*Research Article*

# Combustion Characteristics Of Waste Cooking Oil Bio Diesel On Four Stroke Diesel Engine Using Additives

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**Abstract:** Transport is one of the petroleum and then pollutant most dependent sectors. A new generation of biofuels is under consideration, But usage should be reduced of current ones. The use of cooking oil can be interesting alternative fuels for diesel engines in some unique applications (i.e., public transportation, hybrid or marine propulsion, etc.). The Motor Bio-diesel diesel powered motor's performance and emission properties are highly affected by the ignition and combustion behavior. Combustion properties were studied in this analysis when the engine operating in two different dimensions (B20+1, B20+2) using a combination of different additive solvents (i.e. Isopropyl). The engine was found to have difficulty starting with pure cooking oil because of its high viscosity so that the combination with the diesel is finished. Biodiesel for performance testing was prepared and used for diesel engine.

**Keywords:** combustion, ignition, trans esterification, isopropyl alcohol.

## 1. Introduction

Diesel motors are the main sources of power generation, marine use, etc. While they have a relatively higher fuel efficiency than their spurt, the pollution and noise level are relatively higher. This is the reason why diesel is widely used, however as there is an immediate need for appropriate alternative fuels to use C.I due to the gradual depletion of fossil fuel supplies and the environmental effects of rising exhaust emissions. Motors.Motors. Biodiesel is a petroleum fuel substitute.Biodiesel is a plant or animal oil which is permanently diluted with a viscosity around that of the normal diesel fuel No. 2. Biodiesel is the petrol, since it is mainly made of biodegradable matter and can be used as diesel fuel. Biodiesel may also be used in boilers or furns intended for the use of heating oils or lighting equipment fuelled with oil. It can be used neatly, that is to say 100% biodiesel, or mixed with diesel petroleum.

The aim is to explain how people can make bio-diesel to supply the die dialect machinery on a farm or ranch with fuel. Please note that biodiesel that is used on public roads, just as petroleum diesel is subject to federal, state and regional taxes. In any amount, from one to several gallons, biodiesel can be generated. A batch process suitable for an Individual farmer or rancher has been identified. For plants processing biodiesel steady flow processes are better suited. Since small bugs are better than large bugs, people interested in making bio gasoline may want to start with small lots and work to make bigger lots. [2-5]

Since the very first generation of a Diesel engine, using biodiesel as an energy source has long been recognized. Biodiesels are non-toxic and biodegradable. They have low emission profiles, are sustainable and are thus beneficial to the climate. As a non-toxic, biodegradable and sustainable substitute diesel fuel, vegetable esters are attracting growing attention. These esters are referred to as "biodiesel." The properties of finished biodiesel are primarily based on foodstuffs which are produced and have many benefits from vegetable oils and animal fats, such as renewability, energy-efficiency, no-toxicity, sulfur-free and biologically biodegradable.

## 2.Diesel Engine:

The Diesel engine is a combustion engine used to set the chemical fuel on a combustion chamber, as in a cylinder by using compression heat. An IC Engine is the motor in which the combustion occurs inside the motor. Besides all the other cycle activities, i.e. work carried out within the engine, compression and heat rejection occur, thus an IC engine is a complete facility.

Biodiesel is a fuel which can be made from vegetable oil and animal fats that is organic, non-toxic, biodegradable and ecofriendly. It can be used either directly or in mixed form in all forms of compression ignition engines. The biodiesel engine has lower levels of pollutants like soot, THC, $CO_2$, CO, particulates (PM), sulphur oxides (SOx), polycyclic hydrocarbons (carcinogenic polycycles) and polycyclic aromatics (PAH). Biodiesel is an oxygenated fuel, and thus its combustion is stronger than mineral diesel, which leads to lower emissions of toxic pollutants than mineral diesel.

## 3.Production Of Bio-Diesel

For most industrial biodiesel products, a chemical process called transesterification is used. It can be combined with alcohol in the presence of a catalyst such as sodium hydroxide or potassium hydroxide (usually methanol or ethanol). It creates methyl esters and ethyl esters such as biodiesel and glycerins if methanol is added (if ethanol is applied). Methanol is normally used for economic purposes, according to a report by Idaho University, because its physical and chemical characteristics are "comparable."

### 3.1.Additives:

#### 3.1.1.Iso-Propyl

Colourless, flame retardant liquid, and chemical compounds are the iso-propyl alcohol with heavy odour. The Iso-propyl group is connected with a group of hydroxyls. This is the simplest example of secondary alcohol, in which two carbon atoms are joined together to contain alcohol carbon. Its 1-propanol and ethyl-methyl-ester structural isomer.

**Formula: $C_3H_8O$**

**Density:** 786 kg/m$^3$ **Molar Mass**: 60.1 g/mol

**Boiling Point:** 82.5 ºC **Melting Point:** -89 ºC

**Flash Point:** 11.7 ºC (Open cup), 13 ºC (Closed cup)

**Auto ignition Temperature**: 399ºC

## 4.Literature Review:

**PremKumar and Indraj Singh** (2015) in their paper explained about Assessment of biodiesel production and output from cooking waste oil. A basic transesterification method of waste cooking oil generates 97.15 percent biodiesel yield. In addition, the experimental study shows the same biodiesel properties as diesel fuel obtained from waste cooking oil.

**Zhang.Y et.al (2019)** in his work investigated the effect on the fuel droplet combustion from the biodiesel mixture and the diesel fuel droplet. Besides the clean diesel and biodiesel, biodiesel blends replacing diesel oil at various volumetric concentrations were examined. Speed schlieren and imagery techniques for tracking the combustion of droplets have been used.

**Lu H et.al (2007)** in his paper explained thatthe combustion properties of Qilianta coal and rice straw are analysed in different proportions with Pyris l TGA ThermogravimetricAnalyser (PE/US). The results show that the ignition temperature and times decrease after the biomass is applied to the charcoal. The heating rate increases when the sample is combined in the same volume.

**D.Shin et.al.(2004)** in his paper explained about Usage of a flowing fluidised bed sludge (ICCFBC) internally cycloneda paper mill for a sludge. Operating parameters, including water content, sludge fuel supply and the ratio of secondary injection into air, varied to understand the effect of CO, CxHy and NOx emissions on combustion efficiency studied.

## 5.Experimental Setup:

### 5.1.Production of Bio Diesel

The most common process used to produce Bio diesel is known as **Transesterification Process**.

#### 5.1.1.Transesterification

Transesterification of vegetable oils, animal fats and waste cooking oil is the process behind conventional biodiesel. When a catalyst is present, a glyceride reacts to fatty acid alkyl esters and alcoholic beverages with alcohol (usually methanol or ethanol)

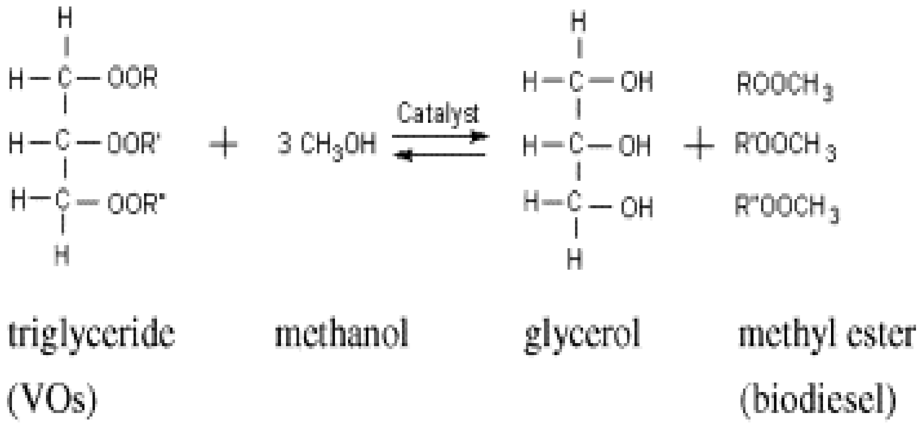



**Fig.1.** Transesterification process

**5.1.2.Biodiesel Preparation Process:-**

**a.** Initially take a beaker of capacity of 500 ml or more. Take 400ml of oil and heat it in magnetic stirrer. Place the magnetic pellet inside the beaker and maintain the speed below 500 RPM. Check the temperature of oil using thermometer at regular intervals. Now, observe temperature of the oil as it reaches $40^{o}$ C pour down the methanol previously mixed. Leave the solution to heat.

**b.** At that time take 12 pellets of sodium hydroxide (NaOH) or approximately 3.5 gm and dissolve it in 125ml of Methanol. When the oil reaches temperature of $56^{o}$ C to $58^{o}$ C reduce the heat. Let the oil to settle down for 1 hour.

**c.** We can here clearly observe the two separated layer of methyl ester and glycerol which has to be separated

**d.** After the oil is settled pour the mixture in the separator funnel. When pour into Separator leave the oils to dissipate glycerine from the oil. Now, collect the glycerine and oil in separate Beaker.

**e.** The oil taken is once again poured into the funnel for water wash. Heat water up to $60^{o}$C and pour inside the separator funnel to get mixed with oil and remove the soap fumes formed inside. This step is repeated for 2-3 times until the water settled inside is clean (with very less amount of fumes).

**f.** Now take out the remaining oil in the beaker. Then heat the oil till the temperature of approximately $90^{o}$C at this temperature the remaining water content will be evaporated. The left oil is Bio Diesel solution required

g. Final Bio diesel produced. Repeat these steps above for every batch of oil.

**5.1.3.Preparation of Bio diesel Blend**

The Blends we have made are by the mixture of three different basic compounds Biodiesel, Isopropyle Alcohol and Diesel. The blends we are adding as two samples with different percentage compositions

**B-20**

i. 20% Bio Diesel ,80% Diesel(Additives Isopropyl Alcohol with 2% of overall solution)here we are taking 400 ml of diesel in a beaker and stir it well while stirring pour 100ml of biodiesel and 10ml of Isopropyl alcohol (taken 2% as the blend is of 500ml ).

ii. 20% Bio Diesel ,80% Diesel(Additives Isopropyl Alcohol with 1% of overall solution) here we are taking 800 ml of diesel in a beaker and stir it well while stirring pour 200ml of biodiesel and 10ml of Isopropyl alcohol (taken 1% as the blend is of 1000ml ).

**5.1.4. Testing Procedure of Biodiesel on Diesel Engine:**

1. Into the panel frame, fill in the diesel fuel tank. 1.

2. Connect a 230 V, single-phase power source instrumentation input plug. The digital metres now show the respective readings, namely RPM and Temperature indicators.

3. Attach the water line and the brake drum to the motor jacket.

4. The oil in the oil sump is tested.

5. Open the valve to make sure that the air in the fuel line is not trapped.

6. Start the engine, record and maintain the engine speed at 1500RPM as per the load applied.

7. Now load the engine in 6 kg load and load the engine in 12 kg steps so that it can stabilise at any load.

8. Record all necessary parameters as shown on digital indicators which are installed on a table like,

a. Digital RPM indicator engine speed.

b. The spring equilibrium load.

c. Office fuel intake.

d. The amount of manometer airflow.

e. Temperature indicator different temperatures.

9. Step by step load the engine.

10. All relevant parameters are registered.

11. Turn off the fuel knob on the test panel.

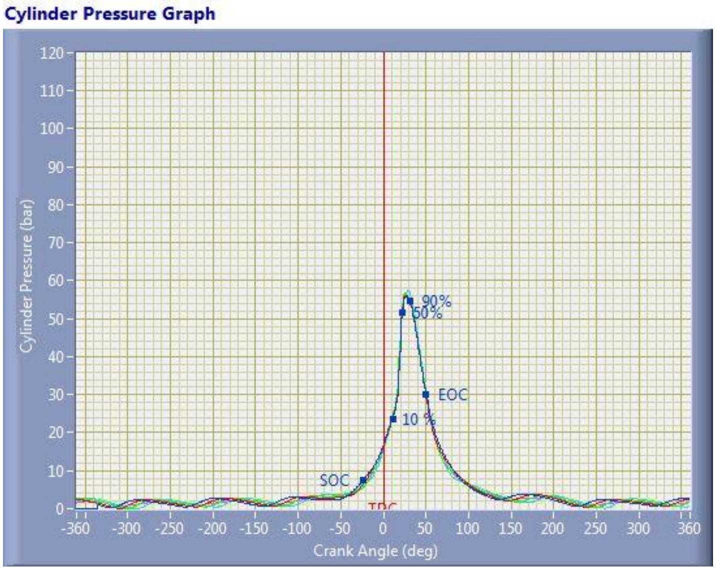
**Fig2**. Engine setup

**6.Results**

**6.1.Combustion Parameters:**

**6.1.1.Performance Analysis Using Theoretical & Practical Graphs:**

**B20 +1% 6 Kg Load**



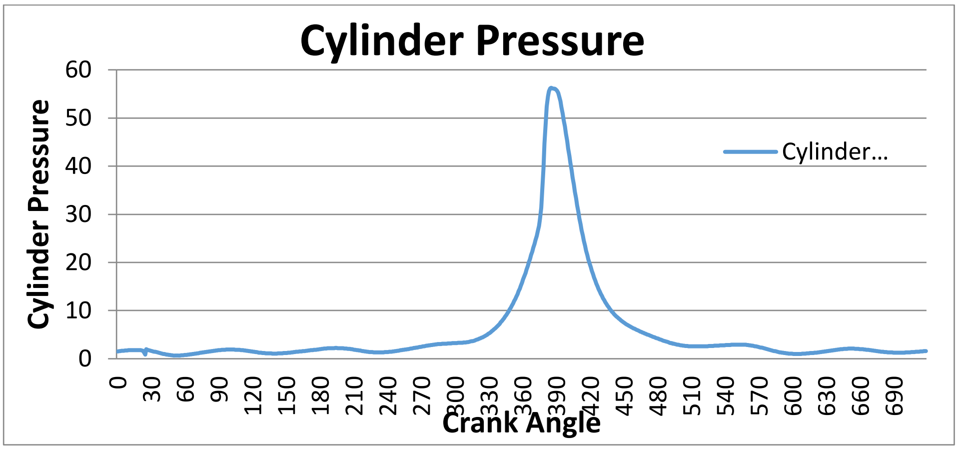




**Fig.3.** Plot between crank angle and cylinder pressure for B20+1% 6kg load

Fig 3 explains the relation between crank angle and cylinder pressure for B20+1% isopropyl alcohol at 6 kg load and it can be observed that the maximum pressure was found to be 55 Pa at around 390 degrees crank angle.

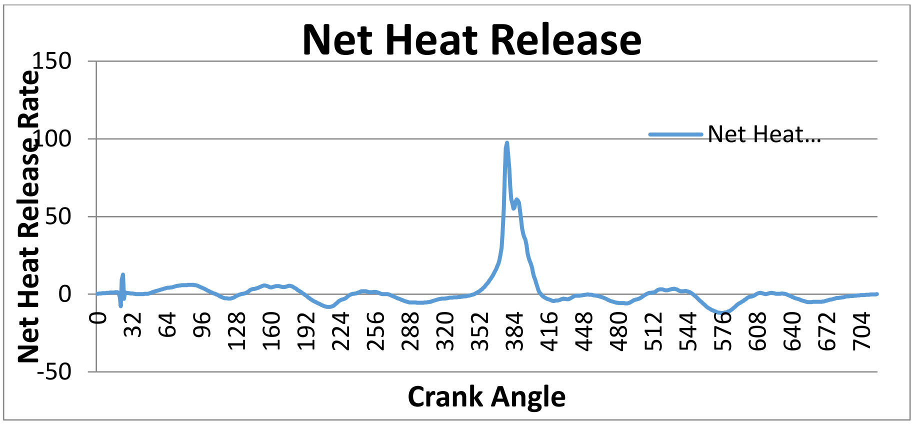
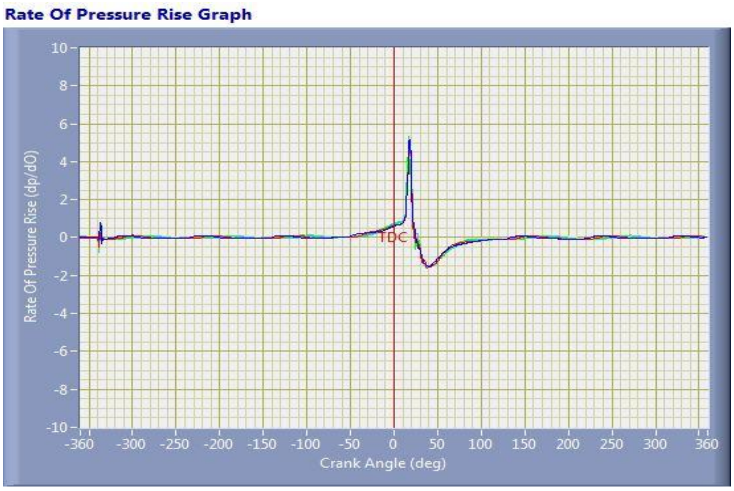



**Fig4.** Plot between crank angle and Net heat release rate for B20+1% 6kg load

Fig 4explains the relation between crank angle and net heat release rate for B20+1% isopropyl alcohol at 6 kg load the maximum net heat release rate at around 384 degrees crank angle has been found to be 100J.



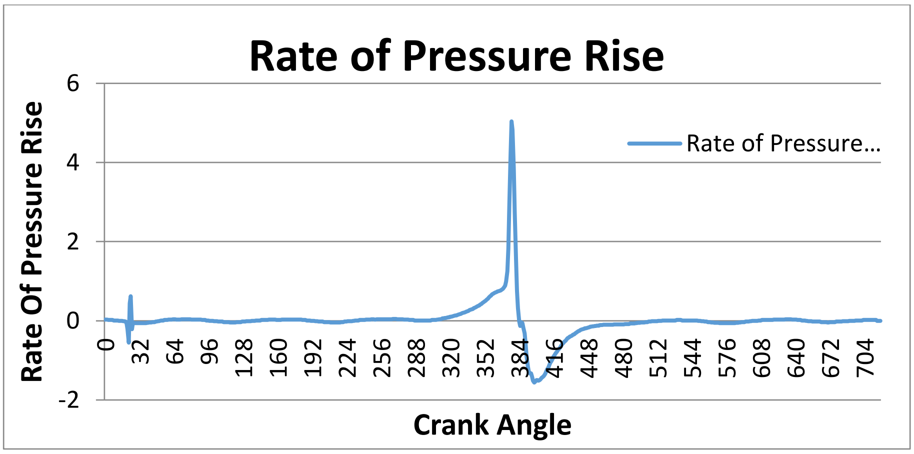
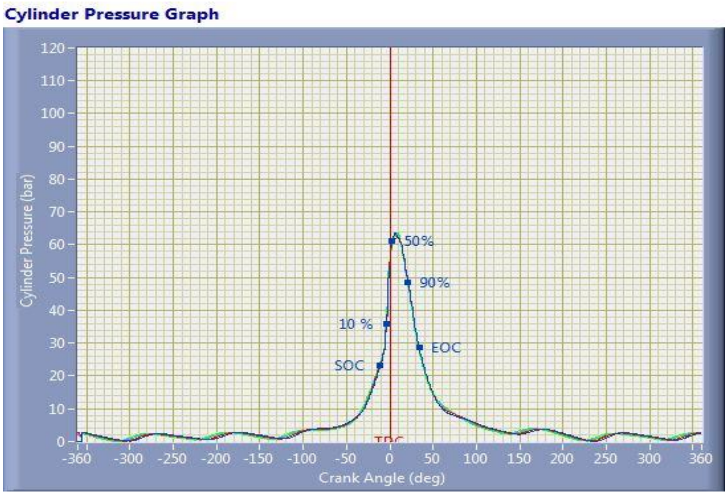




**Fig5.**Plot between crank angle and rate of pressure rise for B20+1% 6kg load

Fig 5explains the relation between crank angle and rate of pressure rise for B20+1% isopropyl alcohol at 6 kg load and it can be observed that the maximum pressure was found to be 5 Pa at around 384 degrees crank angle.

**<u>B20 +1% 12 Kg Load</u>**



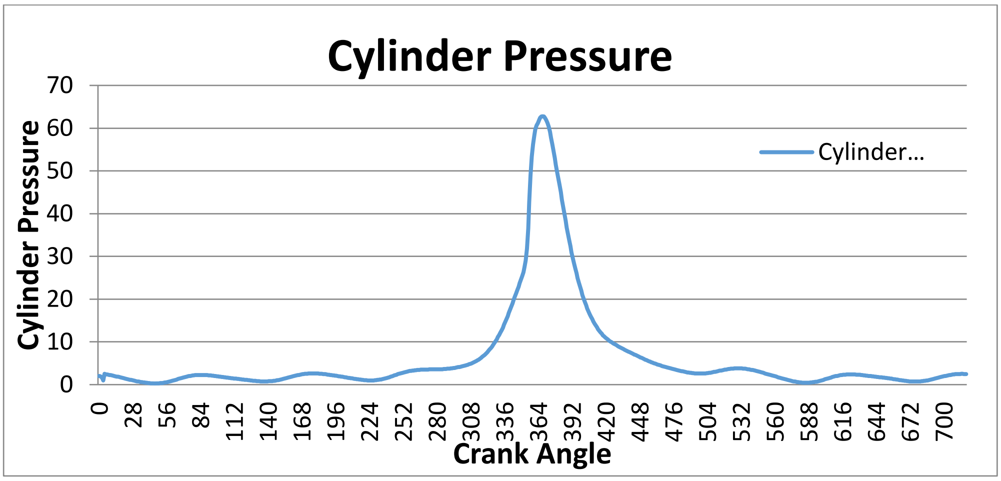
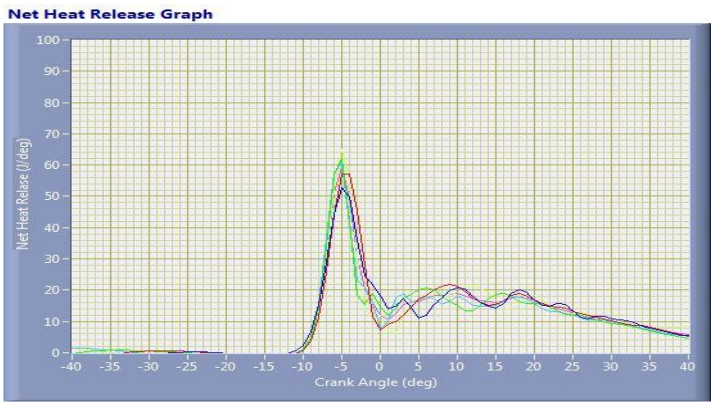




**Fig6.**Plot between crank angle and cylinder pressure for B20+1% 12kg load

Fig 6explains the relation between crank angle and cylinder pressure for B20+1% isopropyl alcohol at 12 kg load and it can be observed that the maximum pressure was found to be 62 Pa at around 364 degrees crank angle.



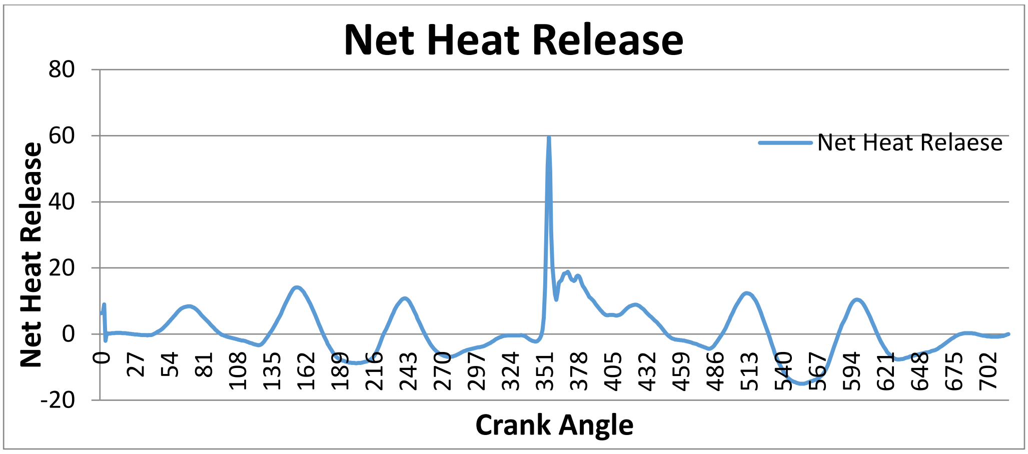
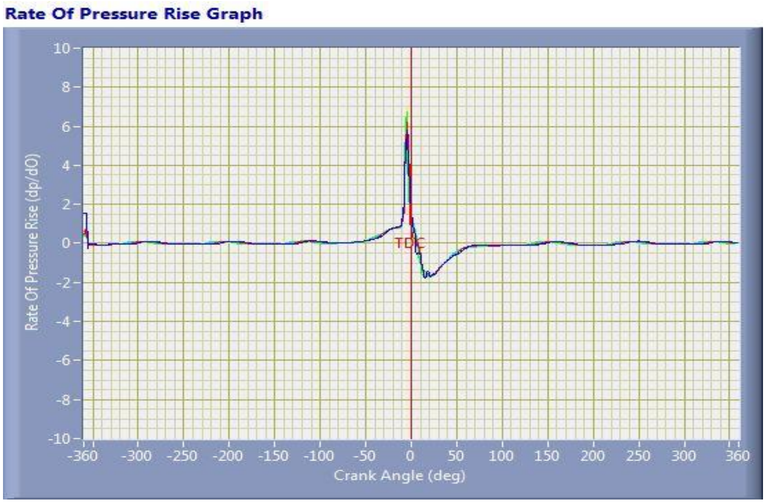



**Fig7.**Plot between crank angle and Net heat release rate for B20+1% 12kg load

Fig 7explains the relation between crank angle and net heat release rate for B20+1% isopropyl alcohol at 12 kg load the maximum net heat release rate at around 364 degrees crank angle has been found to be 60J.



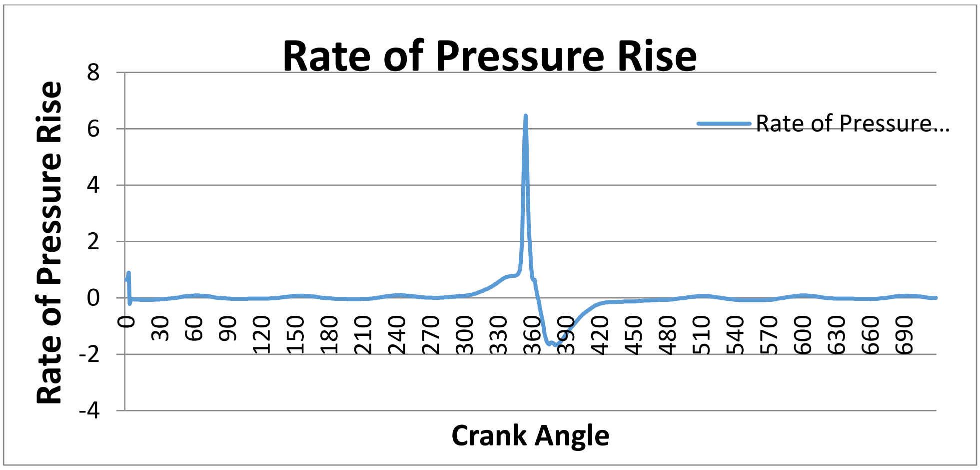




**Fig8.**Plot between crank angle and rate of pressure rise for B20+1% 12kg load

Fig 8explains the relation between crank angle and rate of pressure rise for B20+1% isopropyl alcohol at 12 kg load and it can be observed that the maximum pressure was found to be 6.20 Pa at around 360 degrees crank angle.

**B20 +2% 6 Kg Load**

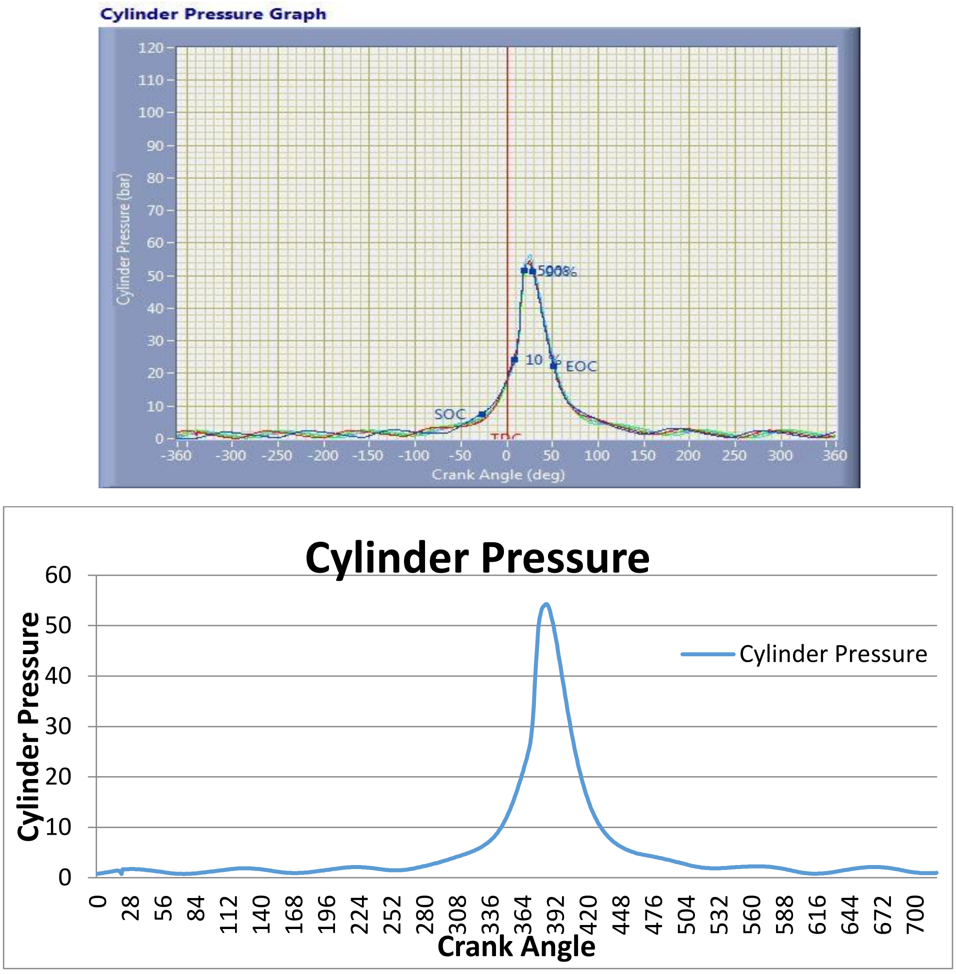



**Fig9.**Plot between crank angle and cylinder pressure for B20+2% 6kg load

Fig 9explains the relation between crank angle and cylinder pressure for B20+2% isopropyl alcohol at 6 kg load and it can be observed that the maximum pressure was found to be 54 Pa at around 392 degrees crank angle.

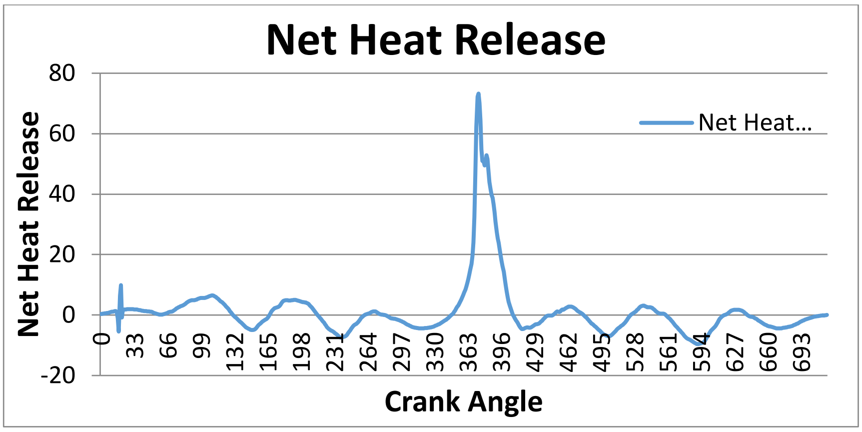
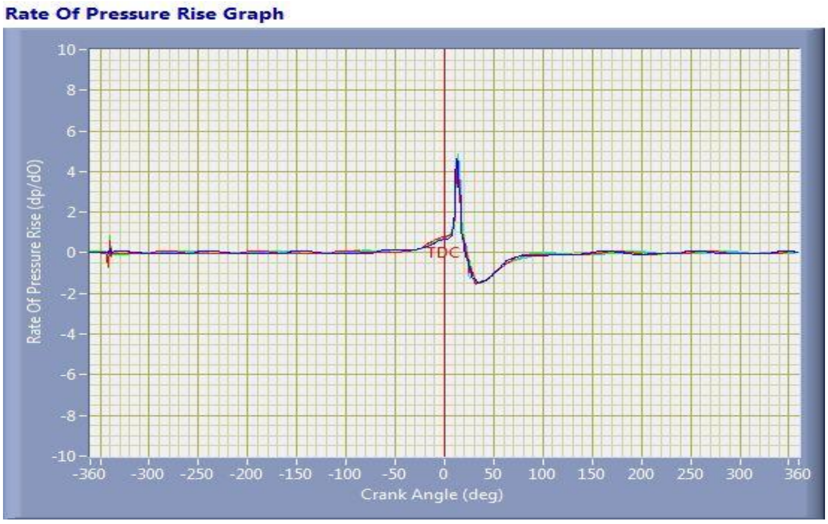



**Fig10.**Plot between crank angle and Net heat release rate for B20+2% 6kg load

Fig 10explains the relation between crank angle and net heat release rate for B20+2% isopropyl alcohol at 6 kg load and it can be observed that the maximum net heat release rate was found to be 76 J at around 384 degrees crank angle



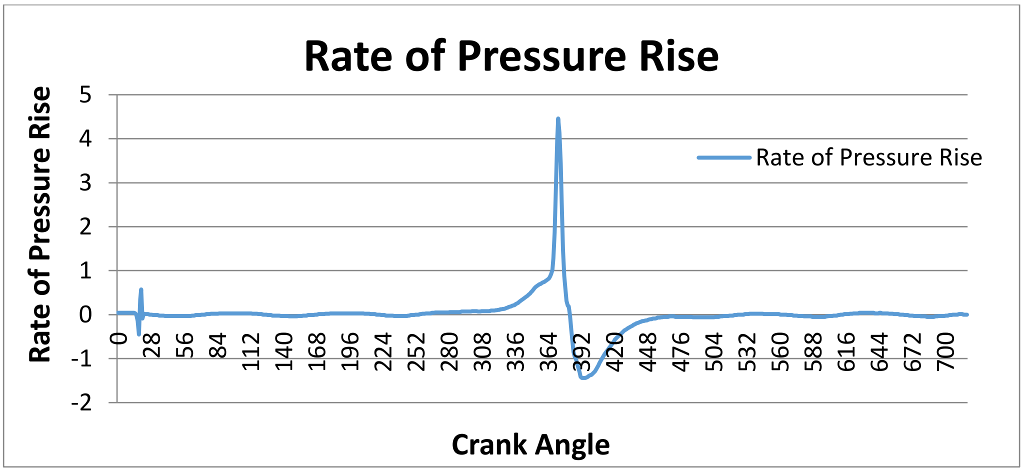
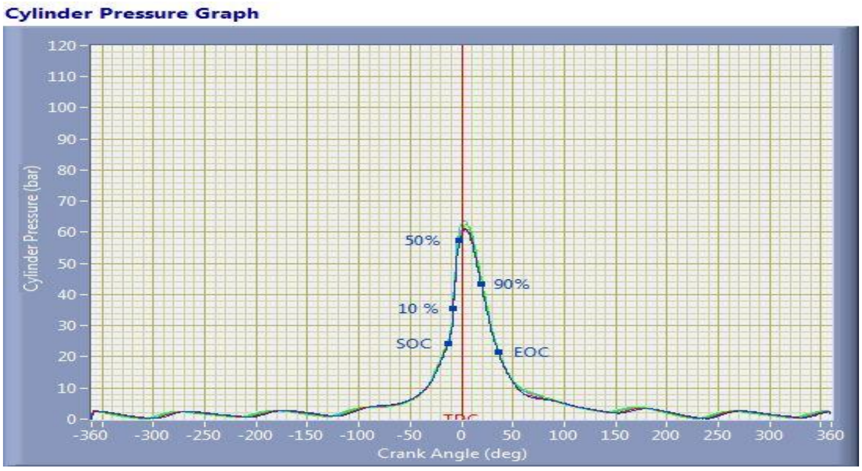




**Fig11.**Plot between crank angle and rate of pressure rise for B20+2% 6kg load

Fig 11explains the relation between crank angle and rate of pressure rise for B20+2% isopropyl alcohol at 6 kg load and it can be observed that the maximum pressure was found to be 4.5 Pa at around 364 degrees crank angle.

**<u>B20 +2% at 12Kg Load</u>**



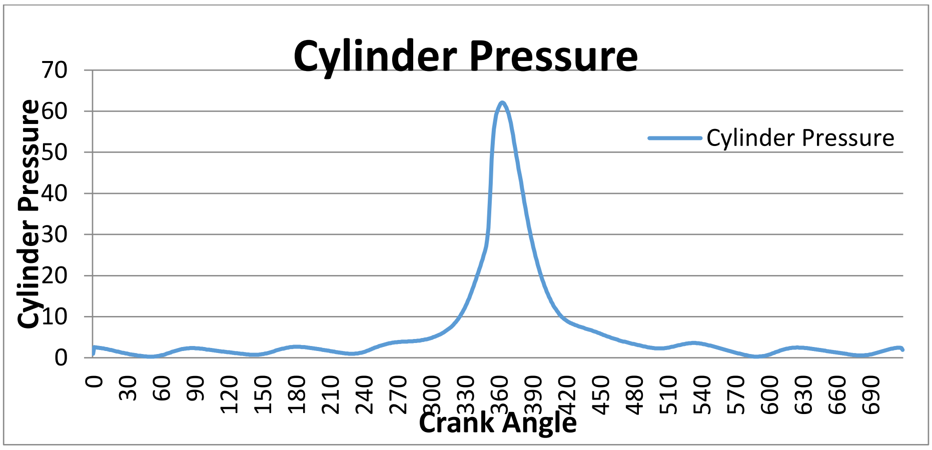
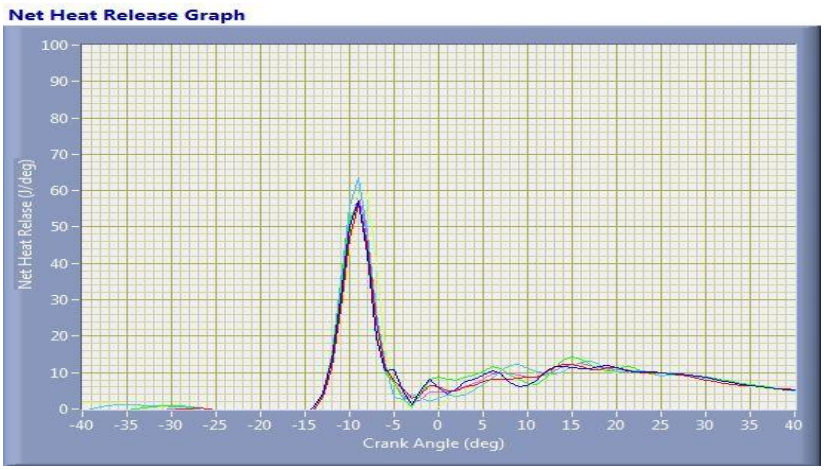




**Fig12.**Plot between crank angle and cylinder pressure for B20+2% 12kg load

Fig 12explains the relation between crank angle and cylinder pressure for B20+2% isopropyl alcohol at 12 kg load and it can be observed that the maximum pressure was found to be 60 Pa at around 370 degrees crank angle.



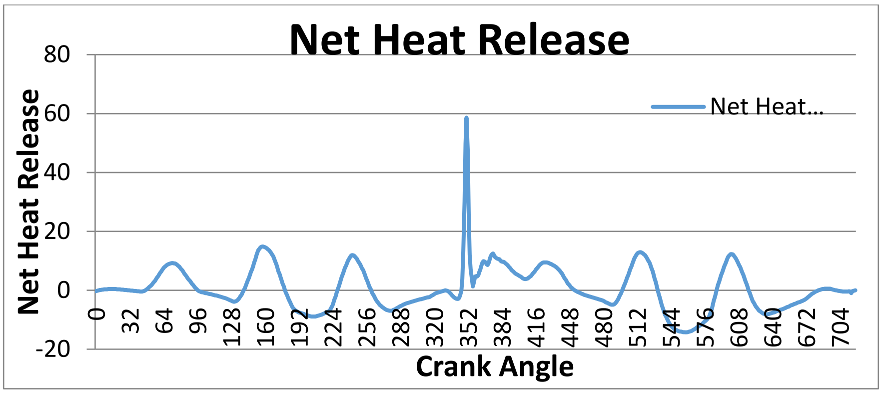



**Fig13.**Plot between crank angle and Net heat release rate for B20+2% 12kg load

Fig 13explains the relation between crank angle and net heat release rate for B20+2% isopropyl alcohol at 12 kg load the maximum net heat release rate at around 360 degrees crank angle has been found to be 60J.

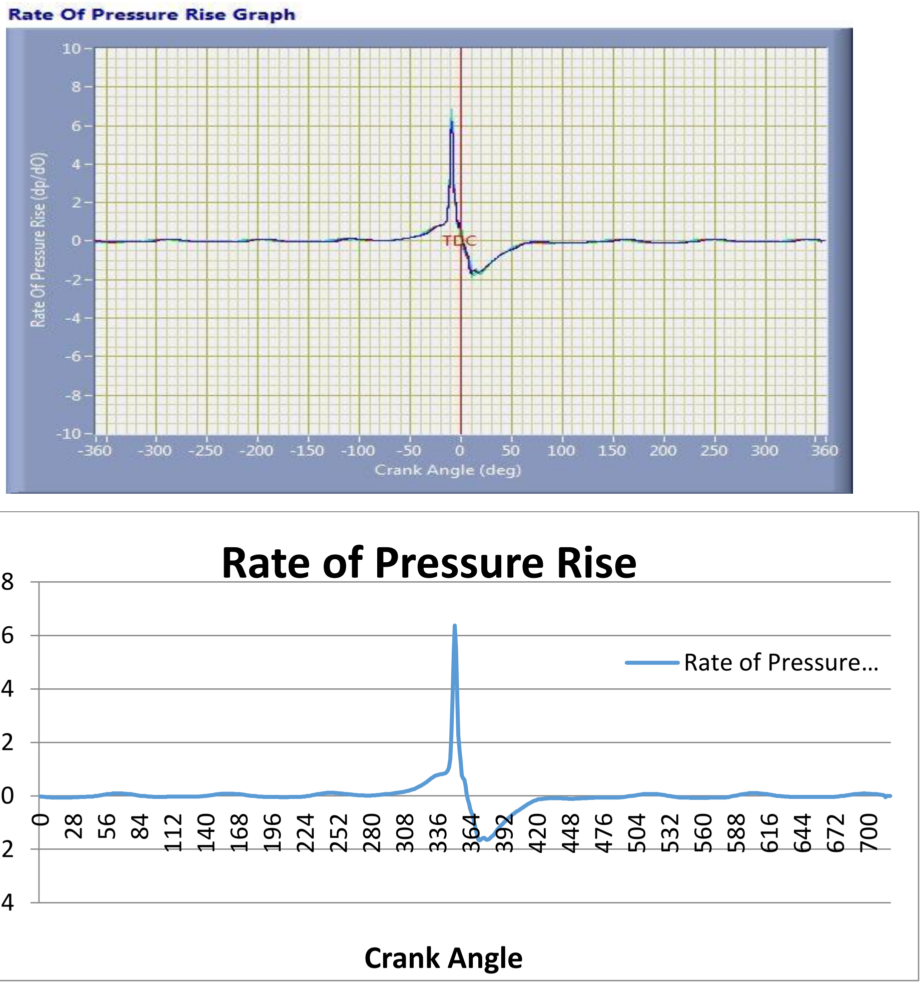



**Fig14.**Plot between crank angle and rate of pressure rise for B20+2% 12kg load

Fig 14explains the relation between crank angle and rate of pressure rise for B20+2% isopropyl alcohol at 12 kg load and it can be observed that the maximum pressure was found to be 6.1 Pa at around 360 degrees crank angle.

**7.Conclusions:**

1. From the results it can be concluded that for the graphs between crank angle and cylinder pressure the maximum cylinder pressure was found to be increasing at 62Pa at around 364 degrees crank angle for B20+1% isopropyl alcohol at 12 kg load

2. From the graphs between crank angle and net heat release rate by the results obtained we can conclude that the net heat release rate is found to be maximum at 100J at around 384 degrees crank angle for B20+1% isopropyl alcohol at 6 kg load
3. From the analysis between crank angle and rate of pressure rise from the results observed the maximum rate of pressure rise is found to be 6.20 Pa at around 360 degrees crank angle for B20+1% isopropyl alcohol at 12 kg load.
4. By the above results it can be concluded that the best combustion characteristics was found to be observed at B20+1% isopropyl alcohol at 12 kg load.

**8.Future Scope:**

1. To improve the performance characteristics of the engine nowadays researchers are implementing new techniques by using additives mixed with various percentage composition to achieve combustion characteristics
2. In our work we have used isopropyl alcohol as an additive taken in volume percentages of 1% and 2% and the combustion characteristics are well achieved

For much better progress other additives such as isobutyl alcohol, cerium oxide and $Fecl_3$ can be used as additives

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