EVALUATION OF EMISSION CHARACTERISTICS AND PERFORMANCE STUDY OF BIODIESEL DERIVED FROM COMPOSITE OILS FROM WASTE COOKING OIL AND JATROPHA OILS ON A COMPUTERIZED C.I ENGINE

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ABSTRACT

It is seen that large progress has been made in the concept of vegetable oils used as alternative fuels for CI engines. In this work composite oils of waste cooking oil and Jatropha oils is mixed with various proportions is used for the investigation. Investigations are the influence of injection pressure of 180 bar on the performance, emission and combustion characteristics of methyl ester of composite oils of waste cooking oil and jatropha oil and diesel blends. A single cylinder diesel engine is used to conduct experiments at a constant speed of 1500rpm under variable load conditions. The experimental results of performance characteristics like brake thermal efficiency, exhaust gas temperature, and emission characteristics like HC, CO, and CO_2 levels are recorded and compared with that of diesel and optimized.

Keywords: Composite oils,biodiesel,Jatropha oil,Waste cooking oil,Transesterification

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1. Introduction:

Biodiesel as an alternative fuel for diesel engines is becoming increasingly important due to diminishing petroleum reserves and the environmental consequences of exhaust gases from petroleum-fuelled engines. As a future prospective fuel, biodiesel has to compete economically with petroleum diesel fuels. The availability and sustainability of sufficient supplies of less expensive feedstock will be a crucial determinant delivering a competitive biodiesel to the commercial filling stations. In the past years, vegetable oils such as rape seed oil and soybean oil are used as feedstock for production of biodiesel in many countries. However, the price of vegetable oils in recent years has grown dramatically, which will lead to higher biodiesel production costs. One way of reducing the biodiesel production costs is to use less expensive feedstock containing fatty acids such as non-edible oils, animal fats, waste food oil and by-products of the refining vegetables oils.

Jatrophacurcas, a non-edible oil-bearing and drought-hardy shrub with ecological advantages, belonging to the Euphorbiaceous family.

Biodiesel is widely produced from oil extracted from Jatropha. The main aim of selection of this plant oil is for utilization of wastelands to sustainable use, conserve ecosystem and biological diversity. It is a non-edible plant that grows mostly in tropical countries. It is proved to be drought resistant. They can be easily be planted and propagated and has very high yielding capacity.Waste cooking oil is used vegetable oil as collected from pubs, restaurants and chip shops, which is the principle ingredient for our fuel. Modified Used Vegetable Oil is a special form of bio-fuel made from waste vegetable fat, which has been cleaned and specially treated with added organic oils and solvents so that it can be used in normal diesel engines, without significant modification.

2. Materials and Methodology

The physical and chemical properties of composite oil of Waste cooking oil and Jatropha oils were measured. The calorific value was measured by Bomb Calorimeter, The viscosity was measured by Redwood Viscometer, The flash point and fire point were determined by Pensky-Martens apparatus by closed-cup method. Before Transesterification the properties of waste cooking oil and Jatropha oils is as shown in the table below.

Composite oils of Waste cooking oil and Jatropha oils is collected and blended for various proportions and are treated with adequate amount of CH_3OH (methanol)and required amount of NaOH (sodium hydroxide) as a catalyst which are available in chemical laboratories. Since these oils are of high viscosity and low volatility, then direct use of feedstock in diesel engines can cause problems including: high carbon deposits, scuffing of engine liner, injection nozzle failure, and gum formation, lubricating oil thickening and high cloud and pour points. In order to avoid these problems, the feedstock is chemically modified to its derivatives which have properties more similar to petro-diesel. The free fatty acids (FFA) and triglycerides contained in the oil are reduced to Fatty Acid Alkyl Esters (FAAEs). This process is known as

Transesterification. Here, we are conducting transesterification process in single stages for the production of biodiesel.

Transesterification process is affected by parameters like amount of methanol, concentration of sodium hydroxide (NaOH), reaction temperature and reaction time. One of the most important variables affecting the yield of biodiesel is the molar ratio of alcohol to vegetable oil used. In the present work we have optimized all these variables.

Table1:Properties of Composite oils of Waste cooking oil and Jatropha oils

Oil ratio	Flash point in ^{0}C	Fire point in ^{0}C	Viscosity	Calorific value KJ/kg
J90-W10	255	270	32.01	39678
J80-W20	260	268	31.59	39167
J70-W30	134	155	30.21	41625.16
J60-W40	121	141	28.86	38095.69
J50-W50	105	125	28.68	38526.93

Table2:Properties of biodiesel after transesterification

Bio-Diesel	Gross calorific value in KJ/Kg	Viscosity at 40^0 C in CST	Flash point in ^{0}C	Fire point in ^{0}C
J90 W10	40775.24	5.68	151	163
J80 W20	36617.75	5.54	157	172
J70 W30	38256.12	5.86	164	178
J60 W40	37856.12	5.76	170	186
J50 W50	40653.2	5.66	177	195

Engine Specifications

Type	Four stroke
Make	Kirloskar AV-1
Bore	80 mm
Stroke	110 mm
Swept volume	553 cc
Cylinder capacity	624.19 cc
Dynamometer	Electrical, Swinging Field Resistive Loading
Cylinder Pressure	By Piezo Sensor, Range: 5000 psi
Compression ratio	16:1 to 25:1
Rated Power	3.75 KW @ 1500 RPM
Loading Type	Direct current generator, Voltage 140 V, Max current 23 amps
Torque, Fuel Flow	By transducers and Digital SensorsAir Flow & Water Flow
Cooling System	Water cooled

Description of the Test Rig

The Test-Rig consists of four stroke Diesel Engine, which is connected to the electrical swinging field dynamometer with the resistive loading.

The DC machine is used as motor for starting the engine. Once the engine is started with the changeover of the switch to the generator mode, it will act as s DC generator which is connected to the resistive Load Air heaters. The engine and the dynamometers are coupled by a coupling.

The exhaust of the engine is connected to the exhaust gal calorimeter. Provision has been made for the following measurements in the test rig. The complete set up is mounted on Anti Vibration Mounts

Engine testing procedure

- Diesel level in the tank is checked an alternate parallel connection of a biodiesel tank is provided to the switch between fuels conveniently.
- Water is left to flow through the Piezo sensor, engine head and the calorimeter by operating valves.
- Mains of the control panel and console are switched on.
- Air flow and torque indicator are calibrated and set to zero.
- Engine is initially started using DC drive and once started, wait for the speed to stabilized.
- Then the fuel is switched to biodiesel by operating valve.
- The engine is left run for a while till the combustion process occurs with the biodiesel.
- Using the loading switch, engine is loaded for different loads.
- The required performance parameters are calculated automatically with the help of the computer.
- Computer shows the readings directly for the applied load including various graphs.
- The tests are conducted for various blends.

RESULTS AND DISCUSSIONS

Performance characteristics of diesel engine

The tests were conducted for 0% load to 100% load condition at 5 various blends from B10 to B50 and its comparison of brake thermal efficiency, indicated thermal efficiency, mechanical efficiency, brake specific fuel consumption for mixed biodiesel with diesel fuels were observed The experiments were conducted at various blends of biodiesel for studying the efficiency of bte ,,bsfc,me on the performance of the diesel engine using jatropha as a major oil with waste cooking oil i.e., J90-W10 means jatropha 90% and waste cooking oil 10%.. The results obtained at various blends of methyl esters of jatropha and waste cooking oil is compared with diesel fuel.

Brake Specific fuel consumption

The Figures 1 to 5 shows the variation of BSFC with various loads for various proportions .Figure shows the brake specific fuel consumption (BSFC) variation for the mixed biodiesel fuel blends and neat diesel with respect to brake power. It is observed that increase in load decreases the specific fuel consumption, we observed for the blend J60-W40 B30 the specific fuel consumption is less i.e., for B30 is 0.29 and for diesel is 0.35 and decreased by 17.1%.

In general, the BSFC values of the blends were slightly lower than those of the diesel fuel at all engine loads. Higher blending is needed to produce the same amount of energy due to its higher specific gravity and lower heating value in comparison to diesel fuel.

The engine emission characteristics using methyl ester of composite oil of Jatropha and Waste cooking oil.

To check the emission levels of the pollutant parameters an emission test was conducted by a certified testing laboratory .Emission check for carbon di-oxide (CO_2), Carbon monoxide (CO), hydrocarbon (HC) were conducted and compared with that of diesel

The emissions of CO increase with increasing load (Fig 6). Higher the load, richer fuel–air Mixture is burned, and thus more CO is produced due to lack of oxygen. At lower loads, CO emissions for mixed blended oil are close to mineral diesel. Jatropha –Waste cooking oil composite oil blends exhibit lower HC emissions compared to diesel (Fig. 8). It can be observed that HC emissions increase with increasing proportion of Jatropha oil in the blends.

Carbon monoxide

It is interesting to note that the engine emits more CO for petro-diesel as compared to mixed JWME blends under all loading conditions It is seen from Fig. 6 that the CO concentration is low compared to diesel for the blends of J60P40B30 i.e. for blend B30 is 0.03 and for diesel is 0.05 and it is improves by 40% over diesel. At lower mixed JPME concentration, the oxygen present in the mixed JPME aids for complete combustion. However, as the JPME concentration increases, the negative effect due to high viscosity and small increase in specific gravity put down by force the complete combustion process which produces small amount of CO.

Carbon dioxide

The carbon dioxide emission from the diesel engine with different blends is shown in Fig 7. The CO_2 increased with increase in load conditions for diesel and for biodiesel blended fuels. The mixed jatropha and waste cooking oil biodiesel followed the same trend of CO_2 emission, which was higher than in case of diesel. . Blends B30 emit very low emissions compared to diesel, for blend J60-P40B30 is 1.6 and for diesel is 2.3 and it is low by 30.4% compared to diesel. This is due to the fact that biodiesel in general is a low carbon fuel and has a lower elemental carbon to hydrogen ratio than diesel fuel.

Hydro carbons

Figure 8 indicates the hydrocarbon emission trends for diesel and mixed biodiesel blends at different engine loads. As the cetane number of ester based fuel is higher than diesel, it exhibits a shorter delay period and results in better combustion. Therefore, oxygen content and cetane number of the mixed biodiesel blends leads to lower hydrocarbon emissions as compared to diesel fuel. For blend of J60-P40B30 the lowest HC emission obtained for B30 is 16 and for petro-diesel 27 and lowered by 40.7% compared to diesel.

NO_X

Figure 9 indicates the NOx emission based on temperature trends for mixed biodiesel blends and diesel at different engine loads. The increase in the local temperature and the oxygen concentration within the fuel spray envelope at increasing power level favours the increase in NOx emissions. The NOx emissions of the blend were slightly higher than those of the diesel fuel at both full and partial loads. The higher temperatures of combustion and the presence of fuel oxygen with the blend caused higher NOx emissions. The less exhaust temperature for the blend J60-P40B30 is 286^0Cand for diesel is 403^0C and NOx is lowered by 29.03% over diesel. The reason may be due to late burning of blends of MEJW-Diesel during expansion. The reason for decrease in NOx with respect to esterified mixed Jatropha and waste cooking oil with Diesel may be due to sustained and prolonged duration of combustion associated with reduction in combustion temperature the exhaust gas temperature increased with increase in load and amount of blended biodiesel in the fuel. The exhaust gas temperature reflects on the status of combustion inside the combustion chamber.

The reason for raise in the exhaust gas temperature may be due to ignition delay and increased quantity of fuel injected. The exhaust gas temperature can be reduced by adjusting the injection timing/injection pressure in to the diesel engine

Performance Graphs

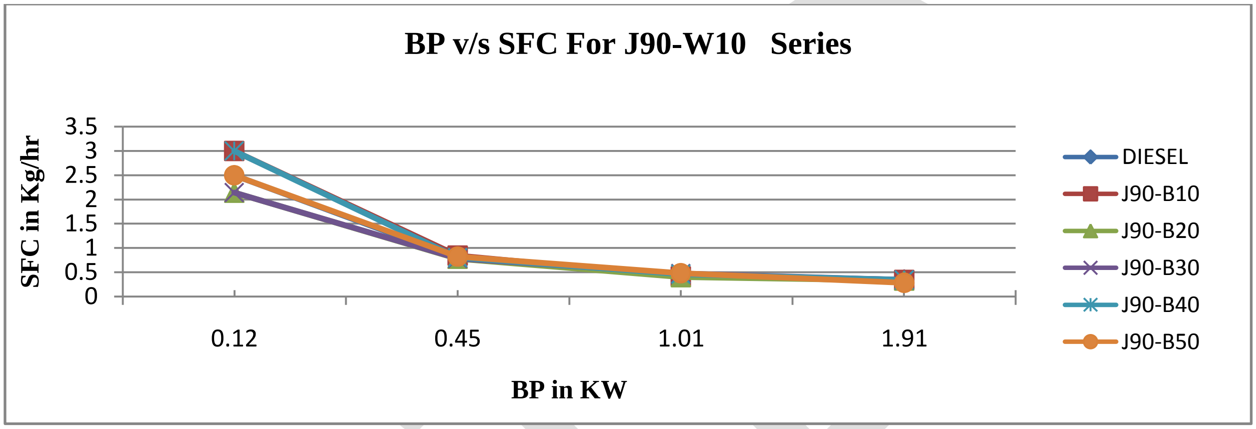

Figure 1: BP v/s SFC For J90-W10 Series

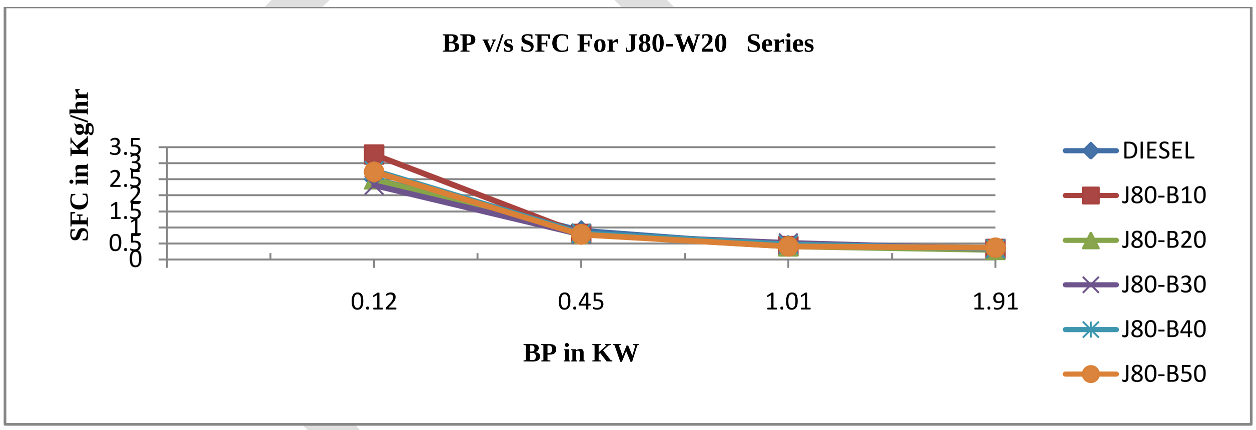

Figure 2: BP v/s SFC For J80-W20 Series

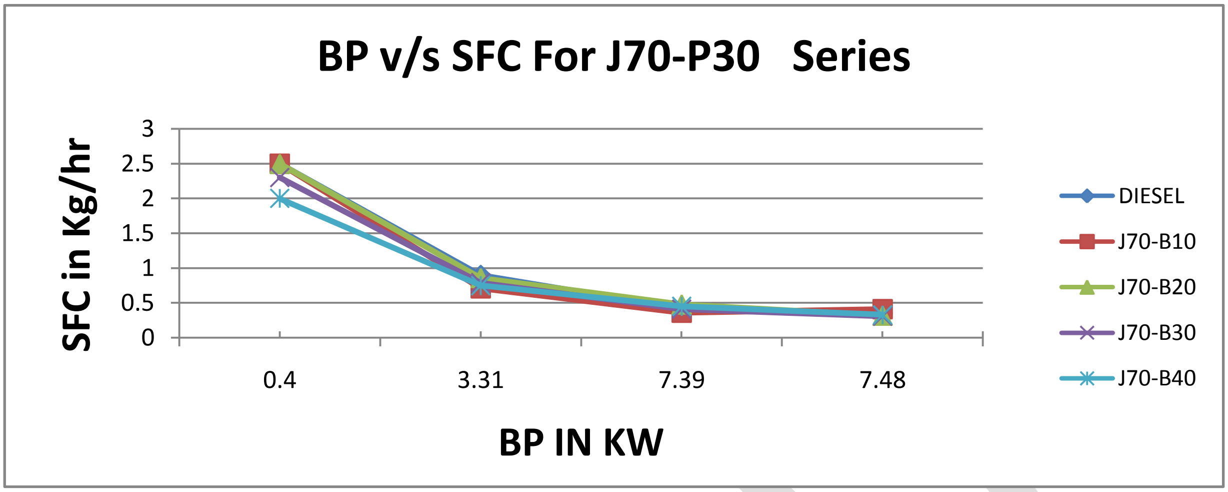

Figure 3: BP v/s SFC For J60-W40 Series

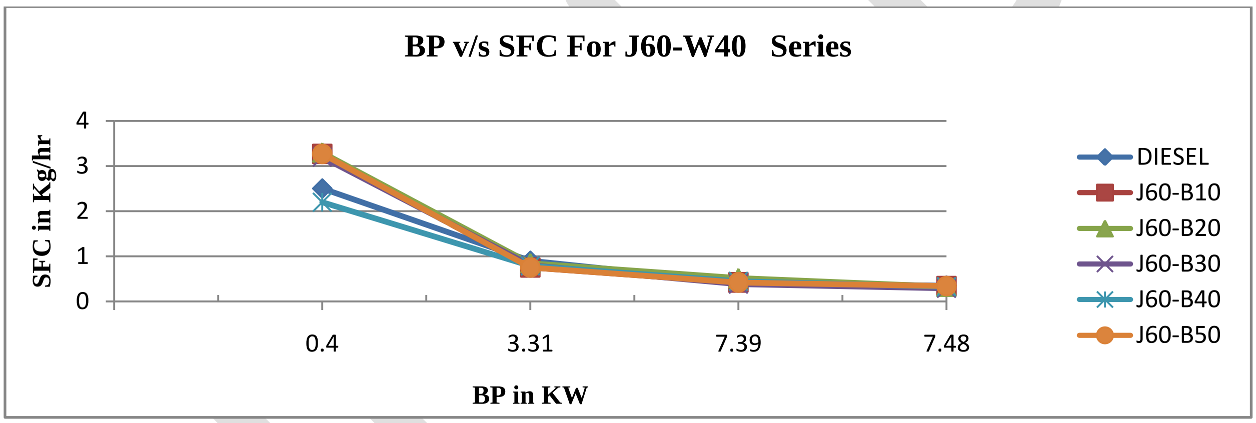

Figure 4: BP v/s SFC For J60-W40 Series

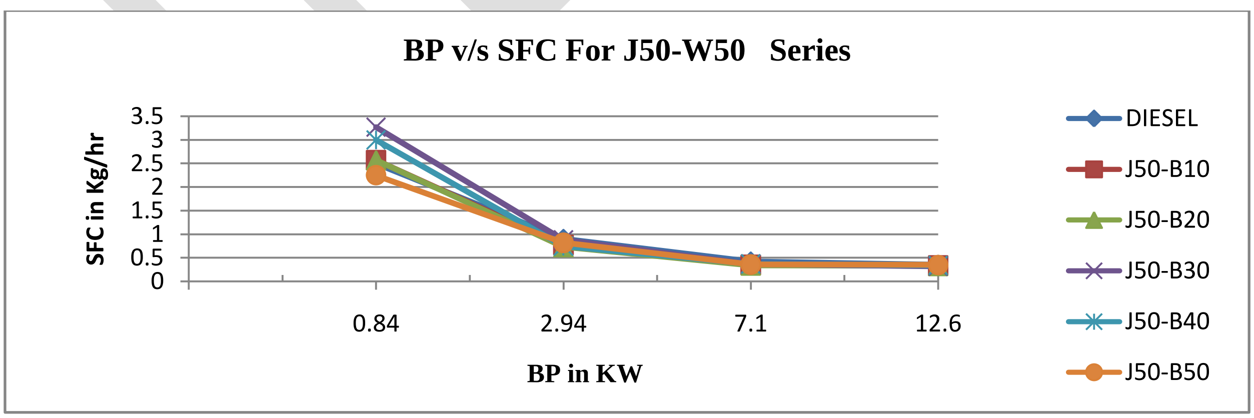

Figure 5: BP v/s SFC For J50-W50 Series

Emission Test Graphs for blends J90-P10 to J50-P50(J-Jatropha oil,P-Waste cooking oil)

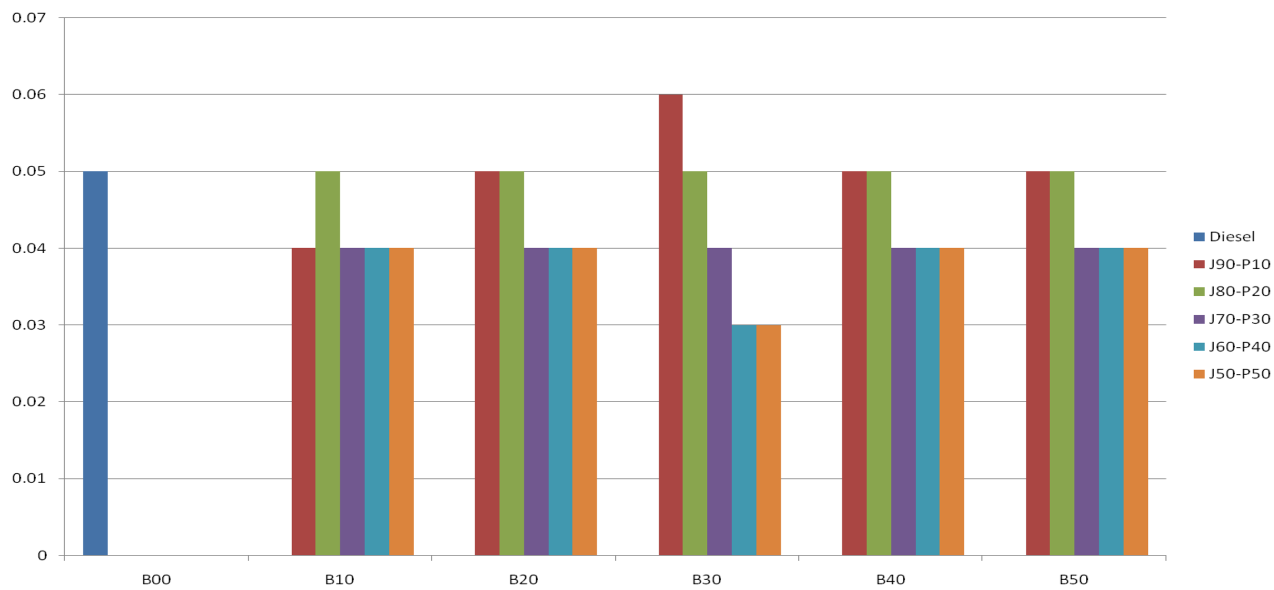

Figure 6: Emission test comparision of CO (in %) for different blends

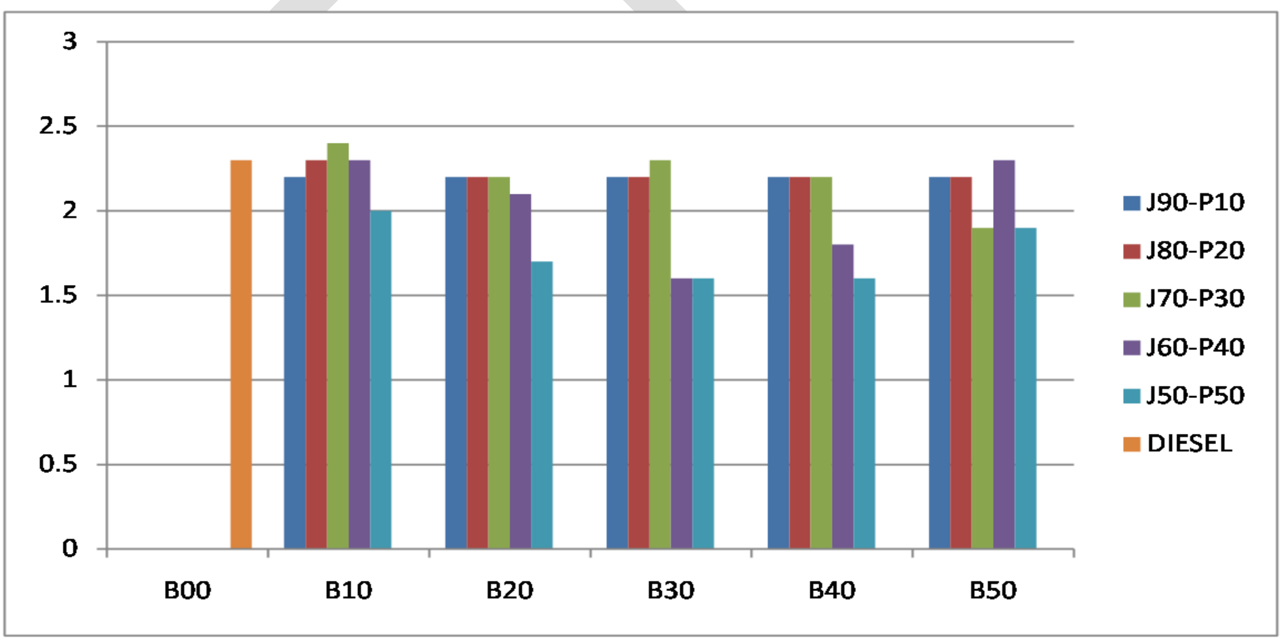

Figure 7: Emission test comparision of CO_2 (in %) for different blends

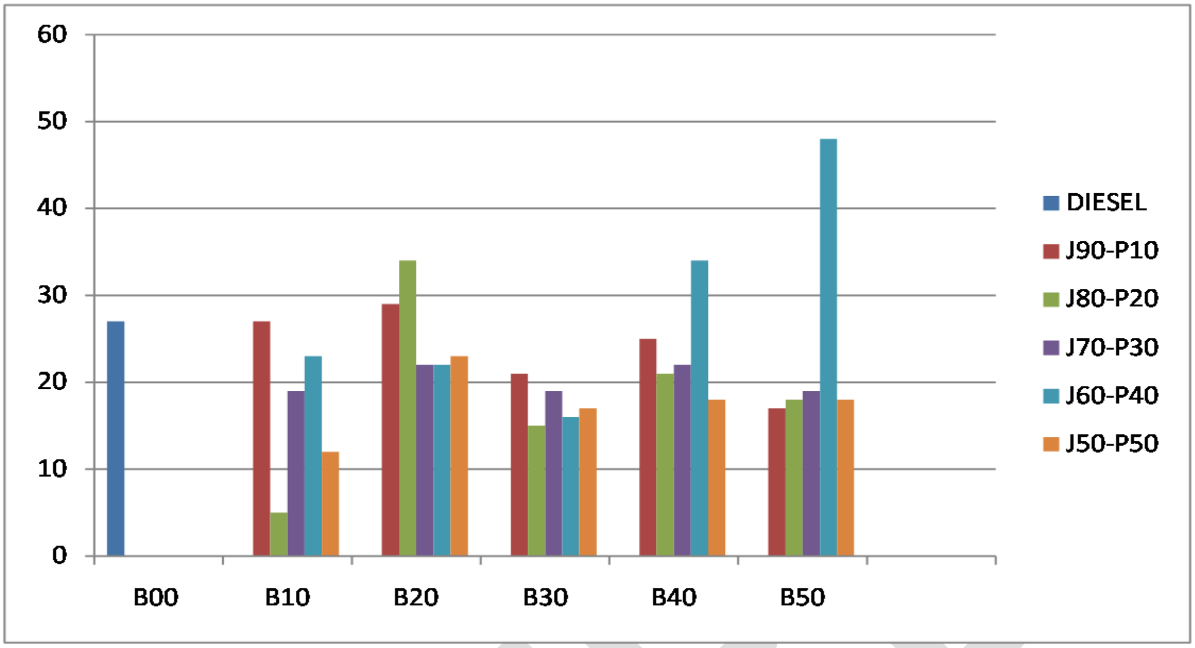

Figure 8: Emission Test Comparison of HC (In ppm) for different blends

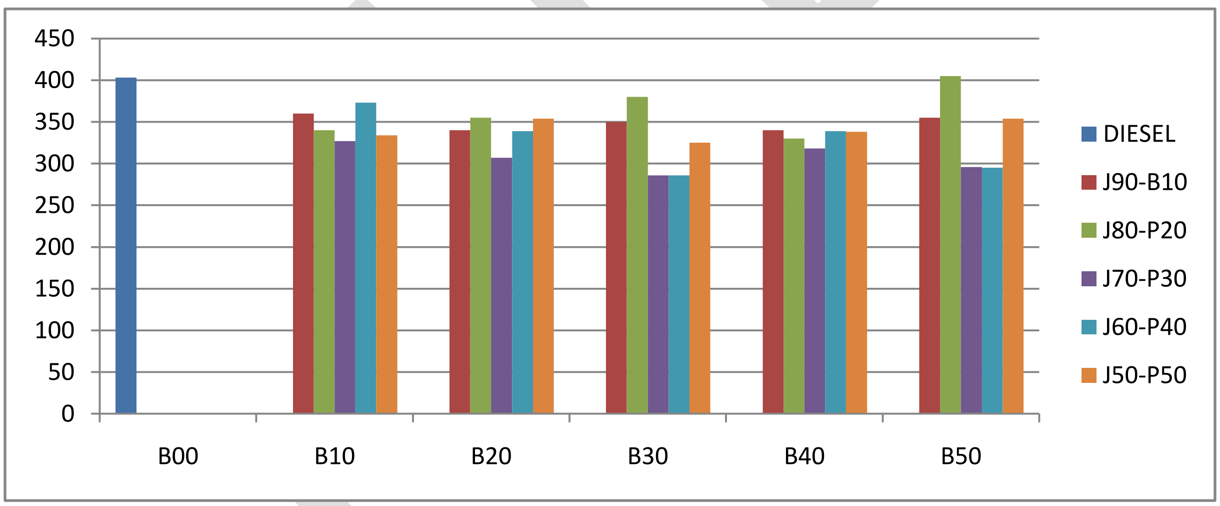

Figure 9: Emission test comparision of NO_X (based on exhaust temp)

Conclusion

Based on the exhaustive engine tests, it could be concluded that the blends of ME-mixed with diesel fuel up to 50% by volume could replace the plain diesel for running the existing diesel engine without any modifications and 30% blend of mixed Jatropha and Waste cooking oil oil ester at full load condition with diesel fuel was found to be the best blend in regard to performance and emission characteristics compared to all other blends considered. Also it could be concluded that the biodiesel reduces the environmental impacts of transportation, reduce the dependence on crude oil imports and offer business possibilities to agricultural enterprises for periods of excess agricultural production. Finally it could be concluded that the blends of B30 - mixed Jatropha-Waste cooking oil Methyl Ester with diesel are found to be a potential alternative fuel to diesel fuel. Since its physical properties are close to those of diesel fuel which is also a renewable source of energy and it can be right solution for India.

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J-Jatropha oil,W-Waste cooking oil ME-methyl esters P-waste cooking oil,bte-brake thermal efficiency,NO_X-oxides of nitrogen