EFFECT OF NERIUM BIODIESELM IN DIESEL ENGINE

S.Prabhakar, S.Prakash, M.Saravana Kumar.
Department of Mechanical Engineering, Aarupadai Veedu Institute of technology, Chennai

*Corresponding author: Email: ruggers955@yahoo.co.in

ABSTRACT

The automobile sector which is growing day to day consumes the fossil fuel more than its growth. So there is a demand for exploring new sources of fuels for existing engines. This led to the growth in bio diesels which is an alternate fuel. An alternative fuel must be technically feasible, economically competitive, environmentally acceptable, and readily available. In this project esterified Nerium oil is used as an alternate fuel. A single cylinder stationary kirloskar engine is used to compare the performance and emission characteristics between pure diesel and Nerium blends. In this project selection of suitable nerium blend and selection of optimized injection timing for the blend is done. The Nerium oil blends are in percentage of 20%, 40%, 60%, 80%, and 100% 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 at 30º BTDC 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 in Salem District around 500kgs of Nerium seeds are collected. After the processing of these seeds, oil was extracted. Approximately 10 liters of oil is obtained from the 20 kg 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 with minimum modification in the engine. It also describes the usage of non-edible oil to a greater extent.

Keywords: Nerium, Injection timings, Esterification

INTRODUCTION

Vegetable oils are considered as good alternative to diesel fuel due to their properties which are much closer to that of diesel. Thus, they offer the advantage of being readily used in existing diesel engines without much modification. They have a reasonably high cetane number. Vegetable oils have a structure similar to that of diesel fuel, but differ in the type of linkage of the chains and have a higher molecular mass and viscosity. The heating value is approximately 90% of diesel fuel. A limitation on the utilization of vegetable oil is its cost. In the present market the price of vegetable oil is higher than that of diesel. However, it is anticipated that in future the cost of vegetable oil will get reduced as a result of developments in agricultural methods and oil extraction techniques. In India, forests and plants based non-edible oils are considered as the main sources for bio diesel production. Non–edible oils can be obtained plant species such as Jatropha, Karanja, Rubber, Mahua and Neem. However, it is not possible for us to get Nerium oil that much easily as that of other oils. Hence, in the present work, Nerium oil based bio-diesel is being considered as an alternate fuel for Diesel engines.

EXPERIMENTAL METHOD

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 (CH3OH) 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 60ºC 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 100ºC 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.

For the present work N20, N40, N60, N80 and N100 blends of Nerium oil bio diesel are being used.

ENGINE SPECIFICATION

| Engine manufacturer | Kirloskar oil engines ltd |
| Bore& stroke        | 87.5 x 110 (mm) |
| Number of cylinders | 1 |
| Compression ratio   | 17.5: 1 |
| Speed               | 1800 rpm |
| Cubic capacity      | 0.661 litres |
| Method of cooling   | water cooled |
Fuel timing -27º by spill (btdc)
Clearance volume -37.8 cc
Rated power -7 and 8 hp
Nozzle opening pressure -200 bars

EXPERIMENTAL SETUP

The engine used for the investigation is kirloskar SV1, 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.

TEST METHOD

The engine was operated initially on diesel for warm up and then with Nerium oil blends. The experiment aims at determining appropriate proportions of biodiesel and diesel for which higher efficiency was obtainable. Hence experiments were conducted for different proportions of biodiesel mixed with diesel. The blends were in the ratio 20%, 40%, 60%, 80%, and 100% with diesel. First these blends were tested at normal injection timing 27º BTDC at constant injection pressure 200 bar and with a constant compression ratio 17.5. Then for the best efficiency blend, the test were conducted at three different injection timings 24º BTDC, 30º BTDC and 33º BTDC and above procedure was followed. Shims were used to change the injection timings.

PERFORMANCE ANALYSIS

BRAKE THERMAL EFFICIENCY

At normal injection timing of 27ºBTDC the brake thermal efficiency for neat diesel at full load is 26.48 %, whereas it was 24.08% , 23.56% , 22.45% , 21.923% , 21.07% for N20,N40,N60,N80 and N100 as shown in Fig 2.1. The best thermal efficiency was obtained for N20 blend and was 2.4% less than that of diesel for full load.

FIG. 2.1 Percentage of nerium oil with diesel

Fig. 2.2 variation of BTE with BP for different injection timings for best efficiency blend

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From the Fig 2.2 it was observed that brake thermal efficiency for different injection timings for best efficiency blend (N20) at 24ºBTDC was 22.60%, 30ºBTDC was 26.12% and 33ºBTDC was 24.61%. For N20 at 30ºBTDC it was found to be 2.04% higher than N20 at 27ºBTDC. This may be due to better spray characteristics and effective utilization of air resulting in complete combustion of the fuel. For 24ºBTDC the brake thermal efficiency is 1.48 less than normal the efficiency of injection timing. This is because of incomplete combustion due to retardation of injection timing.

**SPECIFIC ENERGY CONSUMPTION**

Comparison of the specific energy consumption for the four different injection timings for best efficiency blend (N20) is shown in Fig no.3. It can be seen that the SEC is the highest in the case of 33ºBTDC and is least in the case of 30ºBTDC. This is because at 30ºBTDC the fuel is optimally injected such that proper diffusion of the biodiesel takes place. At 33ºBTDC more amount of fuel is injected into the combustion chamber because of the advance in the timing which leads to excess consumption of biodiesel. At 27ºBTDC and 24ºBTDC there is not enough fuel for the diffusion to takes place which results in poor diffusion and as a result the amount of fuel required to produce one kW of power is higher.

**EMISSION ANALYSIS**

**UNBURNT HYDROCARBON EMISSIONS & CARBON MONOXIDE**

Comparison of the UBHC emissions for the four different injection timings for best efficiency blend (N20) is shown in Fig no.4. Comparison of the carbon monoxide emissions for the four different injection timings for best efficiency blend (N20) is shown in Fig no 5. In both cases it can be seen that the UBHC and carbon monoxide emission is the highest in the case of the 24º BTDC and is least in the case of 30º BTDC. This is because at 30º BTDC proper diffusion and combustion of the biodiesel takes place which results in lower emissions. At 33º BTDC because of the advancement in injection timing, the delay period increases which leads to poor combustion. At 24º BTDC and 27º BTDC there is very less time for the diffusion of the fuel to takes place which leads to increase in emissions.

**OXIDES OF NITROGEN & CARBON DIOXIDE**

Comparison of the oxides of nitrogen emissions for the four different injection timings for best efficiency blend (N20) is shown in Fig no.6. Comparison of the carbon dioxide emissions for the four different injection timings for best efficiency blend (N20) is shown in Fig no 7. In both cases it can be seen that the oxides of nitrogen and carbon di-oxide emission is the highest in the case of the 30º BTDC and is least in the case of 24º BTDC. This is because at 30º BTDC peak temperature in the combustion chamber increases due to the proper combustion which leads to increase in emissions. At 33º BTDC because of the advancement in injection timing, the peak
pressure is lowered due to poor combustion. At 24º BTDC and 27º BTDC due to the poor combustion and spray characteristics, the oxygen content in the fuel is not fully burnt which results in lower emissions.

SOUND CHARACTERISTICS
Comparison of the sound characteristics for the four different injection timings for best efficiency blend (N20) is shown in Fig no.8. It can be seen that the sound characteristics is the highest in the case of the 33º BTDC and is least in the case of 30º BTDC. This is because at 30º BTDC the proper combustion takes places and due to this the power developed helps in smooth running which results in lower noise level. At 24º BTDC and 27º BTDC due to improper combustion the noise level is marginally greater. At 33º BTDC due to higher amount of fuel accumulation in the combustion chamber initially, the engine tends to knock and this leads to increase in noise level.

COMBUSTION ANALYSIS

PEAK PRESSURE RISE
Comparison of the peak pressure rise for the four different injection timings for best efficiency blend (N20) is shown in Fig no.9. Peak pressure for pure diesel at 27ºBTDC is 72 bar. Peak pressure of N20 for 30º BTDC is 70 bar, 33º BTDC is 67 bar, 27º BTDC is 66 bar and 24º BTDC is 63 bar. This is because complete usage of the fuel is observed at 30º BTDC which results in increase in the pressure as a result of proper combustion. At 33º BTDC due to increase in delay period, proper diffusion does not take place which results in lower pressure in the combustion chamber. At 24º BTDC and 27º BTDC due to a part of combustion taking place during the expansion stroke, the peak pressure drops.

INSTANTANEOUS HEAT RELEASE RATE
Comparison of the instantaneous heat release rate for the four different injection timings for best efficiency blend (N20) is shown in Fig no.10. Instantaneous Heat release rate for pure diesel is 76.50 J/deg CA at 27 deg BTDC. Heat release rate of N20 for 30º BTDC is 78.6 J/deg CA, 33º BTDC is 79.7 J/deg CA, 27º BTDC is 80.23 J/deg CA, and 24º BTDC is 86.12 J/deg CA.

This is because at 30º BTDC, the increase in thermal efficiency indicates the complete burning of fuel and lower release of the heat to the exhaust and this reduces the instantaneous heat release rate. At 33º BTDC because of poor combustion the heat release rate is marginally higher. At 27º BTDC and 24º BTDC because of poor diffusion which causes the hot exhaust gases to escape out at a higher rate.
CUMULATIVE HEAT RELEASE RATE

Comparison of the cumulative heat release rate for the four different injection timings for best efficiency blend (N20) is shown in Fig no.11. Cumulative heat release rate for pure diesel is 329.04 J/deg CA at 27deg BTDC. Cumulative heat release rate of N20 for 30º BTDC is 335.01 J/deg CA, 33º BTDC is 340.23 J/deg CA, 27º BTDC is 349.04 J/deg CA, and 24º BTDC is 366.60 J/deg CA.

This is because at 30º BTDC due to proper combustion, the amount of heat released is lower as the heat is utilized to produce better efficiency resulting in lower cumulative heat release rate. At 33º BTDC the cumulative heat release rate is higher due to improper burning at different zones in the combustion chamber. At 27º BTDC and 24º BTDC because of poor combustion which takes place even after the expansion stroke commences which causes the cumulative heat release rate to rise higher.

CONCLUSION

From the above results and discussions, the following important points are observed and the effect of injection timing are listed,

- After trans-esterification of Nerium oil, the kinematic viscosity and density is reduced while the calorific value is increased.
- For Nerium oil, fuel injection at 30º BTDC results in approximately 2% rise in BTE when compared to 27º BTDC where as there is a fall of just 0.36% when compared to diesel at 27º BTDC.
- The UBHC, CO is significantly reduced with biodiesels and its blends.
- Compared to diesel fuel NOx emissions are high for pure diesel and its low for N20 fuel.
- Based on the engine performance and emission tests, at 30º BTDC, the 20% blends of methyl esters with diesel fuel have better performance and lower emissions characteristicis ,compared to other injection timings.
- The experimental results such as performance characteristics, emissions characteristics and combustion characteristics of the blends of nerium biodiesel are almost comparable to that of diesel fuel results.
- Hence Nerium oil, being non-edible oil proves to be a very effective alternate fuel and can substitute mineral diesel with minimum modification in the engine.

REFERENCES

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Fig.11 Variation of Cumulative heat release rate with crank angle for different injection timings for best efficiency blend