The Impact of High And Low Cetane Fuel Blends on Combustion, Performance And Emissions of Compression Ignition Engine

Abhishek Raghuwanshi[2], Dr. Irshad Ahmad Khan[2]
[1]Dept of Mechanical Engineering
[2]Assosicate Professor, Dept of Mechanical Engineering
[1, 2] Sagar Institute of Research & Technology, Bhopal (M.P)

Abstract- *Energy is an essential input for economic growth, social development, human welfare and improving the quality of life. Since their exploration, the fossil fuels continued as the major conventional energy source. With increasing trend of modernization and industrialization, the world energy demand is also growing at a faster rate. Non-eatable (Jatropha Curcas), Karanja (Pongamia Pinnata) and Polanga (Calophyllum Inophyllum) oil-based biodiesel were created and mixed with regular diesel having sulphur content less than 10 mg/kg. Many studies indicated that waste tires can be used to extract energy from them. Pyrolysis is the process through which it is possible. In this current work, four fuel blends were prepared with fuel obtained from tire pyrolysis oil, jatropha biodiesel and diesel. Test information were created under full/part choke position for constant i.e. 1500 rpm. Change in exhaust discharges were additionally investigated for deciding the ideal test fuel at different working conditions.*

Keywords- Engine performance analysis; Biodiesel; Thermochemical process; Energy from waste

I. INTRODUCTION

Energizes of bio-root give a plausible answer for the twin emergencies of "petroleum product consumption" and "natural corruption" by subbing the petrol energizes utilized in interior ignition motors. The powers of bio-starting point might be liquor, vegetable oils, biomass, and biogas. A portion of these energizes can be utilized straightforwardly though others should be planned to bring the pertinent properties near customary fills. A significant research exertion has been coordinated toward utilizing vegetable oils and their subsidiaries as powers for diesel motors. Nonedible vegetable oils in their regular structure, called straight vegetable oils (SVO); methyl or ethyl esters known as treated vegetable oils; and esterified vegetable oils, alluded to as biodiesel, fall in the classification of bio energizes. There exist several vegetables/plants that produce oil and hydrocarbon substances as a piece of their characteristic digestion. These vegetable oils from oil seeds harvests like soybean, sunflower, groundnut mustard, and so on and oil seed from tree root have 90-95% of the energy worth of diesel on a volume premise, tantamount cetane number, and can be subbed 20-100% [1-3]. The status of energy as per world data is given in Fig.1.

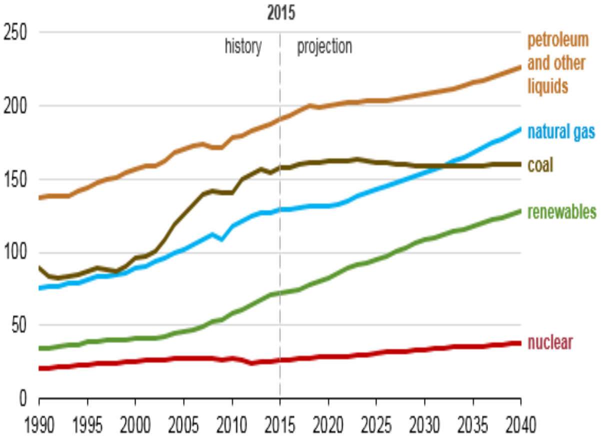

Figure 1. World Energy Status

The idea of utilizing biofuels in diesel motors was started from the show of the main diesel motor by the innovator of diesel motor "Rudolf Diesel" at the World Exhibition in Paris in 1900 by utilizing nut oil as a fuel. Be that as it may, because of bountiful inventory of petro-diesel, R&D exercises on vegetable oil were not truly sought after. It got consideration as of late when it was understood that petrol fills were diminishing quick, and climate agreeable sustainable substitutes should be recognized [4]. In the new year's, genuine endeavors have been made by a few specialists to utilize various wellsprings of energy as fuel in existing diesel motors. The utilization of straight vegetable oils is confined by some horrible actual properties, especially their thickness. Because of higher thickness, the straight vegetable oil causes helpless fuel atomization, deficient burning and carbon statement on the injector and valve seats bringing about genuine motor fouling. It has been accounted for that when direct infusion motors are run with perfect vegetable oil as fuel, injectors get teared up following not many hours and lead to helpless fuel atomization, less proficient ignition and weakening of greasing up oil by somewhat consumed vegetable oil [5]. The waste tyre to energy technique has been described by using Fig.2.

Figure 2. Waste Tire To Energy

The gross calorific worth and different properties were found to be like that of diesel oil. This paper means to clarify the plausibility of delivering tire pyrolysis oil and check whether it can be utilized as substitute fuel in diesel motors.

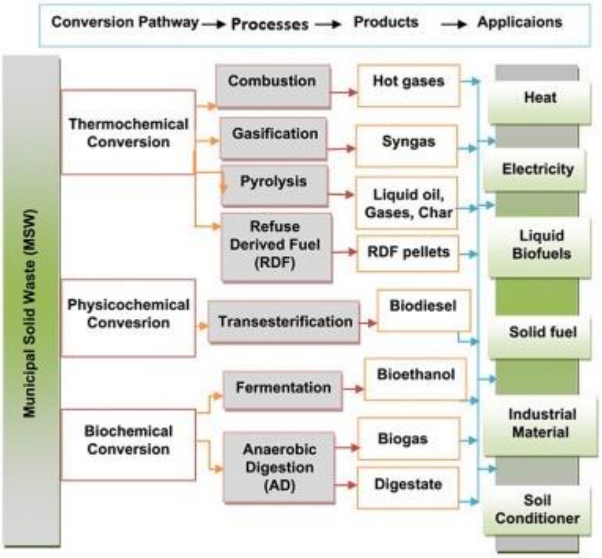

Figure 3. Thermochemical Process

II. FUEL PREPARATION

Two fuels were used in this investigation. One is fuel derived from waste tires which was produced from pyrolysis process. Pyrolysis is another and possible application to recuperate esteem added items from any strong or fluid waste substances. It is the warm corruption of a substance in complete nonattendance of oxygen or presence of lacking oxygen. An endeavour has been made to deliver pyrolysis oil from squander tires under vacuum pyrolysis. Even though strong carbon dark and pyrolysis gas are additionally acquired, the pyrolysis cycle will be substantially more conspicuous to deliver fluid. The second fuel was produced through transesterification process through which Jatropha oil was converted in to biodiesel. The schematic diagram is shown in figure 3.

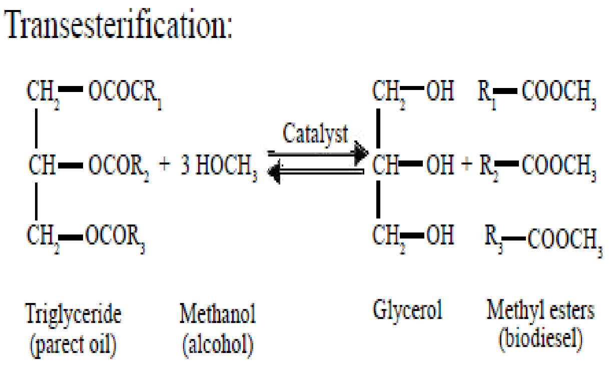

Figure 4. Transesterification Reaction

The other test fuel was derived by the pyrolysis process. The feedstock was used tires. Both the fuels were blended with diesel to get test fuels for the current study.

III. EXPERIMENTATION

Tests have been conducted in a diesel engine to test different types of fuels. The specifications of test engines are given in Table 1. Figure 2 shows the schematic diagram of the experimental set up.

Table 1. Engine Specifications

Make/Model	Kirloskar AV 1
Rated Output	3.72 kW
Rated Speed	1500 rpm
Bore	80 mm
Stroke	110 mm
Compression Ratio	16.5:1
Cooling Method	Water cooled
Engine Position	Vertical
Injection Timing	23° BTDC
Number of Cylinder	Single
Nozzle Type	Multi hole
Ignition Technique	Compression Ignition

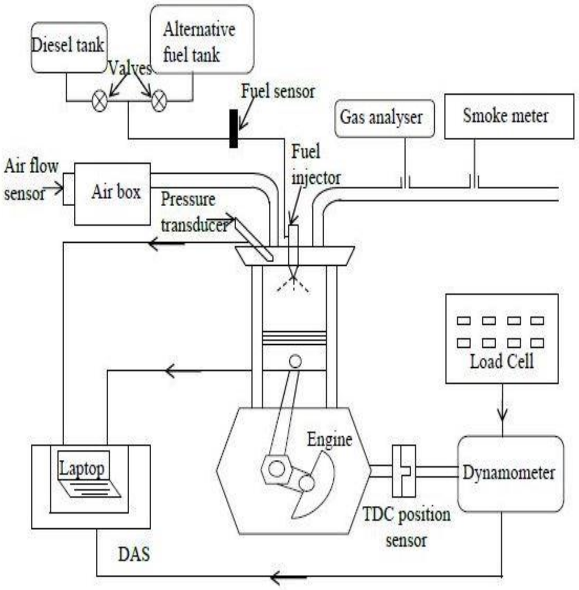

Figure 5. Experimental Setup

IV. RESULTS AND DISCUSSION

This section discusses the results of the performance and emission parameters obtained from the test engine run on diesel, JB and different diesel-JB-TPO blends.

4.1 Ignition Delay

The ignition delay is evaluated as the time difference measured in the crank angle between the start of injection and the start of ignition. This may be due to the higher cetane number of JB, which gives better ignition quality. In addition to this, the presence of oxygen results in improved chemical reactions and more complete combustion. The values of ignition delay for diesel, JB, D90, D80, D70 and D60 are 13.62, 12.47, 13.11, 10.14, 12.80 and 13.67 ˚CA respectively at full load.

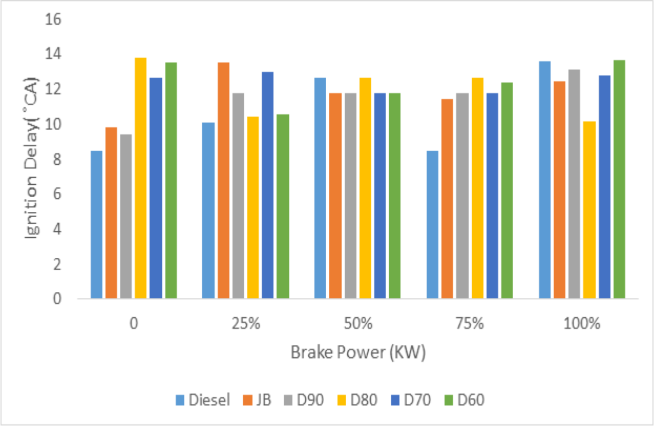

Figure 6. BP vs ID

4.2 Combustion Duration

The combustion duration is described as the time duration required by the combustion process to reach 90% of its mass fractions burned This may be attributed to the oxygen content of JME which improves the oxidation and ensures the completion of initial stage of diffusion combustion in the fuel rich zones and results in higher in-cylinder temperatures. At full load, the values of the combustion duration for diesel are 41.23 ˚CA, while the values are 41.3, 39.91, 40.51, 42.30 and 39.61 ˚CA for JB, D90, D80, D70 and D60 respectively.

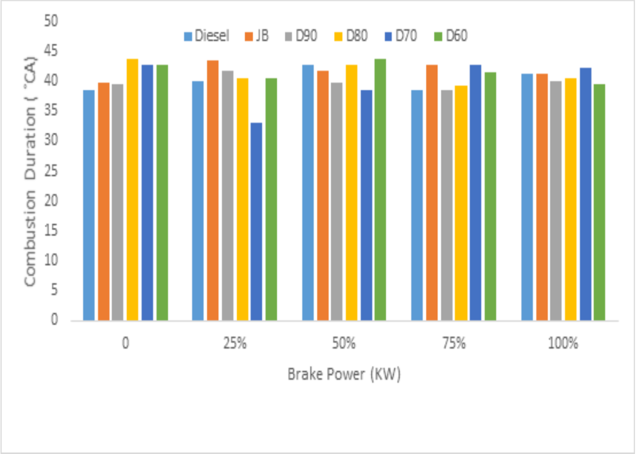

Figure 7. BP vs CD

4.3 Cylinder Peak Pressure

The maximum cylinder pressure is the highest for diesel, than that of JB and its TPO blends at full load. The reason is that more diesel fuel is accumulated in the delay period as a result of longer ignition delay. The maximum cylinder pressures for diesel, JB, D90, D80, D70 and D60 at full load operation are approximately 84.89, 79.61, 85.21, 80.51, 79.30 and 79.31 bar respectively.

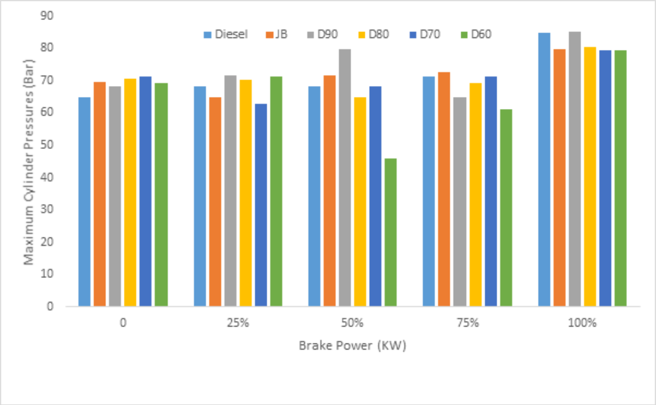

Figure 8. BP vs CPP

4.4 Rate of Pressure Rise

The maximum rate of pressure rise (dp/dθ)max in an engine combustion chamber has a substantial impact on the maximum cylinder pressure and smoothness of the engine operation. The maximum rate of pressure rise is higher for diesel at full load. This is due to the fact that, ignition delay period of diesel is longer than JB and the premixed heat release is higher for the diesel fuel operation. The maximum rates of pressure rise are 7.89, 5.61, 5.21, 6.51, 6.30 and 6.31 bar/˚CA for diesel, JB, D90, D80TPO10JB10, D70 and D60 at full load respectively.

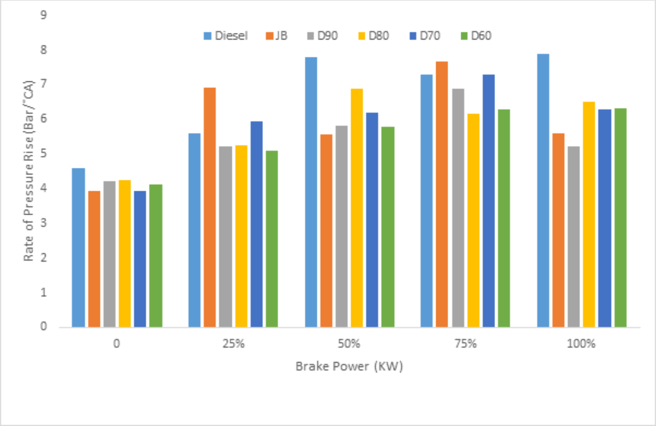

Figure 9. BP vs RPR

4.5 Brake Thermal Efficiency

The brake thermal efficiency reflects quality of combustion and provides comparable of assessing how efficient the energy in the fuel was converted to mechanical power output. The brake thermal efficiency for diesel is 27.89% at full load, which is the highest among all the fuels tested in this study. For JB, D90, D80, D70 and D60, it is 25.61, 25.21, 26.51, 26.3 and 27.51% respectively at full load.

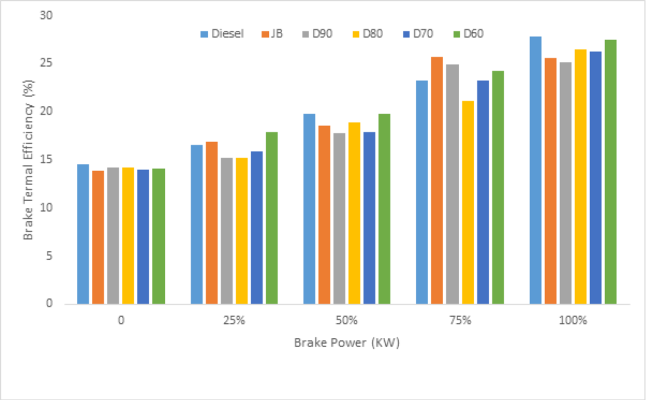

Figure 9. BP Vs BTE

4.6 Brake Specific Energy Consumption

The brake specific fuel consumption is not a reliable factor when two fuels of different calorific values and densities are blended together. The brake specific energy consumption (BSEC) is described as the multiplication of the BSFC and lower calorific value of the fuel. The BSEC for diesel is by about 11.59 MJ/kWh at full load. For the fuels JB, D90, D80, D70 and D60, it is 10.92, 11.21, 12.25, 11.94 and 12.11 MJ/kWh respectively.

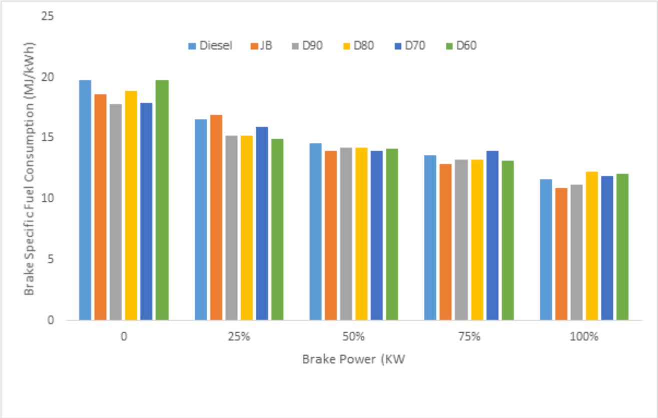

Figure 10. BP vs BSC

4.7 Exhaust Gas Temperature

The exhaust gas temperature gives an indication about the amount of heat going waste with the exhaust gases. The exhaust gas temperature value for diesel at full load was 323 ˚C. It can also be observed that the values of the exhaust gas temperature are found to be about 340, 330, 317, 325, and 328 ˚C for JB, D90, D80, D70 and D60 respectively at full load.

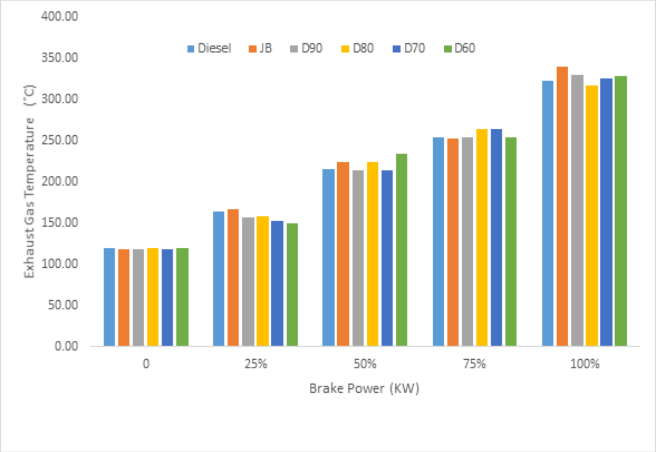

Figure 11. Variation of EGT With BP

4.8 Carbon Monoxide Emission

Carbon monoxide (CO) emission is an intermediate combustion product and is formed mainly due to incomplete combustion of fuel. If combustion is complete, then CO is oxidized to CO2. If the combustion is incomplete due to shortage of air or due to low gas temperature, CO will be formed. Usually, the CO emission of diesel engines is low, because diesel combustion is occurred with lean mixture and has an abundant amount of air. The values of BSCO emission for diesel, JB, D90, D80, D70 and D60 are 0.073, 0.066, 0.045, 0.063, 0.058 and 0.050% respectively, at full load operation.

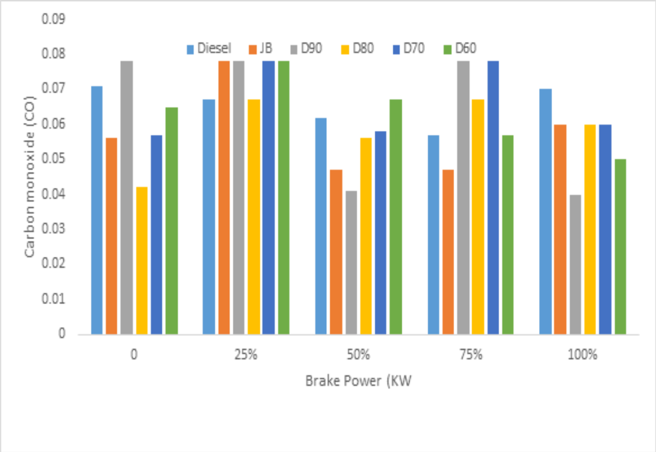

Figure 12. Variation of CO With BP

4.9 Hydrocarbon Emission

Hydrocarbon (HC) emission is product of incomplete combustion. Thus at higher engine loads, the higher combustion temperature promotes more complete combustion and hence less HC emission. The HC values for diesel, JB, D90, D80, D70 and D60 are 13.11, 13.56, 16.78, 16.42, 12.97 and 10.60 ppm at full load.

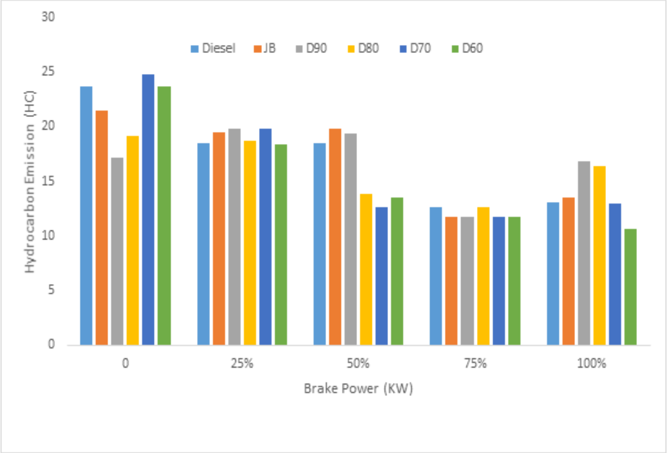

Figure 13. Variation of HC With BP

4.10 Nitric Oxide Emission

Two important factors affecting the formation of nitric oxide (NO) in a CI engine are the combustion temperature and the availability of oxygen The values of NO emission for diesel, JB, D90, D80, D70 and D60 are 423, 580, 530, 517, 525 and 528 ppm respectively, at full load operation.

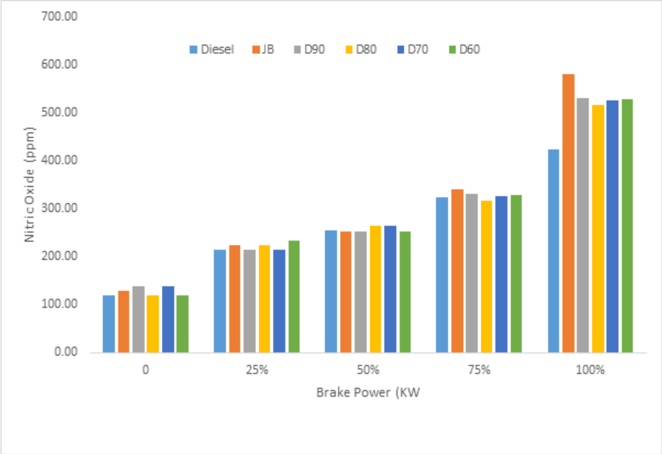

Figure 16. Variation of NC With BP

4.11 Smoke Opacity

Smoke opacity strongly depends on engine load and is the result of incomplete combustion which is formed in the rich mixture zone in the combustion chamber. The smoke opacity values for diesel, JB, D90, D80, D70 and D60 are by about 88.23, 75.62, 87.12, 94.56 96.3, and 85.12% respectively, at full load.

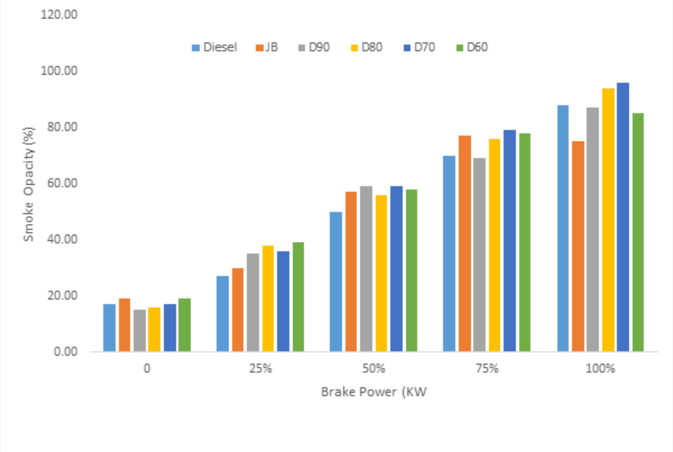

Figure 17. Variation of SO With BP

V. CONCLUSIONS

In this research study we have done test on a diesel engine to check the use of fuel obtained by pyrolysis process. The summary of the tests are given below.

- On the whole it is concluded, that the D60 blend can be used as fuel in a diesel engine directly, without any engine modification. The D60 blend gives the optimum result compared to the other blends.
- It is found that the ignition delay for D60 is almost equal to that of diesel at full load operation.
- The combustion duration for diesel is 38.34 ˚C A at full load. It decreased by about 0.62˚CA for the D60.
- The cylinder peak pressure lowers by about 6 bar for D60 in comparison with diesel at full load.
- At full load, the brake thermal efficiency is almost the same, i.e., 27.89% and 27.51% for D60 and diesel respectively, at full load.
- The EGT is higher for D60 compared to that of diesel at full load.
- The BSEC for diesel is 11.59 MJ/kWh at full load. The BSEC increased by about 4.29 % for D60 , than that of diesel operation at full load.
- The CO, HC and smoke emissions were lower by about 28.57%, 19.14% and 3.5% respectively for D60, compared to diesel at full load.
- Nitric oxide emission was higher by about 24% for D60, in comparison with diesel at full load.
- Overall, by considering the combustion, performance and emission parameters, it can be concluded that the D60 blend showed a better performance and lower emissions compared to those of other Diesel- Tier Pyrolysis Oil -Jatropha biodiesel blends.

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