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# PERFORMANCE AND EMISSION OF A SINGLE CYLINDER DI DIESEL ENGINE OPERATING ON VARIOUS PARAMETERS USING DIESTROL AT EFI SYSTEM

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## ABSTRACT

An important goal of this research is to achieve the lower emission such as HC, CO, NOx and soot particles in diesel engine. Electronic fuel injection system under the high pressure allows a very high degree of flexibility in fuel injection timing, duration and pressure control, which can be used to obtain significant reduction in engine emission and improvement in engine performance. In this project single cylinder diesel engine was used with the help of an electronic direct fuel injection which was operated on biodiesel that produced from jatropha. Here, Injection timings were changed to study their influence on performance and emissions. The results have been compared with biodiesel blend and neat diesel operation. Advancing the injection timing and increasing the injector opening pressure increase the brake thermal efficiency and reduce hydrocarbons (HC) and smoke emissions significantly. This project is also to predict the influence of split multiple stage fuel injection on a DI diesel engine performance and emission characteristics. Split multiple stage fuel injection significantly reduces the formation of NOx compared to that of the continuous fuel injection.

**Key words**: Electronic fuel injection, Jatropha Biodiesel, Advanced injection timing, Split multi stage fuel injection.

## INTRODUCTION

The demand for diesel engines are growing rapidly due to their fuel economy, lower exhaust gas emissions, but the fuel injection timing, duration and pressure control cannot be control by mechanical injection system for that reason electronic fuel injection can be used. The main advantage for using electronic fuel injection system are varying the injection timing, injection pressure, duration and multiple injection strategies can be easily achieved.

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Due to the injection timing advanced, there is more time available for formation of mixture; it leads improved performance and better combustion and also reduction in HC and CO emissions. Due to the increasing injection pressure, improves the better mixing and also fuel particle diameter was reduced, results reduction of smoke and HC emissions. When the split multistage fuel injection is included, it results reduction of peak cycle temperature, hence NOx formation was reduced. The main advantage of using alternate fuels in the diesel engine was improving the performance and emission characteristics. The long chain hydrocarbon structure, vegetable oils have good ignition. Characteristics, however they cause serious problems such as carbon deposits build up, poor durability, high density, high viscosity, lower calorific value, more molecular weight and poor combustion. These problems lead to poor thermal efficiency, while using vegetable oil in the diesel engine. We can rectify these problems by Trans esterification process. However the Nitrogen oxide emission is more for jatropha and to reduce that the Electronic fuel injection method is introduced compared to normal injection.

**Table 2.1: Properties of fuel properties of vegetable oil before transesterification compared with diesel fuel**

| Properties | Diesel | Jatropha oil |
|---|---|---|
| Density (kg/m3) | 840 | 917 |
| Kinematic viscosity at $40^0$C (cst) | 2.6 | 36 |
| Calorific value (MJ/kg) | 45.343 | 38.5 |
| Cetane number | 48-56 | 23-41 |
| Flash point ($^0$C) | 74 | 235 |
| Fire point ($^0$C) | 78 | 256 |
| Carbon residue (% w) | 0.1 | 0.8 |
| Ash content (% w) | 0.01 | 0.03 |
| Sulphur (% w) | 0.25 | 0 |
| Carbon (% w) | 86.83 | 76.11 |
| Hydrogen (% w) | 12.72 | 10.52 |
| Oxygen (% w) | 1.19 | 11.06 |

**Table 2.2: Comparison between bio diesel and diesel properties of vegetable oil after transesterification compared with diesel fuel**

| Properties of vegetable oil after transesterifcation compared with diesel fuel properties | Diesel | Jatropha oil ester |
|---|---|---|
| Density at $15^0$C,kg/m$^3$ | 840 | 879 |
| Kinematic viscosity at $40^0$C (cst) | 2.6 | 4.82 |
| Higher calorific value (MJ/kg) | 45.343 | 42.84 |
| Cetane number | 48-56 | 51-52 |
| Flash point ($^0$C) | 74 | 191 |
| Fire point ($^0$C) | 78 | 136 |
| Carbon residue (% w) | 0.1 | 0.01 |
| Ash content (% w) | 0.01 | 0.013 |
| Sulphur (% w) | 0.25 | 0.001 |
| Carbon (% w) | 86.83 | 77.1 |
| Hydrogen (% w) | 12.72 | 11.81 |
| Oxygen (% w) | 1.19 | 10.97 |

## EXPERIMENTAL

The present work is carried out to study the performance and emission characteristics of a small direct injection (DI) type compression ignition engine using the vegetable oil methyl esters. An Eddy current dynamometer is connected with this engine to determine the engine performance with varying engine speed. A gas analyzer and smoke meter are used with this diesel engine to determine the emission characteristics of the engine.

### Experimental setup overview

The schematic diagram of the engine test rig is used. The engine is fully equipped with measurements of all operating parameters. The arrangement requires the following systems and apparatus for carrying out the desired experiment.

(1) Diesel engine

(2) Eddy current dynamometer

(3) Exhaust gas analyzer

(4) Smoke meter

The test rig used for the present study has been developed in the dynamometer laboratory of the Madras Institute of Technology, Chennai. The test engine and Eddy Current dynamometer are mounted on channels which are embedded on concrete foundation.

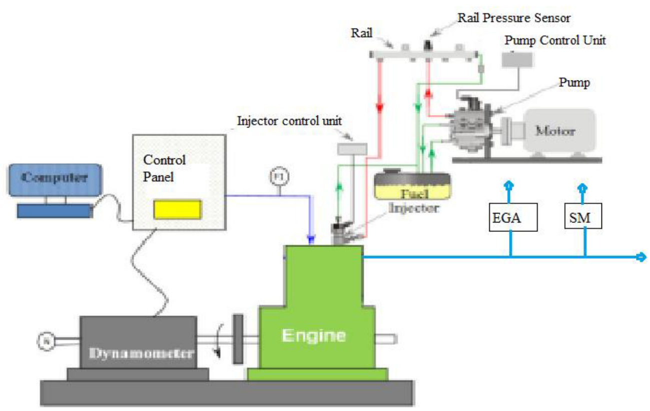


**Fig. 3.1 Experimental setup**

An electronically controlled four-stroke-single cylinder direct fuel injection (EDI) CI engine was used which was developed in our laboratory. The schematic diagrams of the complete experimental setup test rig with electronic direct fuel injection (EDI) system are shown in the above figure. The specifications of engine are given in Table 2. This work aims to study in detail through experiments the influence of injection timing and injection pressure and split multistage injection on the performance, emissions and combustion characteristics of EDI engine. Experiments were done at a constant speed of 1500 rpm with diesel and biodiesel blend.

**Table 3.1: Engine specifications**

| Type | Single cylinder 4s C. I. engine (Kirloskar) |
|---|---|
| Bore | 80 mm |
| Stroke | 110 mm |
| Displacement | 661CC |

Cont…

| Type | Single cylinder 4s C. I. engine (Kirloskar) |
|---|---|
| Compression ratio | 17.5:1 |
| Brake power | 3.2 KW |
| Speed | 1500 RPM |
| Injection timing | 23˚ C TDC |
| Dynamometer | Eddy current dynamometer |
| Cooling system | Water cooled |

Parameters like injection timing and injection pressure were varied. Experimental results of brake thermal efficiency, HC, CO, NOx, smoke levels and heat release rate are presented and compared with that of diesel.

## Electronic fuel injection system

### Methods of fuel injection system

The two important methods of fuel injection systems as follows:

### Continuous fuel injection system

In this system, fuel is sprayed at low pressure continuously in the air supply that has the advantage of fuel promoting efficient atomization of fuel. The amount of fuel is governed by air throttle opening and no timing is used in addition the evaporative effects of fuel cools the compressed charge and gives the higher volumetric efficiency. The method requires only one fuel injection pump and one injector.

### Timed injection system

The timed injection system is similar to continuous fuel injection system, which is used in high speed diesel engines. Fuel is injected during the injection stroke over limited period. The injection of fuel into combustion chamber can be done by employing any these following methods:

1. Direct injection of fuel into the cylinder.
2. Injection of fuel close to the inlet valve
3. Injection of fuel into the inlet manifold.

The electronic fuel injection kit made for this research is timed injection system that is direct injection of fuel into the cylinder.

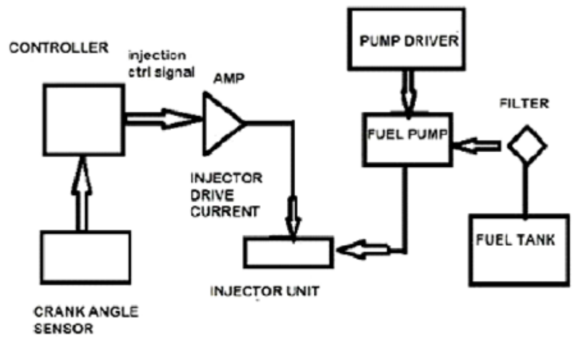


**Fig. 4.1: Block diagram of Electronic Fuel Injection (EFI) system**

This system consists of electronic fuel injector, rotary fuel pump, fuel tank, pump driver, filter, microcontroller, crank shaft position sensor.

The fuel pump supplies the fuel from the tank to the fuel injector at high pressure. The fuel injector will be operated by getting the signal from the microcontroller. The crank shaft position sensor is used to determine the position of the crank shaft with the help of this data; the microcontroller will give control signal to operate the fuel injector at the correct position for every cycle. The length of pulse determines the quantity fuel delivered.

### Performance characteristics

### Brake thermal efficiency

The brake thermal efficiency of the fuel blend is higher than jatropha biodiesel. At 60% load condition the blend gives more thermal efficiency. Thus the efficiency is increases in J20 and closer to that of diesel shown in above graph.

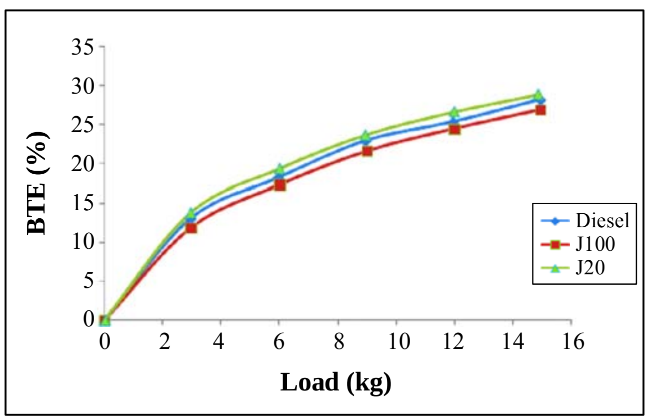


**Fig. 5.1: BTE Vs Load**

## Total fuel consumption

From the above graph, it is noted that the total fuel consumption for the blends are slightly lower than jatropha biodiesel. At 60% load condition, TFC of J20 is closer to the diesel.

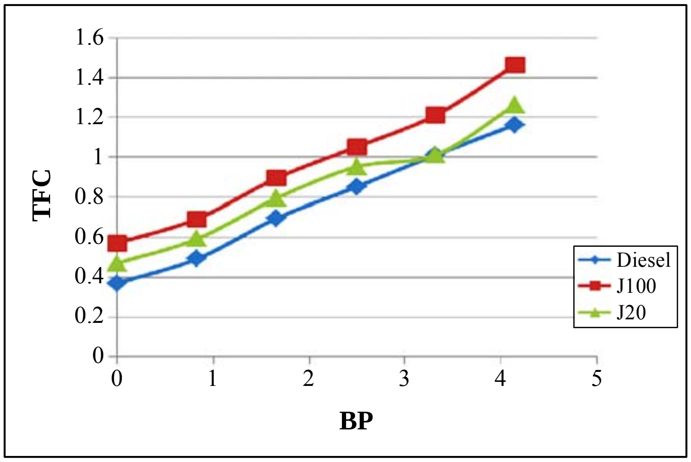


**Fig. 5.2: TFC Vs BP**

## Specific energy consumption

From the below graph it is noted that the specific energy consumption for the blends are higher than the diesel.

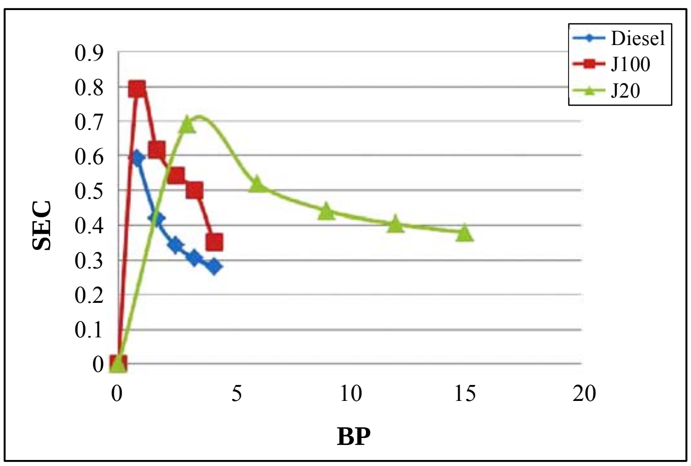


**Fig. 5.3: SEC Vs BP**

## Emission characteristics

### Carbon monoxide

From the above graph it is noted down that CO emission is almost same in the all the blends. At 60% load condition all the blends gives the same amount of CO.

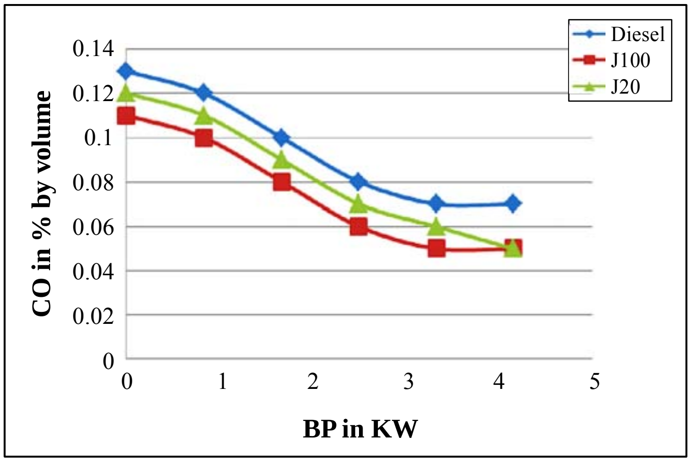


**Fig. 6.1 CO Vs BP**

### Smoke

From the above graph, Smoke emission is very less for Jatropha blend 20% of Jatropha blend also gives the lower smoke emissions compare to that of the diesel.

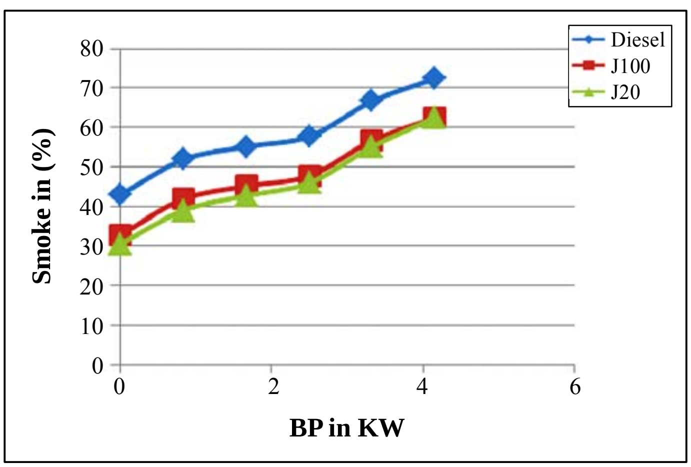


**Fig. 6.2 Smoke Vs BP**

**Hydrocarbon**

From the above graph it is noted down the unburned hydro carbon emission is low for 20% Jatropha blend over the full load variation. At the start of the engine the diesel gives more amount of unburned hydro carbon and at full load it is lowered considerably due to high temperature of the chamber.

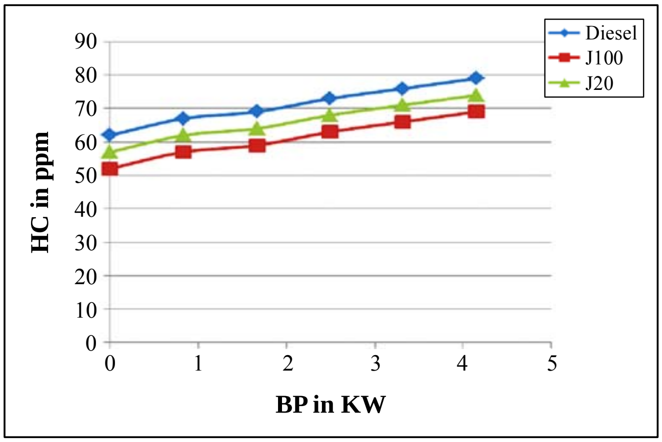


**Fig. 6.3: HC Vs BP**

**$NO_X$ Emission**

From the above graph when the brake power is increasing NOx emission also increases for blends of Jatropha. This may be due to late burning, prolonged duration of combustion of Jatropha blend.

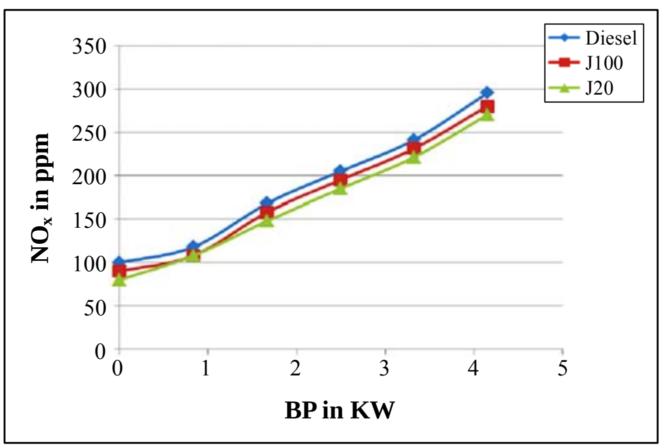


**Fig. 6.4 NOx Vs BP**

## CONCLUSION

The experimental work was conducted on Diesel to examine the effect of an engine performance and emission characteristics and also found that the Brake thermal efficiency at various load. The experimental work was conducted to examine the effect of a Jatropha on DI diesel engine performance and emission characteristics. It is found that the efficiency of Jatropha Blend 20 is closer to that of diesel. The CO, HC and smoke emission are less for Jatropha Blend. Further the blends J20 of Jatropha Blend are calculated for performance and emission it is very clear from the graph that the brake thermal efficiency is more for diesel followed by J20 Jatropha Blend to J40 Jatropha Blend. As the percentages of the blends are increasing then the efficiency is also decreasing but however the efficiency of Jatropha Blend 20 is closer to the diesel. Thus by implementing the concept of Electronic fuel injection in DI Diesel engine for vegetable oils there is a considerable decrease in the emission and increasing performance when compared to diesel and making the globe free from pollution.

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