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PERFORMANCE MEASUREMENT OF FOUR STROKE CI ENGINE USING PREHEATED NEEM BIO DIESEL

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ABSTRACT

B20 and B40 fuel with preheating show improvement in brake thermal efficiency by 24% and 10.54% respectively compared to diesel fuel. B20 and B40 fuel with preheating show decrease in BSEC by 20.49%, and 10.82% respectively compared to diesel fuel. EGT increases with increase in bake power for all fuels. B20 and B40 fuel with different preheating show decrease in CO emission by 1.8% and 2.7% respectively compared to diesel fuel. HC emission is decreased by 18%, 20.48% and 39.75% for B20 and B40 fuels respectively compared to diesel fuel at no load.

KEYWORDS: Four stroke CI engine.

INTRODUCTION

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. 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. 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. One of the major advantages of bio-diesel is the fact that it can be used in existing engines and fuel injection equipment with little impact to operating performance. Bio-diesel has a higher cetane number than diesel fuel. In over 15 million miles of in-field demonstrations bio-diesel showed similar fuel consumption, horsepower, torque and haulage rates as conventional diesel fuel. . Even bio-diesel level as low as 1% can provide up to 65% increase in lubricity in distillate fuels. One of the major advantages of bio-diesel is the fact that it can be used in existing engines and fuel injection equipment with little impact to operating performance. Bio-diesel has a higher cetane number than diesel fuel. 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.Using high % blends fuel system components (primarily fuel hoses and fuel pump seals) that contain elastomers compounds incompatible with bio-diesel.

OBJECTIVE

The objective of this research is to investigate effect of Neem bio-diesel blending with fuel preheating on performance and emission of multi cylinder, four stroke, water cooled, direct injection, CI engine by

Determining the relationship between pollutant concentrations in diesel engine exhaust and the percentage of Neem bio-diesel in fuel blends. Determining the relationship between diesel engine performance and the percentage of Neem bio-diesel in fuel blends with using different preheating blend.Determining the relationship between diesel engine performance and the percentage of Neem bio-diesel in fuel blends with using different preheating blend.

MATERIALS AND METHODS

Experimental setup

Experimental setup used is shown in figure 1. Engine specification, exhaust gas analyzer device and other details are discussed in following section. Also, cooling of hydraulic dynamometer is done with water circulation.

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3.1 Engine Specification

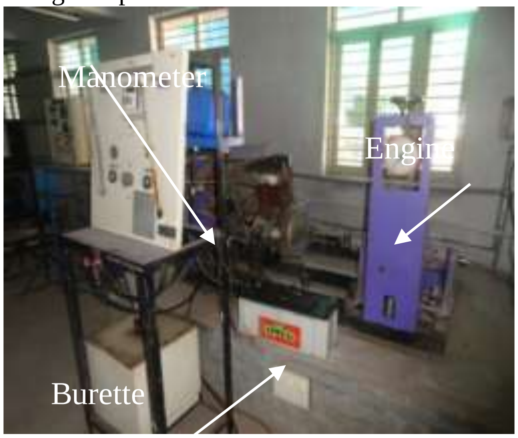

Figure 1. Engine Test Rig

Multi cylinder, four stroke, water cooled, direct injection CI engine is used for experimental purpose. Figure 1 shows the position of engine in experimental setup. Table 1 shows details of engine specification and other details of engine. Cooling water is circulated at constant flow rate.

Table 1. Engine Specification

Make & Model	Mahindra Engine MDI-3200
General Details	Four stroke, Four cylinder, Vertical, Compression Ignition, Water cooled, Direct injection.
Bore	90.9 mm
Stroke	92.4 mm
Firing Order	1-3-4-2
Lubricating Oil	SAE 20 / SAE 40
Max. Power	40 B.H.P.@ 3000 rpm.

3.2 Exhaust Gas Analyzer Specification

Figure 2. Exhaust Gas Analyzer

Table 2 Exhaust Gas Analyzer Specification

Emission Parameter	Range	Resolution
CO (%)	0-15.0	0.01
CO2(%)	0-20	0.01
	0-3000 (Propane)	1
HC (ppm)	0-15000(Hexane)	1
O2(%)	0-25.00	0.01

Exhaust gas analyzer shown in figure 2 is used for measurement of different pollutants. Indus made (model PEA 205) exhaust gas analyzer is capable to measure carbon monoxide, hydrocarbon, carbon dioxide, oxygen and nitric oxide range and resolution for each parameter is shown in table 2.

3.3 Temperature Measurement

To measure the temperature of the exhaust gas, thermocouple with digital indicator is used. The thermocouple is standard K-type thermocouple made from nickel-chromium and nickel-aluminium alloys in lead. The common K-type thermocouple has a temperature range between 0 ºC to 750 ºC. The thermocouple probe tip measures the temperature of the exhaust gas at its approximate center of outlet pipe

Figure 3 Thermocouple with Indicator

EXPERIMENTAL PROCEDURE

Experiments are carried out at constant engine speed of 1500 RPM. Load is varied by changing excitation of hydraulic dynamometer. Starting from no load observations are taken for each fuel at six different loads. Observations are taken at time when exhaust gas temperature remains steady. Various performance and emission parameters are measured at each load and test fuel are mentioned below. Using measured data, brake power, brake thermal efficiency, brake specific energy consumption are calculated for each test fuel including diesel.

Time taken for 20ml fuel consumption.

Exhaust Gas Temperature.

Load on Dynamometer

Carbon Monoxide

Hydrocarbon.

Engine performance with diesel is measured first followed by B20, B40, B60 and B100. Data measured and calculated thus used for comparison with mineral diesel. Sample calculation to calculate brake power, brake thermal efficiency and brake specific energy consumption are described in following section

RESULT

Effect of Bio-diesel blending with Preheating on CI engine

Engine Performance Parameters

Figures 4 and 5 shows variations in brake thermal efficiency with brake power, Neem bio-diesel blending with different additive.

Brake Thermal Efficiency

From figure 4 one can see effect of additive results in to higher brake thermal efficiency for all fuels. The reason behind this may be better mixing of fuel with air which leads to improvements in thermal efficiency. Due to preheating better mixing of fuel with air, combustion rate gets enhanced. Thus results in to higher brake thermal efficiency. Maximum brake thermal efficiency using diesel, B20 and B40 fuels are 39.79%, 49.342% and 43.986% respectively.B20 and B40 fuel with preheating show improvement in brake thermal efficiency by 24% and 10.54% respectively compared to diesel fuel.The reason behind this is in B20 blend which influences the conversion of thermal energy into work or increases the fuel conversion efficiency by improving the fuel ignition and combustion quality (complete combustion).

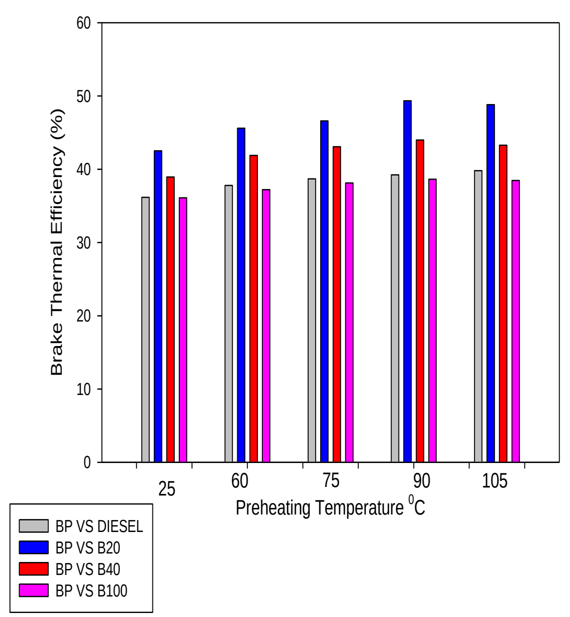

Figure 4 Variations in Brake Thermal Efficiency with Brake Power and Preheating at different temperature.

4.2 Brake Specific Energy Consumption

Figure 4. shows variations in brake specific energy consumption with brake power utilizing different fuels. As seen from figures 4 and 5, BSEC decreases with increase in brake power from no load. After reaching minimum value, the BSEC increases again for all fuels. This is due to good combustion ability, reliable viscosity and good wear properties. Inbuilt oxygen content, lower kinematic viscosity and lower combustion duration compared to diesel may be major contributor for lower BSEC. As load on engine increases temperature inside cylinder increases which results in tends to complete more combustion of fuel. Hence, BSEC shows decreasing trend for increasing brake power or load. Figure 5 show variations in BSEC with brake power for B20, B40 and B100 fuels. Minimum BSEC for B20 fuel is achieved is 7.296 MJ/kWh at brake power of 25.423 kW. Minimum BSEC using diesel, B20, B40 and B100 fuels are 9.177 MJ/kWh, 7.296 MJ/kWh, 8.184 MJ/kWh and 9.317 MJ/kWh respectively. B20 and B40 fuel with preheating show decrease in BSEC by 20.49%, and 10.82% respectively compared to diesel fuel.

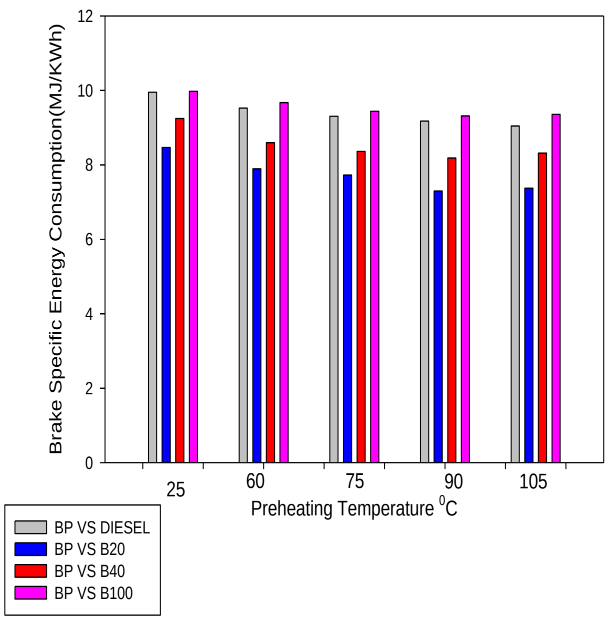

Figure 5Variations in Brake Specific Energy Consumption with Brake Power Preheating at different temperature.

4.3 Exhaust Gas Temperature

Figure 6 show variation in exhaust gas temperature with brake power using various fuels. As seen from figures 6 EGT increases with increase in bake power for all fuels. Maximum EGT is reached at brake power of 25.42 kW for all fuels. Figure 6 shows variations in EGT with brake power for diesel, B20, B40 and B100 fuels. Maximum EGT found is 425 °C, 414 °C, 420 °C and 434 °C for diesel, B20, B40 and B100 fuels respectively. , B20, B40 and B100 fuel with different preheating temperature show reduction in exhaust gas temperature by 2.5%, 1.1% and 1.8% respectively compared to diesel fuel.

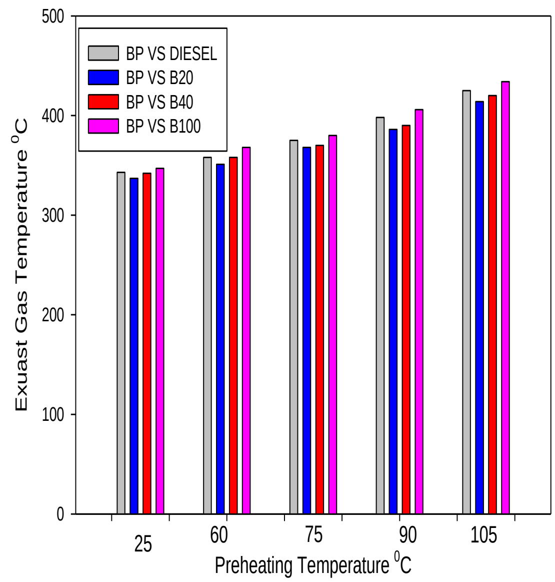

Figure 6 Variations in Exhaust Gas Temperature with Brake Power and Preheating at different temperature.

Engine Emission Parameters

4.4 Carbon Monoxide

Figure 7 shows variations in CO emission with brake power using various fuels. As shown in figures 7 emissions of CO decreases with increase in brake power from initial no load condition for all fuels. The reason behind may be lower cylinder temperature at no load condition results in to incomplete combustion of fuel. With increase in brake power cylinder temperature rises and hence due to more complete combustion of fuel emissions of CO decreases. The reasons behind this are same as discussed during CO emission of Neem bio-diesel blends. In spite of increasing oxygen content of fuel with high Neem bio-diesel percentage, CO emission found little more at high brake power mainly due to high rate of fuel injection, larger droplet diameter and poor spray characteristic of Neem bio-diesel fuel. Figure 7 shows variations in CO emission with brake power for diesel, B20, B40 and B100 fuels. Minimum amount of CO emission is achieved for diesel, B20, B40 and B100 fuels are 0.0208 %/Vol., 0.02042 %/Vol., 0.02012 %/Vol., and 0.02024 %/Vol. respectively at brake power of 25.42 kW. B20 and B40 fuel with different preheating show decrease in CO emission by 1.8% and 2.7% respectively compared to diesel fuel.

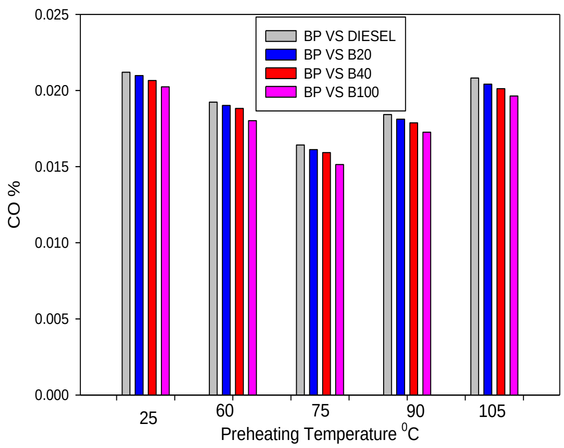

Figure 7 Variations in Carbon Monoxide Emission with Brake Power and Preheating at different temperature.

4.5 Hydrocarbon

As shown in figure 8 emissions of HC decrease with increase in brake power for all fuels. Emission of HC decreases because of better mixing of fuel and air. Figure 8 shows variations in HC emissions with brake power for diesel, B20, B40 and B100 fuels. At no load, amount of HC emission for diesel, B20, B40 and B100 fuels are 8.3 ppm, 6.8 ppm, 6.6ppm and 5 ppm respectively. HC emission is decreased by 18%, 20.48% and 39.75% for B20 and B40 fuels respectively compared to diesel fuel at no load.

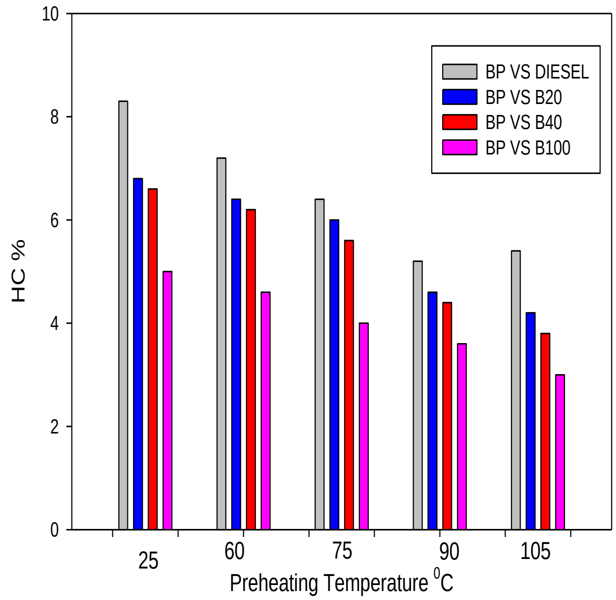

Figure 8 Variations in Hydrocarbon Emission with Brake Power and Preheating at different temperature.

CONCLUSION

The following are the conclusion from the results obtained after experimentations while running four cylinder, four stroke, direct injection diesel engine fuelled with blends of Neem bio-diesel and diesel with and without different preheated. The results obtained were compared with diesel fuel. Neem bio-diesel has comparative properties to diesel. Neem bio-diesel has 10.17 % lower energy content than diesel. Maximum power produced using pure Neem bio-diesel can be less compared to diesel because of lower calorific value. Neem bio-diesel has 180% higher kinematic viscosity compared to diesel. Due to higher kinematic viscosity, Neem bio-diesel requires higher injection pressure than diesel to obtain lesser diameter droplet. Minimum emission of CO with diesel, B20, B40 and B100 fuels are 0.0348 %/Vol., 0.0327 %/Vol., 0.0327 %/Vol. and 0.0330 %/Vol. respectively at brake power of 10.16 KW. Among all compared fuels, CO emission for B20 is lowest followed by B40, diesel and B100. At maximum brake power of 25.42 kW, emission of CO with diesel, B20, B40 and B100 fuels are 0.055 %/Vol., 0.058 %/Vol., 0.059 %/Vol. and 0.0651 %/Vol. respectively. CO emission with B100 fuel is 30% higher compared to diesel fuel. B20X1, B20X2 and B20X3 fuel with different additives show decrease in CO emission by 7%, 6% and 6.6%

respectively compared to diesel fuel. CO emission with B40X1, B40X2 and B40X3 fuel with different additives are lower by 7%, 6% and 6.6% respectively compared to diesel fuel

Highest HC emissions for diesel, B20, B40 and B100 fuel are 12 ppm, 11 ppm, 10 ppm and 9.5 ppm respectively at no load. While using B100 fuel emission of HC reduces approximately half the value of HC emissions using diesel fuel. HC emission is decreased by 5%, 4.5% and 4.8% for B20X1, B20X2 and B20X3 fuels respectively compared to diesel fuel at no load. HC emission is decreased by 17%, 17% and 17.3% for B40X1, B40X2 and B40X3 fuels respectively compared to diesel fuel at no load.

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