured on the volumetric basis using a burette and a stopwatch. AVL smoke meter was used to measure the CO and HC emissions from the engine. The NOX emission from the test engine was measured by chemical luminescent detector type NOX analyser. For the measurement of cylinder pressure, a pressure transducer was fitted on engine cylinder head and a crank angle encoder was used for the measurement of crank angle. The sound from the engine was measured by Rion sound level meter. The experimental setup is shown in the Fig. 1.

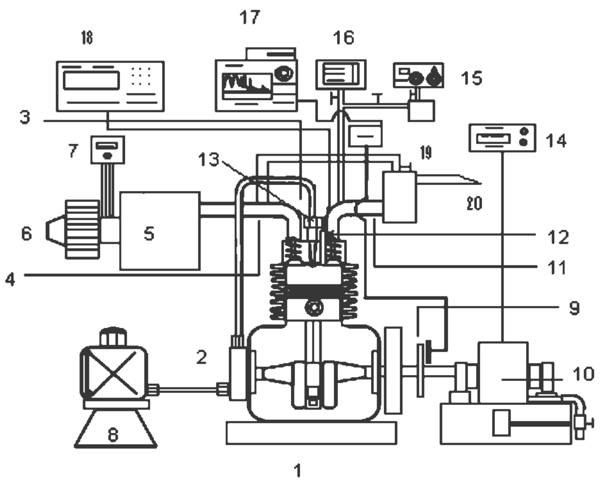

Fig. 1. Kirloskar SV1 Engine

1. Engine	11. Exhaust manifold
2. Fuel injection pump	12. Compression pressure transducer
3. Fuel injection nozzle	13. Injector needle life sensor
4. Intake manifold	14. Dynamometer control panel
5. Intake air surge tank	15. Exhaust gas analyzer
6. Air cleaner	16. Smoke meter
7. U - Tube Manometer	17. Digital scope recorder
8. Fuel tank	18. Exhaust temp sensor
9. Crank angle detector	19. EGR system
10. Electric dynamometer	20. Exhaust pipe

IV. ECONOMIC OF BIODIESEL

In India, tentative cost of biodiesel is as follows plantation and maintenance costs for 1 ha = 30,000; 1 ha produce = 3700 kg of seeds; 1 kg of seed of produce = 0.331 of oil; extracting oil from 1 kg of seeds = Rs. 2; 3700 kg of seeds produce = 1221 1 of oil for Rs 7400; 1 1 of oil requires Rs 33 for transeterification process;

V. HOMOGENOUSLY CHARGED DIESEL

In conventional diesel injection diesel engines although in is a lean combustion in average because the fuel is sprayed in to the cylinder, spatial distribution of air fuel ratios in the combustion chamber raines widely from rich to lean. Nox is formed at stoichiometric zone between rich and lean regions and smoke is formed at diffusion combustion region.

In order to reduce such harmful substance drastically some researches were attempted such that the pre-mixture was formed at the starting ignition and lean-bum is performed in overall combustion chamber.

VI. PERFORMANCE ANALYSIS

A. *Brake thermal efficiency*

The brake thermal efficiency for neat diesel at full load is 28.75 %,where as it was 24.08%, 23.56%, 22.45%, 21.923%, 21.07% for N20, N40, N60, N80 and N100 as shown in Fig. 2. Drop in BTE with N100 can be attributed to poor fuel combustion due to relatively high viscosity and poor volatility. The best thermal efficiency was obtained for N20 blend and was 4.67% less than that of diesel for full load. This may ta due availability of 0_2, which helps in complete combustion of the fuel.

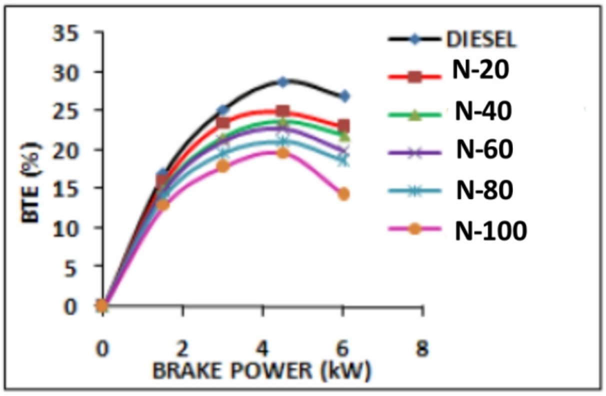

Fig. 2. Variation of BTE vs BP

B. *Specific Energy Consumption:*

It can be seen that the SEC is the highest in the case of N100 and least in the case of N20 fuel.

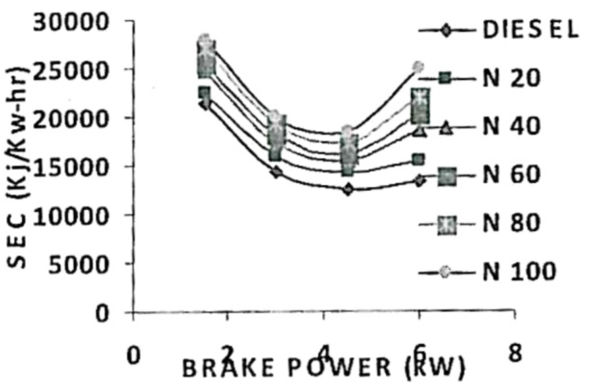

Fig. 3. Variation of SEC vs BP

Comparison of the specific energy consumption for different Nerium blends is shown in Fig.3. The SEC is 40.32% higher in case of biodiesels and its blends when compared to diesel [11, 12, 13]. The SEC for N20 is 7.5% higher than the diesel fuel. This may be due to higher density and viscosity of the fuel blends.

VII. EMISSION ANALYSIS

A. *Unburnt hydrocarbon*

The UBHC emissions is approximately 16.86% less in case of biodiesels and its blends when compared to diesel. Comparison of the UBHC emissions for the different Nerium blends is shown in Fig. 4. The UBHC increases with increase in load for all fuels. The UBHC for N20 is approximately 5% less than the diesel, which indicates more complete combustion of the fuel.

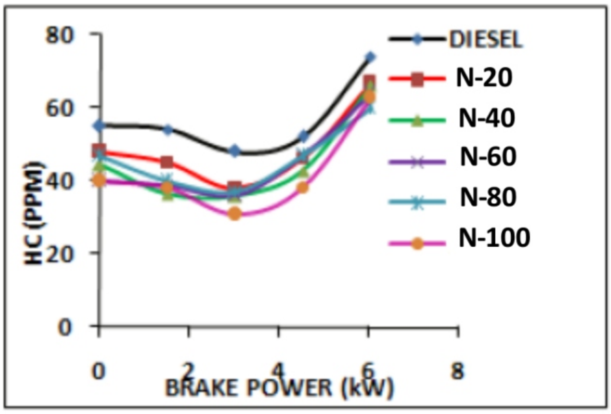

Fig. 4. Variation HC vs BP

B. *Carbon monoxide*

The CO emissions of N_2o is 0.013% lower than the diesel fuel. Comparison of the carbon monoxide emissions for the different Nerium blends is shown in Fig. 5. The CO emissions decreases with increase in

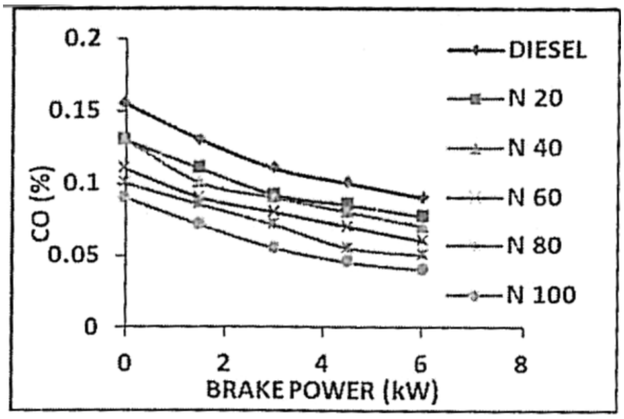

Fig. 5. Variation of CO vs BP

load for all fuels. The CO emissions are approximately 0.05% less in case of biodiesels and its blends when compared to diesel. This is due to the presence of oxygen content in the fuels, which promotes more complete combustion.

C. Oxides of nitrogen

The amount of NOx emissions is increases with increase in load for all fuels. This is due to complete combustion of the fuel, which increasing the temperatures of the exhaust gas and also due to the presence of oxygen in the biodiesel molecules. Comparison of the oxides of nitrogen emissions for the different Nerium blends is shown in Fig. 6. The NOx emissions is 35.16% higher in case of biodiesels and its blends when compared to diesel. The NOx emissions of N_2O is 17.9% higher than the diesel fuel.

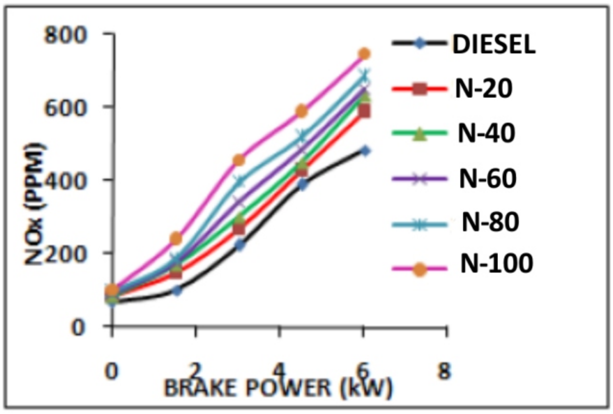

Fig. 6. Variation of NOx vs BP

D. Sound Characteristics:

This is due to higher amount of fuel accumulation in the combustion chamber initially and due to this the engine tends to knock and this leads to increase in

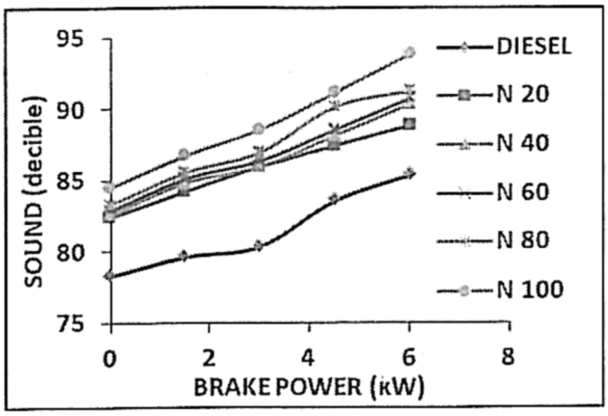

Fig. 7. Variation of noise level vs BP for different injection timings for best efficiency blend

noise level. Comparison of the sound characteristics for the different Nerium blends is shown in Fig. 7. It is observed that Noise increases with increase in load for all fuels. The Noise is 9.06 higher in case of biodiesels and its blends when compared lo diesel. The Noise of N20 is 3.9% higher than the diesel fuel.

E. Carbon Di-oxide

The CO_2 emissions is 34.2% higher in case of biodiesels and its blends when compared to diesel. The CO_2 emissions of N_2O is 14.3% higher than the diesel fuel. Comparison of the carbon Di-oxide emissions for the different Nerium blends is shown in Fig. 8. The amount o CO_2 emissions is increases with increase in load for all fuels. This is because biodiesels is generally a low carbon fuels an: has a lower elemental carbon to hydrogen ratio than dies; fuel.

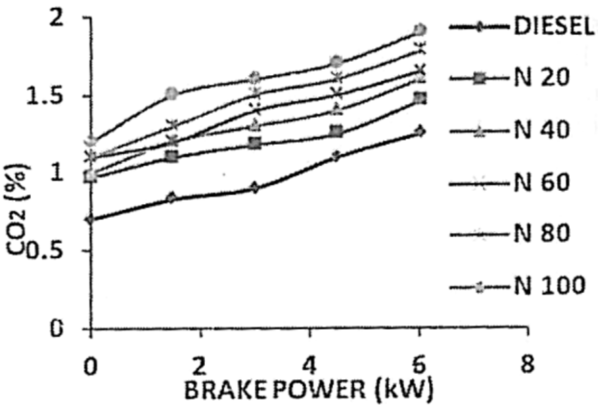

Fig 8. Variation of CO_2 vs BP

VIII. COMBUSTION ANALYSIS

A. Peak pressure rise

This is due to increase in delay period, proper diffusion does not take place which results in lower

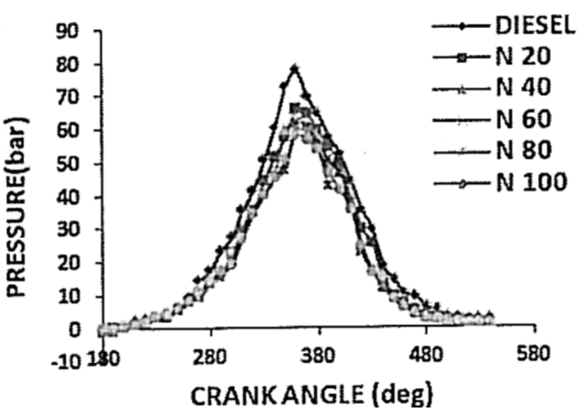

Fig. 9. Variation of peak pressure vs crank angle

pressure in the combustion chamber for the fuels blends compared to diesel. Comparison of the peak pressure rise for the different Nerium blends is shown in Fig. 9. Peak pressure for pure diesel at 27° BTDC is 77 bar. Peak pressure for N20 is 66 bar, N40 is 63 bar, N60 is 61 bar, N80 is 59 bar and N100 is 58 bar.

B. Instantaneous Heat Release Rate

Comparison of the instantaneous heat release rate for the different Nerium blends is shown in Fig. 10. Instantaneous Heat release rate for pure diesel is 76.50 J/deg CA. Heat release rate for N20 is 80.23 J/deg CA, N40 is 83.73 J/deg CA, N60 is 86.17 J/deg CA, N80 is 88.1 J/deg CA and N100 is 91.9 J/deg CA. This is due to poor diffusion which causes the hot exhaust gases to escape out at a higher rate for the fuels blends compared to diesel.

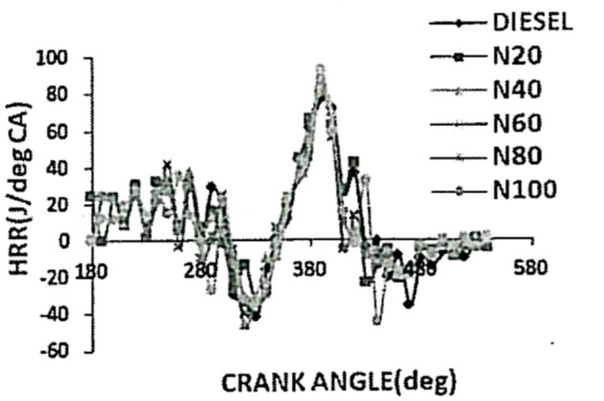

Fig. 10. Variation of Instantaneous heat release rate with crank angle

C. Cumulative Heat Release Rate:

Cumulative heat release rate for N20 is 346.04 J/deg CA, N40 is 351.93 J/deg CA, N60 is 367.05

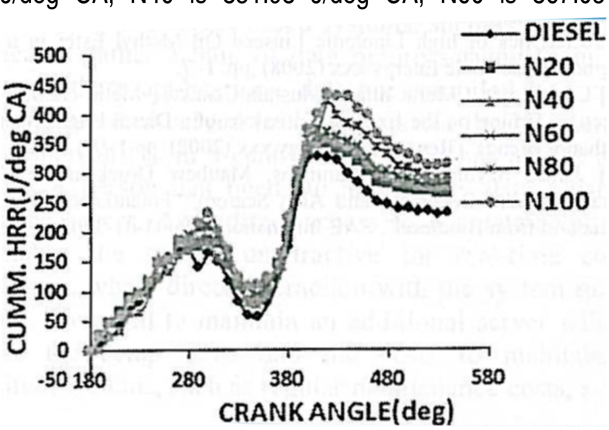

Fig. 11. Variation of Cumulative heat release rate with crank angle

J/deg CA, N80 is 420 J/deg CA, and N100 is 433.9 J/deg CA. Comparison of the cumulative heat release rate for the different Nerium blends is shown in Fig. 11. Cumulative heat release rate for pure diesel is 329.04 J/deg CA. This is due to poor combustion which takes place even after the expansion stroke commences which causes the cumulative heat release rate to rise higher for the fuels blends compared to diesel.

IX. CONCLUSION

The following conclusions are made based on the results obtained from both Experimental and Characteristics analysis of Nerium oil are listed below,

- After trans-esterification of Nerium oil, the kinematic viscosity and density is reduced while the calorific value is increased.
- When comparing the emission characteristics HC, CO is reduced when compared to diesel, however NOx emission is slightly increased when compared to diesel.
- Nerium oil, being non-edible oil proves to be a very effective alternate fuel.

From the above discussions it is concluded that among all Diesel and Nerium blends, 20% of nerium and 80% of diesel blend gives better performance nearing the diesel.

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