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Performance Study on Variable Compression Ratio (VCR) Engine Using Different Blends of Neem Biodiesel as Alternative Fuel

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Abstract - *This paper deals with biodiesel production from neem oil, which is mono-ester produced used transesterification process. Biodiesel is reliable, renewable, biodegradable and regarded as a clean alternative fuel to reduce exhaust emissions. Vegetable oil cannot be directly used in the VCR engine for its high viscosity, high density, high flash point and lower calorific value. So it needs to be converted into biodiesel to make it consistent with fuel properties of diesel. Vegetable oils have become more attractive for the production of biodiesel in the recent past owing to its environmental benefits and the fact that it is made from renewable resources. Biodiesel is produced by the transesterification of glycerides of neem oil using methanol with alkaline catalyst NAOH/KOH. The performance investigation is carried out in VCR engine with biodiesel by mixing with blends NB10, NB30, NB50. The parameters evaluated were performance and emission characteristics at compression ratio 15. NB10 and NB30 possess better brake thermal efficiencies. By adding methanol (5%) to NB50 as additive to improve the brake thermal efficiency while the specific fuel consumption more is obtained*.

Key Words: Neem oil, Transesterification, Methanol, VCR, Performance.

NOMENCLATURE:

VCR Engine- variable compression ratio engine

NB10- Neem biodiesel 10%

NB30- Neem biodiesel 30%

NB50- Neem biodiesel 50%

M5%-Methanol 5%

CR15-Compression ratio 15

1. INTRODUCTION

In the modern world, the demand for non-renewable energy sources is increasing day by day due to modernization and mechanization. Demand for electricity and enormous increase in the number of automobiles has resulted in greater demand for petroleum products. The increasing demand for the petroleum based fuels has led to oil crises in the recent times. Therefore attention has been focused on developing the renewable or alternate fuels to replace the petroleum based fuels for transport vehicles.

Fossil fuels are still being created today by underground heat and pressure; they are being consumed more rapidly than they are being created. Insufficient quantities or unreasonable price of petroleum fuels deeply concerns us whereas the renewable energy is a promising alternative solution because it is clean and environmentally safe. Due to petroleum fuel, Pollution and accelerating energy consumption have already affected equilibrium of the earth's landmasses and biodiversity.

Since petroleum diesel and gasoline consist of blends of hundreds of different chemicals of varying hydrocarbon chains, many of these are hazardous and toxic. Carbon monoxide (produced when combustion is inefficient or incomplete), nitrogen oxides (produced when combustion occurs at very high temperatures), sulphur oxides (produced when elemental sulphur is present in the fuel), and particulates that are generally produced during combustion are other specific emissions of concern. So it is time to search for its alternative fuels. There are several alternative sources of fuel like vegetable oils, biogas, biomass, primary alcohols which are all renewable in nature. Among these fuels, vegetable oils appear to have an exceptional importance as they are renewable and widely available, biodegradable, non-toxic and environment friendly. The alternative fuel that much closer to diesel engine is 'biodiesel'. . Shruthi H. Heroor et.al suggested that Biodiesel production from neem oil, which is mono- ester produced using transesterification process. It has high lubricity, clean burning fuel and can be a fuel component for use in existing unmodified diesel engine. 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.

Meda Chandra Sekhar et.al suggested that important properties of the biodiesel oil such as flashpoint, viscosity, calorific value, density is comparable with the diesel. The

viscosity of biodiesel oil is nearer to that of diesel and the calorific value is about 16% less than that of diesel. A two-step transesterification process is developed to convert the high FFA non edible oils to its esters. The first step (acid catalysed transesterification) reduces the FFA content of the oil to less than 2%. The alkaline catalyst transesterification process converts the products of the first step to its monoesters and glycerol. Factors effecting the biodiesel production (reaction temperature, reaction rate & catalyst) are analyzed. 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.

Nithyananda B. S et.al has suggested that conclusions are drawn from this investigation are the transesterification process used for making biodiesel is simple to solve viscosity problems encountered with vegetable oils. The fuel properties results of all blends show that blends of up to 20% have values nearer to properties of diesel. The existing diesel engine performs satisfactorily on biodiesel fuel without any engine modifications. It is observed from this research that yield of neem biodiesel is low. Engine performance with biodiesel does not differ much the neat diesel. Biodiesel blend B10 shows good results comparable with other blends.

Biodiesel refers to a family of products made from vegetable oil or animal fats and alcohol, such as methanol or ethanol, called mono alkyl esters of fatty acids. Study shows that, on the mass basis, biodiesel has an energy content of about 12% less than petroleum based diesel fuel. It reduces unburned hydrocarbons (HC), carbon monoxide (CO), and increase oxides of nitrogen (NOx) than diesel-fuelled engine. It is a domestic, renewable fuel for diesel engine derived from natural oil like Neem oil. Biodiesel is environment friendly liquid fluid similar to conventional diesel fuel in engine tests, the power and fuel consumption.

2. METHODOLOGY

2.1 Transesterification Process:

Transesterification is the reaction of a fat or oil with an alcohol to form esters and glycerol. Alcohol combines with the triglycerides to form glycerol and esters. A catalyst is usually used to improve the reaction rate and yield. Since the reaction is reversible, excess alcohol is required to shift the equilibrium to the product side. Among the alcohols that can be used in the transesterification process are methanol, ethanol, propanol, butanol and amyl alcohol. Alkali-catalysed transesterification much faster than acid-catalysed transesterification and is most often used commercially. R1, R2, R3 and R' represent various alkyl groups. The process of transesterification brings about drastic change in viscosity of vegetable oil. The biodiesel thus produced by this process is totally miscible with mineral diesel in any proportion.

3. PROPERTIES OF BIODIESEL

Properties	Neem Oil B100	Neem Oil B10	Neem Oil B30	Neem Oil B50
Kinematic viscosity @40°C in cst	5.7	3.09	3.7	4.143
Flash point	195°C	71°C	92°C	124°C
Fire point	205°C	77°C	99°C	132°C
Gross calorific value kj/kg	33,724.93	41,622.49	39,867.47	38,112.46
Density in kg/m3	904	829	845	870

Properties of Neem Biodiesel with Methanol (5%)

Properties	Methanol	B50 + Methanol (5%)
Kinematic viscosity @40°C in cst	0.57	4.1
Flash point	11°C	119
Gross calorific value kj/kg	19,267.46	37,148.65
Density in kg/m3	792	868

4. EXPERIMENTAL SETUP

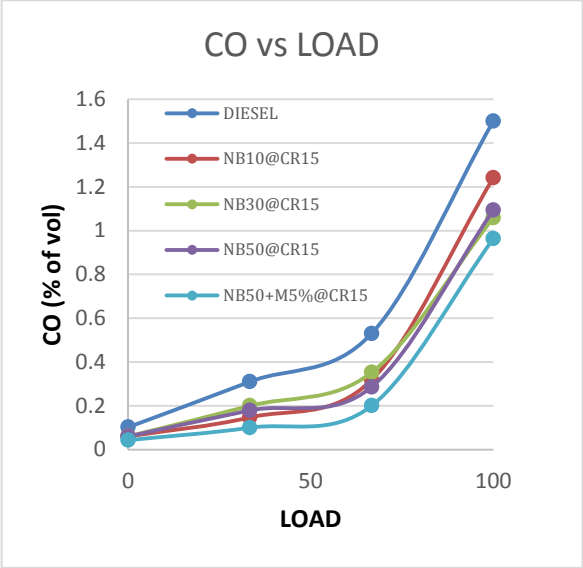
The experiments were conducted on a Kirloskar made four stroke single cylinder water cooled variable compression ratio engine. Neem biodiesel blends (B10, B30, and B50) and diesel was used to test a conventional engine. The engine was coupled with an eddy current dynamometer to apply different loads. Performance parameters like brake power, brake specific fuel consumption and brake thermal efficiency were evaluated. The engine specifications are given in the Table.

Type	Kirloskar
Details	Single Cylinder, four stroke, water cooled
Bore & Stroke	Stroke 110mm
Rated Power	3.5 KW at1500 RPM
Compression ratio	16 - 19
Starting	Hand start with cranking handle

5. Results and Discussion

5.1 Emissions

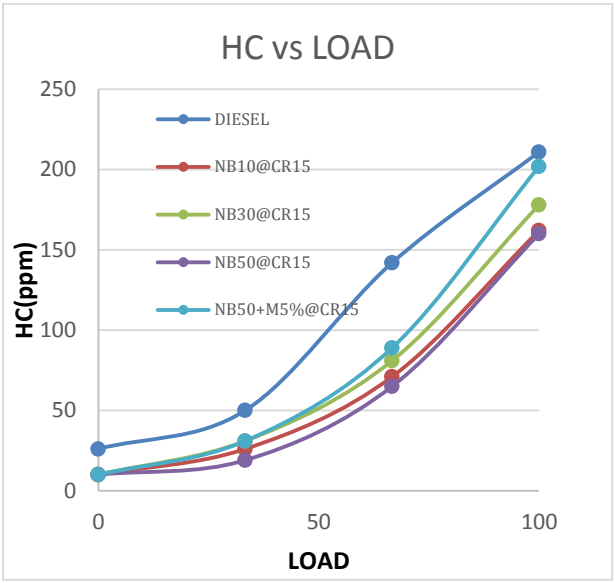
CO



The CO emitted by all the blends is lower than that of diesel at all loads. This is due to the better combustion of the blends provided by the additional oxygen content the incomplete combustion of the fuel due to very short time available for combustion.

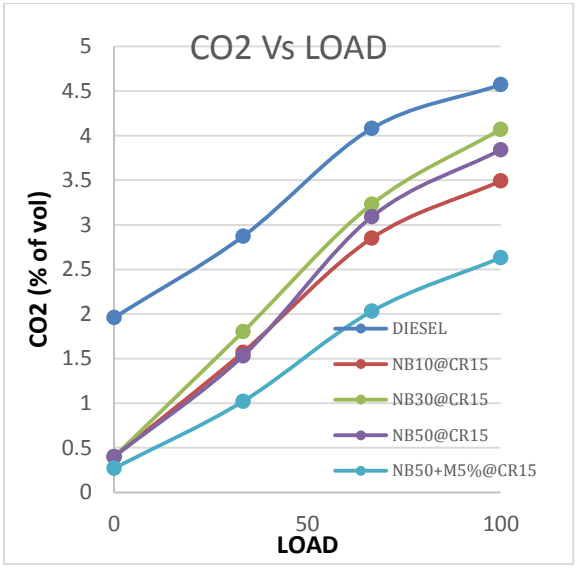
From the graph the level of CO of biodiesels are lower than diesel. Among all the blends NB50+M5% exhibits very low CO emissions.

HC



It is observed that for all the fuels tested, the HC emission is found to increase with increase in load. The incomplete combustion of the fuel due to the higher viscosity offered by the biodiesel content and poor mixing of fuel with air could be the reason for increased HC emission. From the graph biodiesels emits less hydro carbon emissions than diesel. NB50+M5% at compression ratio 15 exhibits very high HC emissions than B10, B30 and B50.

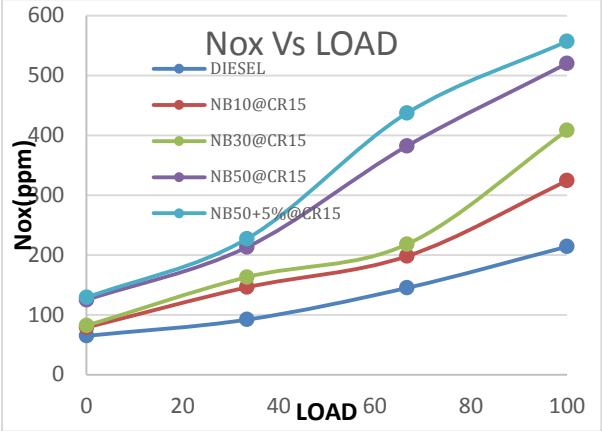
CO_2



From the above graph the carbon dioxide emits very low level emissions than diesel. This is due to the fact that the biodiesel in general is a low carbon fuel and has lower elemental carbon to hydrogen ratio than diesel.

Due to the adding of methanol to the blend NB50 (NB50+M5%) there is a rapidly decreasing of CO_2 emissions are occur.

NO_x



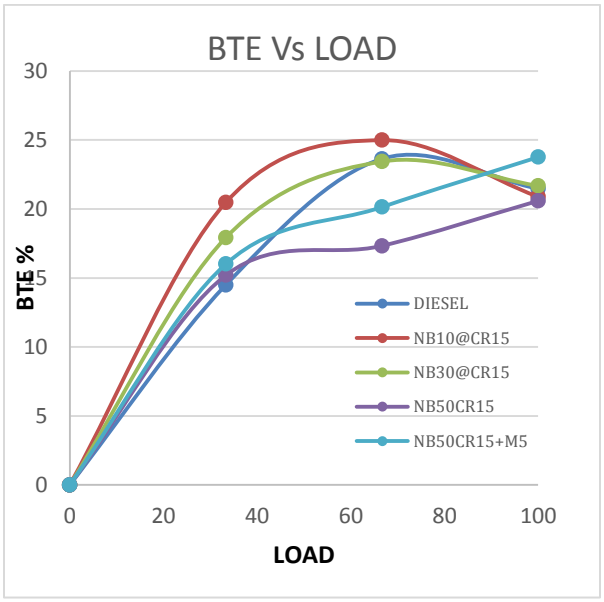
From the figure, it is observed that all the blends tested produced higher NO*x* emission than diesel at all loads. Also, the percentage increase in NO*x* emission is more at high loads.

The addition of methanol to the biodiesel–diesel blends as oxygenates could have enhanced the combustion efficiency leading to higher combustion temperature and higher NO*x* formation

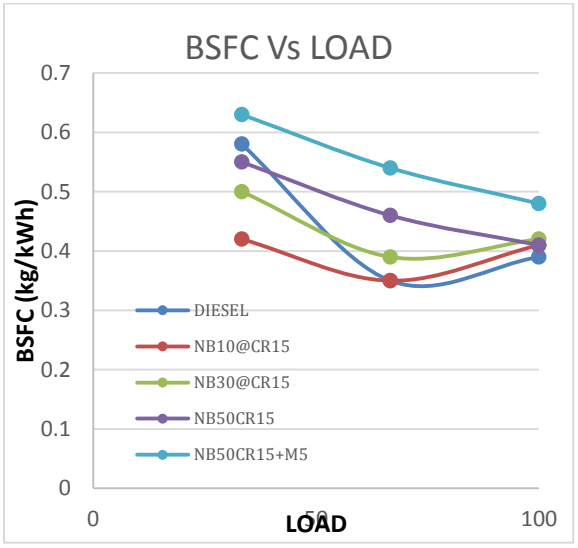
5.2 Brake Thermal Efficiency

The Figure shows the variation of the brake thermal efficiency of the test fuels with engine load. NB50+Methanol give highest efficiency than diesel at full load. The percentage increase in the value of brake thermal efficiency is higher at high load conditions.

This is due to the better combustion of the blends, owing to 10–12% dissolved oxygen content and the additional lubricity provided by the biodiesel content in the blends



5.3 Brake Specific Fuel Consumption



The variation in BSFC of the test fuels with respect to load is shown in figure. It is observed that the BSFC for all the test fuels are higher than that of the diesel at all loads. The BSFC for the blends NB50 without methanol at CR15 is closely to diesel. While the NB50+Methanol consumption of fuel is slightly more due to its lowest heating value.

6. Conclusion

The engine performance, brake specific fuel consumption, HC, CO, CO2, NOx of neem biodiesel on variable compression ratio engine were investigated.

- The brake specific fuel consumption of the methanol blend increases due to its lower heating value of alcohols.

- The brake thermal efficiency of NB50+Methanol having more efficiency than NB50.
- Increasing carbon monoxide, hydro carbons, carbon dioxide and nitrogen oxide effects a slightly difference than diesel while the NB50+Methanol possess more emissions due to the percentage of methanol.

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