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4 authors, including:

Karikalan Loganathan
Vels University

Dr.M. Chandrasekaran
Vels institute of Science Technology and Advanced Studies

Vinod Kumar
Vels University

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BEHAVIOUR OF CI ENGINE PERFORMANCE, COMBUSTION AND EXHAUST EMISSION WITH NEEM BIODIESEL AT VARIED FUEL INJECTION RATES

Karikalan.L[1], Chandrasekaran.M[2], Vinod Kumar.T[3] and Sridhar.R[4]

[1]*Department of Automobile Engineering, VELS University, Chennai*
[2, 3, 4] *Department of Mechanical Engineering, VELS University, Chennai*

e-mail ID: karilk2005@yahoo.co.in

Abstract: Motorization, fast depletion of fossil fuel reserves and issues like global warming have led the researchers all over the sphere for substitute fuels. Biodiesel resultant from vegetable oil is being used around the globe to lessen air pollution and necessity on diesel fuel. The current study covers the various aspects of N20 neem biodiesel with increased fuel injection pressure. The blends of N20 were tested with increased fuel injection pressure to examine the characteristics like brake thermal efficiency, fuel consumption, emission and combustion parameters. Experimental results indicated that N20 with 240bar has closer performance to diesel, reduced exhaust emission and improved combustion parameters.

Keywords: Engine, Diesel, Biodiesel, Performance, Emission, Combustion

1. INTRODUCTION

The demand for alternative energy sources is growing owing to mechanization of globe and the consideration has been motivated on evolving the renewable fuels to substitute the diesel fuels. There are numerous alternate for fuel like vegetable oil, biomass, biogas, alcohol which are all available in nature. Amongst these energies, vegetable oil seems to have extraordinary reputation as they are extensively available, non-toxic and eco-friendly. The alternate fuel nearer to diesel is biodiesel. Biodiesel generally derived from the family products of vegetable oil and alcohol, named mono alkyl esters of fatty acid. Biodiesel is eco-friendly fuel comparable to diesel in testing of the engines [1, 2]. Biodiesel can be obtained from non-edible oils like Jatropha, Neem, Pongamia, Mahua, Linseed, Castor, Kusum, etc. Oil contented in the Pongamia seed and Jatropha seed is about 35-40 %. India has about 90-110 million hectares of suitable land for Pongamia and Jatropha farmstead. India is a unique country in producing Neem oil and its kernels comprises 35% oil contented [3-5].

Conversely, engine long run test outcomes exhibited that problems were faced with plant oils like formation of carbon deposits and contamination of lubricating oil. Accordingly, it was decided that plant oils must be chemically transformed or combined with diesel to avoid early engine let-down. Blending, Emulsification, Pyrolysis or transesterification of plant oils may overwhelm these difficulties [6, 7]. Warming and mixing of plant oils may lessen the viscosity and progress volatility of plant oils but its molecular construction are unaffected.

Neem kernels have 35% of oil which has great prospective for the making of biodiesel. It has a higher viscosity and density than diesel. Neem oil is usually bitter, dark brown and has a solid odor. Neem kernels contains mostly of triglycerides and great quantities of triterpenoid mixtures. It comprises four noteworthy soaked fatty acids of palmitic and stearic acids. It also comprises oleic acid and linoleic acids. By tradition, neem oil has been utlized as fuel in lamps lightening in countryside and for making soaps, pharmaceutical, cosmetics products. The kernels on Neem yield 35%-60% mass of seed. Neem oil is plant oil hard-pressed from seeds of neem fruit [8, 9]. In current phases, the global warming has been detected and believed that is the commencement of the devastation of Globe. A awaken up sound is frightened for the sapiens to react to this condition.

2. NEEM OIL BIODIESEL

Neem oil is demonstrated to comprise methyl ester which is considered as the base of a biodiesel. This biodiesel comprises alkyl esters of the fatty acids which is the outcome of transesterification of the Neem oil. Extraction of diesel is complicated but its results are more effective like little CO emission, increased engine performance, lesser consumption of fuel and reduce the smoke density. In the new era of Bio-fuel, Neem Oil even though has its own identity as a medicinal plant, creates a new spot as a bio diesel. Neem oil is plant oil hard-pressed from the seeds of the Neem fruit. It is the utmost commercially accessible yields of Neem for biological farming and medicines. The effort of the transesterification is to lessen the neem oil viscosity. The transesterification supervenes fine in the firm of certain identical substances such as KOH, NaOH and sulphuric acid, or dissimilar compounds such as metal oxides or carbonates. NaOH is well recognized and extensively utilized, because of its lower cost and higher yield. Transesterification is the exercise of switching the alkoxy cluster of an ester combined with added alcohol [10]. Vegetables oils could be effectively utilized in diesel engine with engine/fuel modification.

3. MATERIALS AND METHODS

The current study is to reduce the viscosity of Neem oil close to diesel in directive to spot it appropriate for diesel engine and to evaluate the performance with dissimilar alternate fuels. Test fuel viscosity was condensed by mixing the Neem Biodiesel with diesel. The combinations of Neem biodiesel and diesel mixtures utilized in this trial are N20 (Neem Biodiesel 20%+ Diesel 80%). The diesel and biodiesel blends were tried at standard engine specification at normal injection timing 27^0BTDC, with compression ratio of 17.5 at varied fuel injection pressure of 180bar, 200bar, 220bar, 240bar.The density of the diesel, neem oil and neem biodiesel are 822kg/m3, 918 kg/m3, 868 kg/m3 respectively. The calorific value of the diesel, neem oil and neem biodiesel are 42.2 MJ/kg-K, 34.1 MJ/kg-K and 35.2 MJ/kg-K respectively.

4. EXPERIMENTAL SETUP

A single cylinder DI diesel engine broadly used has been chosen for present study. The engine terms are detailed in Table 1. The engine is tangled to a single phase swing field electrical dynamometer for testing the engine over a resistive load. The figure of trial procedure is shown in Figure 4.1 and 4.2. The engine is cranked with diesel and then it is shifted to Neem biodiesel blends.

TABLE.1 Engine Specification

Make and model	KIRLOSKAR, TAF1
Bore x Stroke	80mm x 110mm
Compression ratio	17.5:1
Power output	4.4 kW at 1500 rpm
Injection timing	23^0 bTDC
Combustion chamber	Hemispherical Open

A thermocouple fixed in the exhaust way to gauge the gas temperature. To quantify the current and voltage distributed in the load series were computed by ammeter and voltmeter. Smoke was computed with AVL 415 smoke meter. The exhaust gas was quantified by AVL DIGAS444 exhaust gas analyser for quantifying CO_2, CO, HC, NO_X and O_2 emission. The trials were directed with diesel to make standard data through a model fuel injection pressure. In the successive part, trials were piloted by mixtures of Neem biodiesel blends through the engine functioning on varied fuel injection pressure of 180bar, 200bar, 220bar and 240bar respectively. These mixtures stayed and exposed to the performance and emission on the engine. The performance and pollutants figures were explored for all trials and the outcomes are stated in the subsequent division.

Figure.4.1 Picture of Experiment Setup

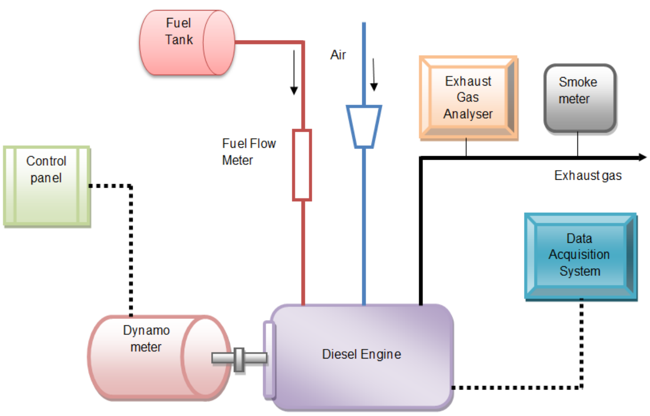


Figure.4.2 Layout of Experiment

5. RESULTS AND DISCUSSIONS

5.1 Brake Thermal Efficiency (BTE)

Figure.5.1 displays the assessment of BTE against brake power at dissimilar injection pressures for N20 blend. The investigational results display that the BTE declines when injection pressure is retarded and rises once injection pressure is advanced. The higher BTE for dissimilar injection pressures for N20 blend is witnessed at 75% of load. The BTE at 75% of load rises by 1.54% at 220bar and 3.05% at 240bar while equated to N20 at 200bar. For N20 blend at 240bar, at 75% of load the higher brake thermal efficiency was achieved when equated to other injection pressures at 75% of load. This is because at this injection pressure, the fuel sprayed entirely diffuses with air in the combustion chamber which progresses the whole burning prospect.

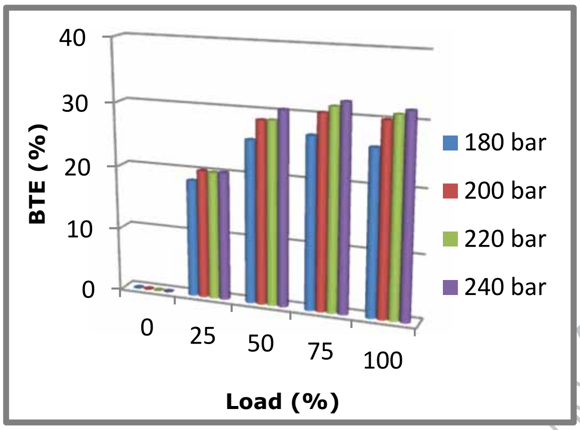


Figure.5.1 BTE vs. Load

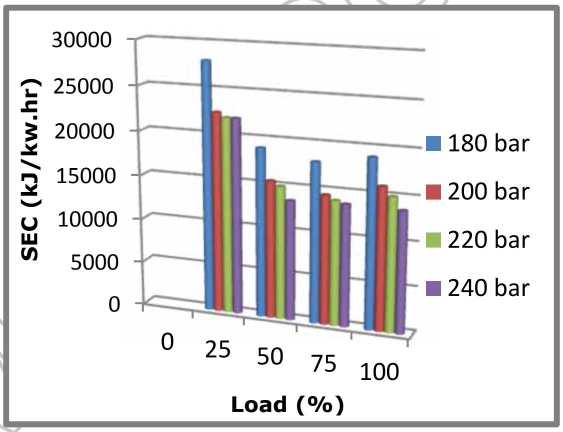


Figure.5.2 SEC vs. Load

5.2 Specific Energy Consumption (SEC)

Figure.5.2 displays the evaluation of SEC against brake power at different injection pressures for N20 combination. The experimental outcomes show that the SEC increases when injection pressure is retarded and decreases when injection pressure is advanced. For all the injection pressures, SEC decreases up to lesser load and rises there on. The SEC at full load decreases by 3.2% at 220 bar and 12.26% for at 240bar, when equated to 200bar at maximum load. For N20 blend at 240bar, at maximum load the lower specific energy consumption was obtained when compared to other injection pressures at maximum load. This may be due to the fact that fuel is optimally injected such that proper diffusion of the biodiesel takes place, which results in better combustion.

5.3 Hydrocarbon emission (HC)

Figure.5.3 displays the comparison of HC release against brake power at different injection pressures for N20 blend. The experimental results show that the Hydrocarbon emission increases when injection pressure is retarded and decreases when injection pressure is advanced. For all the injection pressures, Hydrocarbon emission decreases up to lesser load and rises there on. The HC emission at full load decreases by 1.3% at 220bar and 14.5% at 240bar, when equated to 200bar at maximum load. For N20 blend at 240bar, at maximum load the lower HC emission was obtained when compared to other injection pressures at maximum load. This is because of proper diffusion takes place at this injection pressure, due to this it is clear that more amount of fuel is burnt and hence the HC content reduces.

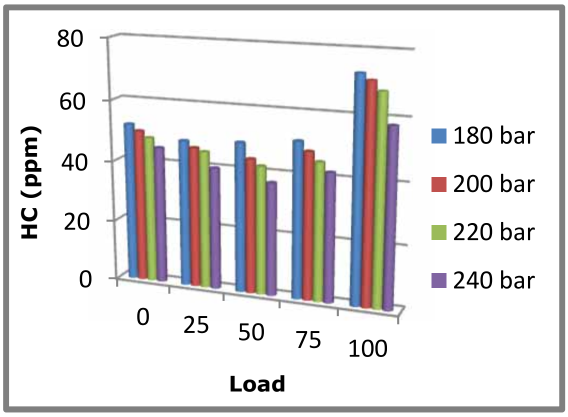


Figure.5.3 HC vs. Load

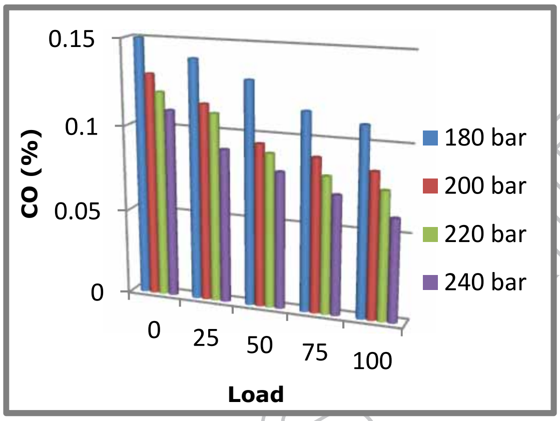


Figure.5.4 CO vs. Load

5.4 Carbon monoxide emission (CO)

Figure.5.4 displays the comparison of CO discharge against brake power at different injection pressures for N20 blend. The investigational outcomes show that the CO discharge increases when injection pressure is retarded and decreases when injection pressure is advanced. For all the injection pressures, CO discharge decreases with increase in brake power. The CO discharge at maximum load decreases by 0.006% at 220bar and 0.017% at 240bar, when equated to 200bar at maximum load. For N20 blend at 240bar, at maximum load the lower CO emission was obtained when compared to other injection pressures at maximum load. This may be due to the proper burning, which converts the carbon molecules to CO2 molecules.

5.5 Oxides of Nitrogen Emission (NO_X)

Figure.5.5 displays the comparison of NO_X release with brake power at different injection pressures for N20 blend. The experimental results show that the NO_X release decreases when injection pressure is retarded and increases when injection pressure is advanced. For entire injection pressures, NO_X release surges with rise in brake power. The NO_X emission at maximum load increases by 5.3% at 220bar and 19.8% at 240bar, when equated to 200bar at maximum load. For N20 blend at 240bar, at full load the higher NO_X release was obtained when equated to other injection pressures at maximum load. This may be due to the good atomization and spray characteristics, which results in higher adiabatic flame temperature.

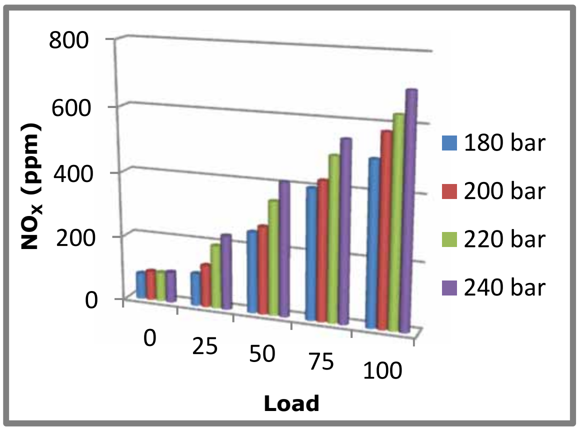


Figure.5.5 NOx vs. Load

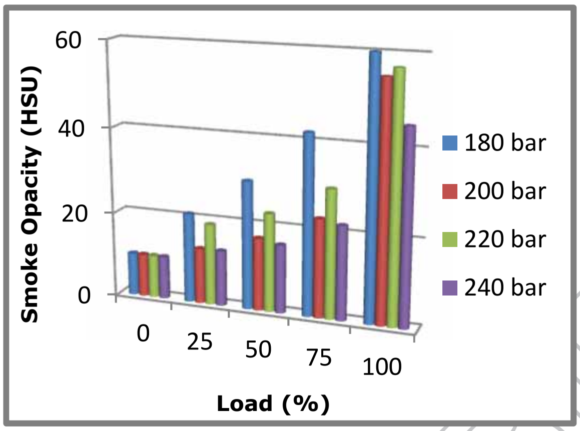


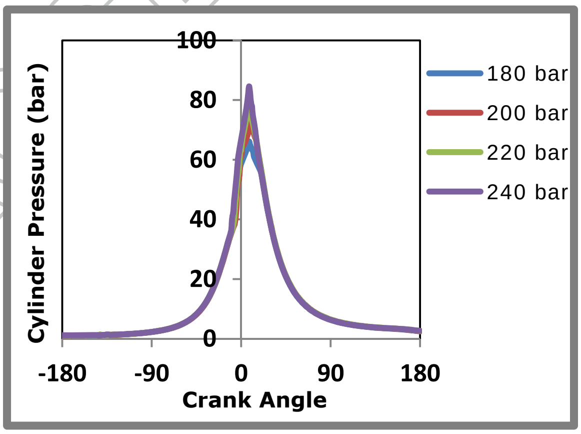
Figure.5.6 Smoke vs. Load

5.6 Smoke opacity

Figure.5.6 displays the evaluation of Smoke opaqueness with brake power at different injection pressures for N20 blend. The experimental results show that the Smoke opaqueness rises when injection pressure is retarded and decreases when injection pressure is advanced. For all the injection pressures, Smoke opaqueness surges with rise in brake power. The Smoke opacity at maximum load decreases by 3.05 HSU at 220bar and 16.08 HSU at 240bar, when equated to 200bar at maximum load. For N20 blend at 240bar, at maximum load the lower Smoke opacity was obtained when compared to other injection pressures at maximum load. This might be owing to the improved mixture creation, resulting in lower smoke emission.

5.7 Cylinder Pressure

Figure.5.7 displays the comparison of Cylinder pressure against Crank angle at dissimilar injection pressures for N20 blend. The investigational outcomes show that the Crowning pressure decreases when injection pressure is retarded and increases when injection pressure is advanced. The maximum crowning pressure is observed at 75% of load for entire fuels. The Crowning pressure at 75% of load increases by 5.03% at 220bar and 16.77% at 240bar, when equated to at 200bar at maximum load. For N20 blend at 240bar, at 75% of load the Peak pressure is establish to be 2.9% upper when equated to diesel at 75% of load at typical engine specification. This may be due to the better utilization of the fuel is which results in increase in the pressure as a result of proper combustion.



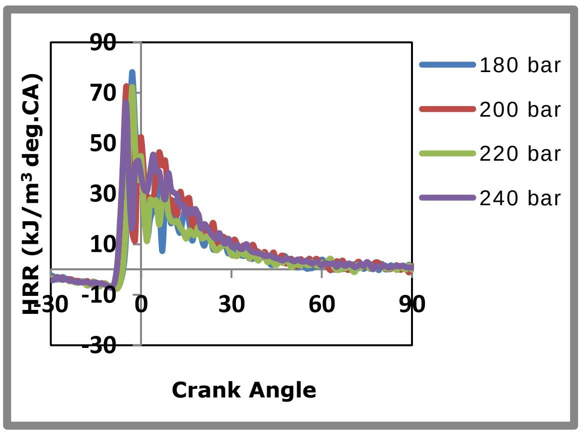


Figure.5.7 Cylinder Pressure vs. Load Figure.5.8 HRR vs. Load

5.8 Heat Release Rate (HRR)

Figure.6.9 displays the comparison of HRR against Crank angle at dissimilar injection pressures for N20 blend. The experimental results show that the HRR rises when injection pressure is retarded and decreases when injection pressure is advanced. The lower HRR is perceived at 75% of load for entire fuels. The HRR at 75% of load declines by 0.16% at 220 bar, 8.86% at 240bar, when compared to 200bar at maximum load. For N20 blend at 240bar, at 75% of load the HRR is establish to be 4.4% lower when equated to diesel at 75% of load. This may be owing to the lower release of the temperature to the exhaust, which reduces the heat release rate.

6. CONCLUSION

Brake thermal efficiency of N20 blend at 240 bar is higher than the N20 blend at other injection pressures and slightly higher when compared to diesel. Specific energy consumption for N20 at 240 bar is lower than the N20 blend at other injection pressures and lower when equated to diesel. HC, CO and Smoke emission for 20 at 240 bar are lower than the N20 blend at other injection pressures and lower when compared to diesel. NOX emission for N20 at 240 bar is higher than the N20 blend at other injection pressures and higher when compared to diesel. It can be concluded that N20 biodiesel blend at 240bar fuel injection pressure is optimal for the diesel engine performance.

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