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Experimental investigation on Performance and Emission Characteristics of J20, P20, N20 Biodiesel blends and Sound Characteristics of P20 Biodiesel blend Used in Single Cylinder Diesel Engine

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Abstract-Present work provides the effect of biodiesel blends and Sound Characteristics of P20 Biodiesel blend compared with Performance and emission Characteristics of diesel. Methods and analysis biodiesel blends was prepared by the Transesterification Process. Experiments were conducted in single cylinder constant speed direct injection diesel engine for various test fuels. Research is mainly focused on pongamia oil .It was observed that a 20% Pongamia oil blends and its properties were similar to diesel. The results showed that 20% Pongamia oil blends gave better performance, less in noise and emission compared with ester of Jatropha and neem oil blends. Hence Pongamia blends can be used in existing diesel engine without compromising the engine performance.

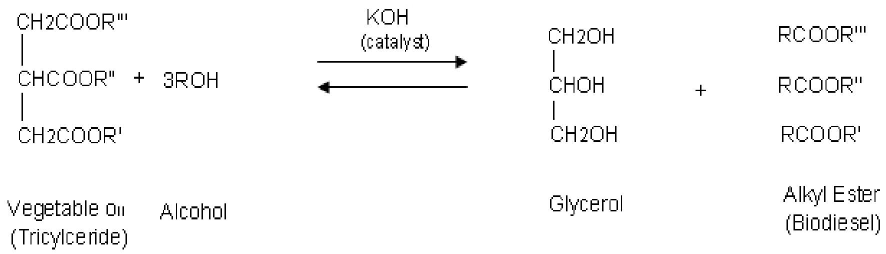
1. Introduction:

The demand of petrodiesel is resend days due to depletion of fossil fuels. The substitute source of vegetable oil biodiesel blends can be used in CI engines. The various properties and performance of different biodiesel blends of cotton seed methyl ester and neem oil methyl ester compared to diesel fuel. C20 biodiesel blend results are closer performance to diesel [1]. Biodiesel has been found as an alternative fuel for compression ignition engine because of increased performance and reduced emission. The waste cooking oil methyl ester (WCO) biodiesel has similar results to that of diesel. Brake thermal efficiency, carbon monoxide emission, hydrocarbon emission, and smoke emission are lower compared to pure diesel and specific energy consumption and oxides of nitrogen is higher compared to diesel [2].The depleting petroleum fuel resources increase the price of fuel continuously. The various biodiesel fuels identified and tested successfully. The performance and emissions of different rubber seed oil (RSO) biodiesel blend compared with diesel. B30 biodiesel blend are closer performance and lower emission compared to diesel [3].Direct use of neem oil is problem for diesel engine because of very high viscosity. Esterified neem oil different biodiesel blends are tested in compression ignition engine. The experiment concluded that B20 biodiesel blend gave better performance and lower emission because of extra amount of oxygen present in the blend [4] [5] various properties of B20 biodiesel blends shown in table1.

Table1. Properties of Diesel and Bio-diesel Oils

PROPERTIES	DIESEL	J20	P20	N20
Calorific Value(kJ/kg)	43000	41600	41300	35125
Flash Point (0c)	50	57	56	68
Viscosity(cst)	3.9	4.3	4.1	4.7
Density (kg/m3)	840	860	850	920
Cetane number	50	54	52	57

1.1 Procedure For Transesterification Process:



The required amount of catalyst pellets (NaOH / KOH) is quickly weighed, shielding it as much as possible from atmospheric moisture and carbon di-oxide. The pellets are quickly transferred to the dry mixture grinder to convert into powder form. The powdered form of catalyst and solvents (methanol) solution is then vigorously shaken in a conical flask for homogeneous mixing. At this point dissolved catalyst (NaOH) is presumed to have been converted into potassium/sodium/ ethoxide/ methoxide. A fixed quantity of solvent and catalyst solution is poured into the oil to mark the beginning of the reaction. Once the reaction reaches the preset reaction time, heating and stirring are stopped. Once the reaction period is over, the product is permitted to settle overnight. Two different liquid phases are identified. Crude esters at the top and glycerol phase at bottom. That is bio diesel process turns the oil into esters, extrication out the glycerol. The glycerol sinks at the bottom and the bio diesel float on top and can be siphoned off. The crude ester phase is separated and glycerol phase is then washed by warm de-ionized (double distilled) water for four times and water becomes clear. So no need for further wash. The excess methanol and water in the ester phase is removed (or recycled) by evaporation under atmospheric condition after being measured for product yield calculation.

1.2 Description of Engine setup:

Figure 1. Experimental setup

The Kirloskar engine is one of the widely used engines in agricultural, transport-vehicles, pump sets, small and medium scale commercial purposes. Further, the necessary modification on the cylinder head and piston crown can be easily carried out in this type of engine. Hence this engine is selected for present research work.

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A single cylinder, four stroke compression ignition engines with a displacement volume of 661 cc, compression ratio of 17.5:1, and developing 5.9kW at 1800 rpm was used for the present study. The specifications of the engine are given in table 2. Variable load tests are conducted for no load, 25%, 50%, 75% and 100% power output at a constant rated speed of 1800 rpm, with fuel injection pressure of 200 bars and cooling water exit temperature at 600 C. The injection timing recommended by the manufacturer was 270 bTDC. The governor was used to maintain constant speed under varying load conditions. Experimental setup is shown in fig1.2 and engine specifications shown in table 2.

Table2. Technical specifications of engine

Manufacturer	Kirloskar oil engines ltd, pune, india
Type of Engine	Vertical,4Stroke cycle, Single acting, Single cylinder, high speed compression ignition diesel engine
Speed	1800 rpm
Rating at 1500 rpm	5.2 kw
Bore (B) & Stroke (S)	87.5 & 110
Compression Ratio	17.5:1
Fuel Injection Timing	27˚ BTDC
Method of Cooling	Water cooling
Injection pressure	200-205 bar

2. Result and Discussion:

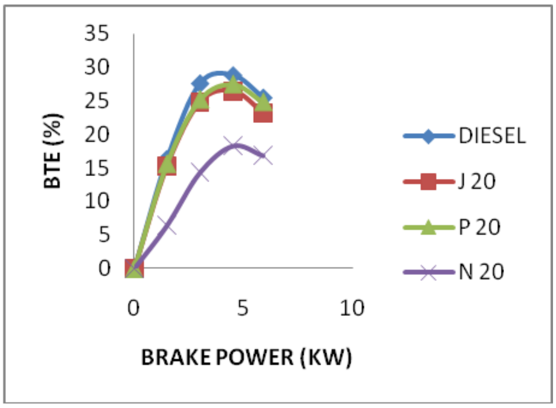

Figure 2. Variation of BTE with BP

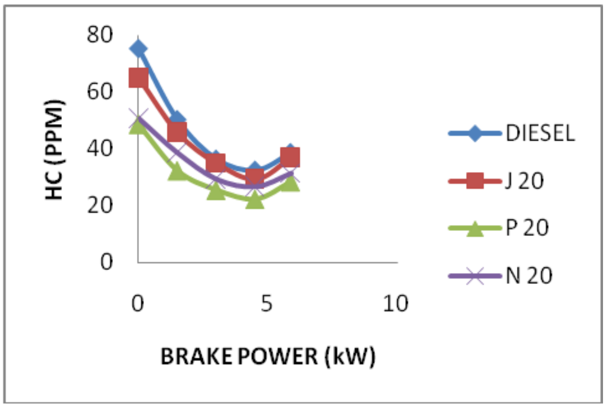

Figure 3. Variation of HC with BP

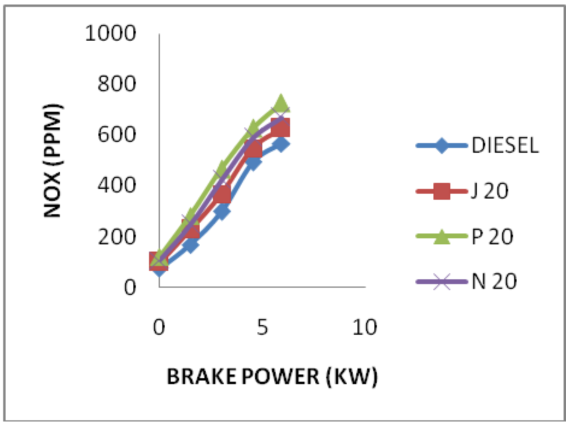

Figure 4. Variation of NOX with BP

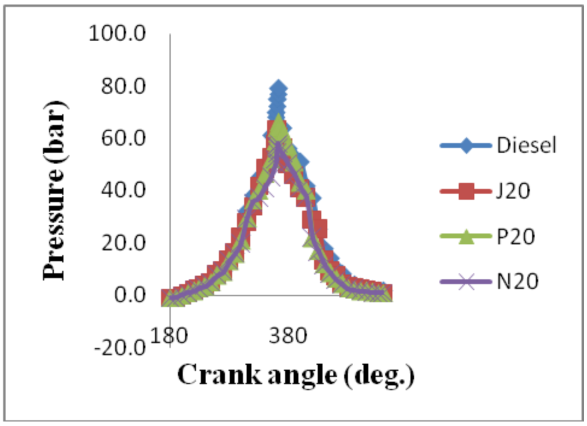

Figure 5. Comparison of Pressure with crank angle

In Figure 2, a slight drop in efficiency was found with methyl esters (biodiesel) when compared with pure diesel. This drop in thermal efficiency must be attributed to the poor combustion characteristics of methyl esters due to high viscosity. It was experimental that the brake thermal efficiency of B20 methyl ester of Pongamia methyl ester (MEOP) had better brake thermal efficiency than compared with the methyl esters of Jatropha and Neem. So B20 can be suggested as best blend for biodiesel preparation with Pongamia oil.
Figure 3 shows the comparison of HC emissions for diesel, J20, P20 and N20 at standard engine specification. The experimental results show that for all the blends, the HC emissions were lower at part load, but increases with increase in load. The HC emission for pure diesel at maximum load was 38.7 ppm, where it was decreased by 4.7%, 26.1% and18.61% for J20, P20and N20 blend. This may be due to the fact that all the biodiesel contain oxygen in their chemical composition. This favors comparatively better combustion for biodiesel when compared with diesel
Figure 4 shows the comparison of NOX emissions for pure diesel, J20, P20 and N20 at standard engine specification. The experimental results show that for all the blends, the NOX emissions were lower at part load, but increases with increase in load. As stated, the presence of oxygen in the biodiesel has led to complete combustion of biodiesel better than diesel. As a result, the adiabatic flame temperature inside the cylinder is more in case of biodiesel than pure diesel. Hence this catalyzes the reactions for oxidation of nitrogen and hence NOx emissions are more for diesel. The NOx emission for diesel at maximum load was 567ppm, where as it is more by 10.58%, 28.04% and 17.98 % for J20, P20 and N20 blend. This is due to the fact that all the biodiesels contain little nitrogen when compared with pure diesel.
Figure 5 shows the comparison of cylinder pressure for pure diesel, J20, P20 and N20 at standard engine specification. The Peak pressure for neat diesel was 79.24 bars, whereas at decreases by 20.24%, 16.45% and 26.57% for J20, P20 and J20 blend. This is due to the increased calorific value and decreased viscosity of diesel compared to biodiesel which leads to complete combustion. Among the bio diesel blends, the peak pressure was obtained for P20 blend. This may be due to the reduced viscosity and increased calorific value which leads to better combustion compared to other biodiesel blends.

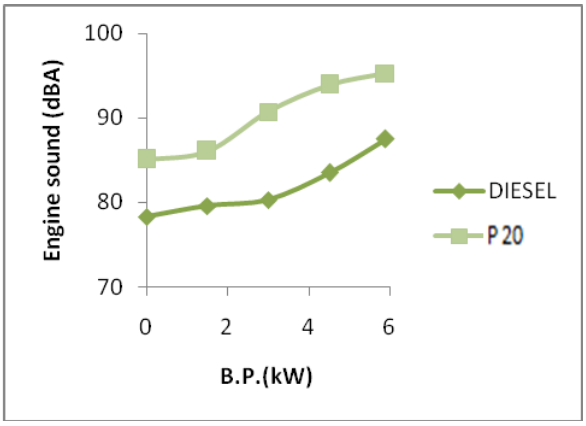

Figure 6. Variation of Engine sound (dBA) with B.P.

Figures 2.5 show the variations of engine sound in degree dBA with brake power for MEOP and its blends with diesel at an injection timing of 270bTDC .In general, the engine sound level is increased with increase in load. The engine sound level at 270bTDC is 95.3 dBA. This may be due to large drop let size of the fuel compared to diesel.

3. Conclusions:

From the conclusions of present investigation are drawn, Brake thermal efficiency of P20 bio-diesel is very close to pure diesel because fuel properties like viscosity, flash and fire point, calorific value are closer to diesel. HC emission for P20 blend is very less when compared to pure diesel. This may be due to higher oxygen content of bio-diesel. NOx emission for P20 blend is very high. This may be due to high adiabatic flame temperature at the end of combustion and higher oxygen content compared to pure diesel. Peak pressure for P20 blend is very close to diesel because of slightly higher viscosity and lower calorific value compared to pure diesel. Noise of P20 blend is lower compared to diesel, because of slower heat release rate and lower max pressure rise compared to pure diesel.

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