

Investigations on Combustion Characteristics of Ci Diesel Engine Using PSME with Varied Parameters

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ABSTRACT: Indiscriminate extraction and lavish consumption of fossil fuels have led to a reduction in underground-based carbon resources. The search for an alternative fuel, which promises a harmonious correlation with sustainable development, energy conservation, management and environmental preservation, has become highly pronounced in the present context. The alternate fuels (most of the bio-diesels) are inferior to diesel fuel. Therefore, in this work an attempt is made for better combustion of bio-diesel injecting it at various pressures and with different numbers of nozzle holes. Effective combustion may result in increased overall efficiency. Fuel nozzle sprays the liquid fuel into combustion chamber and the nozzle design influences combustion process. In this work, Fuel injection pressure and the nozzle design parameters such as nozzle holes, nozzle diameter etc. are varied. Both Diesel and Palm stearin methyl ester Bio-diesel are used for conducting the experiments. The combustion characteristics and performance parameters are evaluated. An experimental investigations was carried out in a single cylinder, four stroke, vertical, water cooled, direct injection CI engine. The performance characteristics such as brake thermal efficiency, specific fuel consumption, indicated thermal efficiency, mechanical efficiency etc. are evaluated. The results indicate that the brake thermal efficiency for Palm stearin methyl ester biodiesel is higher with 3 hole.

KEYWORDS: IC Engine, biodiesel, Palm stearin methyl ester, injection pressure.

I. INTRODUCTION

Industrialization and growing population have pushed the nation to confront with twin crisis of fossil fuel depletion and environmental degradation. Indiscriminate extraction and lavish consumption of petroleum reserves have led to reduction of carbon resources. An alternative energy resource like biodiesel from edible and non-edible oils such as soya beans, jatropha (*Jatropacurcas*), sunflower and karanja (*PongamiaPinnata*), palm and neem has started attracting significant attention of researchers, governments and industries. Petroleum resources are the main sources of world energy supply, there need to be focus on renewable, biodegradable, and non-toxic energy source. Several studies conducted by researchers identify that biofuels as a potential alternative fuel for internal combustion engines. It has been found that engines running on biodiesel run successfully for longer durations and the performance and emission characteristics are quite comparable to that of petroleum based diesel fuel. Presently, India produces only 30% of the total petroleum fuels required and the remaining 70% is imported, which costs about Rs. 8,00,000 million per year. It is evident that mixing of 5% of biodiesel fuel to the present diesel fuel can save Rs. 40,000 million per year. It is also estimated that India can supplement 41.14% of the total diesel fuel consumption, if resources like waste cooking oil and other bio wastes were used as raw material for biodiesel production Waste cooking oil cannot be used directly in diesel engines as it has higher viscosity, free fatty acid and moisture content with low volatility leading to severe engine

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deposits, injector chocking and piston ring sticking. These undesirable effects can be removed by transesterification of waste cooking oil.

This experimental investigation, an alternative fuel such as palm stearin methyl ester biodiesel has been used instead of diesel fuel in a compression ignition engine. The palm stearin methyl ester has been collected from a local commercial supplier and its usability was investigated as pure biodiesel as fuel in a single cylinder, four-stroke, direct injection, air-cooled stationary compression ignition engine.

Using biodiesel, optimized blends of biodiesel and diesel can help reduce some significant percentage of the world's dependence on fossil fuels without modification of CI Engine, and it also important for environmental benefits.

II. ENGINE SPECIFICATIONS AND EXPERIMENTAL PROCEDURE

A. ENGINE SPECIFICATIONS

Specifications of Test Engine	
Number of cylinders	1
Number of strokes	4
Fuel	Diesel
Rated Power	5.2 KW @ 1500 RPM
Cylinder bore	87.5mm
Stroke Length	110mm
Compression Ratio	17.5:1
Dynamometer arm length	185mm
Dynamometer Type	Eddy Current
Type of cooling	water cooled

Table 2.1 Specifications of Compression Ignition Engine

The table 2.1 shows the specifications of Compression Ignition Engine. The setup consists of a single cylinder, four strokes, naturally aspirated, water cooled Diesel engine connected to eddy current dynamometer. This eddy current dynamometer is used for loading the engine.

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B. ENGINE EXPERIMENTAL SETUP

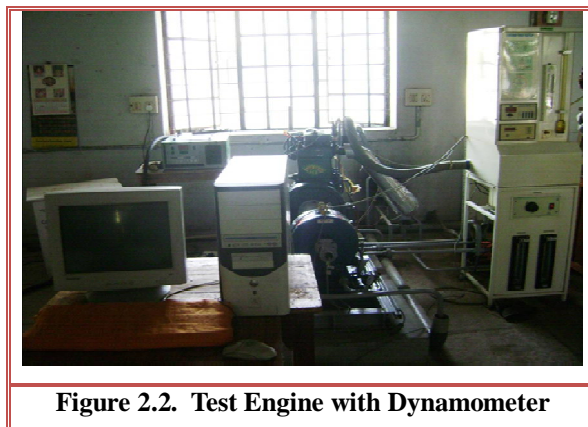


Figure 2.2. Test Engine with Dynamometer

The figure 2.2 shows the test engine with dynamometer.

C. EXPERIMENTAL PROCEDURE

2.3.1 Experimental procedure with Diesel Fuel

For experimentation the compression ignition engine has to run at a rated speed and is allowed to obtain thermal equilibrium condition. Once the warm up period is completed, then the experiments are conducted by varying the loads like no load, 10%, 20%, 30%, 40%, 50%, 60% and 70% etc. at a rated speed. At each loading the inlet air flow rate, time consumed for 10cc fuel, the ambient temperature, the exhaust gas temperature, the cooling water flow rate, the temperature readings are noted.

The engine is first started by using Diesel as a fuel at injection pressure of 180 bars with 3hole nozzle. The input parameters are noted and performance parameters like as Brake Power (BP), Brake thermal efficiency ($\eta_{B.th}$), Specific Fuel consumption (SFC), are evaluated. These results are the standard results and are used for comparison of performance of biodiesels and with different fuel nozzle holes and different injection pressures.

2.3.2 Experimental procedure with Shallow Depth Chamber and PSME

The experiments are conducted after changing the hemispherical piston with shallow depth chamber piston and following set of readings are taken with Palm stearin methyl ester:

- 3 hole nozzle with injection pressures of 180 bar, 200 bar, and 220 bar
- 4 hole nozzle with injection pressures of 180 bar, 200 bar, and 220 bar
- 5 hole nozzle with injection pressures of 180 bar, 200 bar, and 220 bar

The readings are noted separately and performance parameters are evaluated. The performance parameters of Diesel fuel at 180 bar with 3 hole nozzle used as standard readings. The performance parameters of biodiesel with the above injection pressures and nozzle configurations are then compared with above standard parameters. The engine was sufficiently warmed up and stabilized before taking all the readings.

III. RESULTS AND DISCUSSION

The experimental investigations are carried out in a Kirloskar make, single cylinder, and direct injection, 4-stroke stationary diesel engine using diesel as a conventional fuel and PSME biodiesel as an alternative fuel. Hemispherical piston changed with Shallow depth chamber piston. The achieved experimental results are analyzed and discussed in this section.

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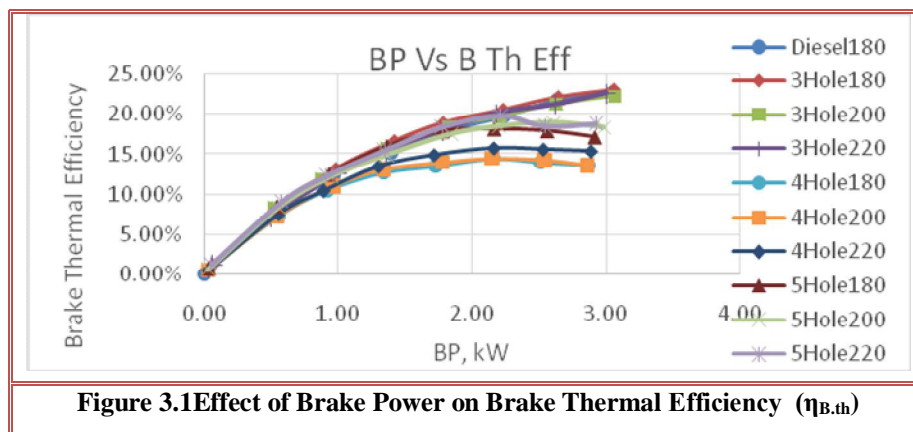
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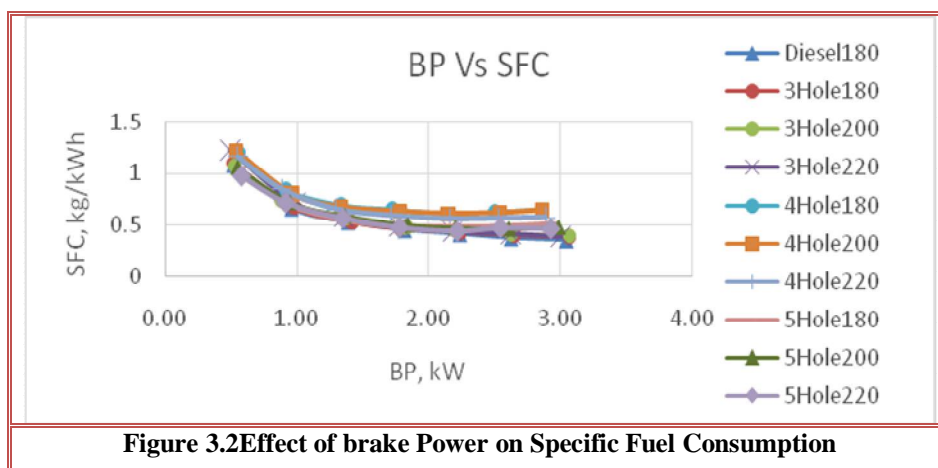
3.1. Engine Performance Parameters for Diesel and Biodiesel with different Nozzle holes and Injection pressures

3.1.1 Brake Thermal Efficiency



The Brake thermal efficiency increases with increase brake power as shown in fig.3.1. The variation of Brake Thermal Efficiency ($\eta_{B.th}$) by varying the brake power of the Compression Ignition (CI) engine by using Diesel at 180 bar with 3 Hole Nozzle and palm stearin methyl ester biodiesel as an alternate fuel with at 180 bar, 200 bar, 220 bar using 3 Hole Nozzle, 4 Hole Nozzle, 5 Hole Nozzle respectively. The maximum Brake thermal efficiency obtained for Bio Diesel is 23.07% at 70% load at 220 bar with 3 Hole Nozzle is higher than diesel fuel. Finally it is concluded that the Brake thermal efficiency increases with increase in brake power which is proportional to load for Diesel and Biodiesel.

3.1.2 Specific Fuel Consumption



The specific fuel consumption is increases with increase Brake power as shown in fig.3.2. The variation of specific fuel consumption by varying the brake power of the Compression Ignition (CI) engine by using Diesel at 180 bar with 3 Hole Nozzle and Palm stearin methyl ester biodiesel as an alternate fuel with at 180 bar, 200 bar, 220 bar using 3 Hole Nozzle, 4 Hole Nozzle, 5 Hole Nozzle respectively. From the fig. it is observed that Specific Fuel Consumption obtained for Diesel is 0.35 kg/kWh and 0.38 kg/kWh for Palm stearin methyl ester BioDiesel at 220 bar with 3 Hole

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Nozzle.

3.1.3 Indicated Thermal Efficiency

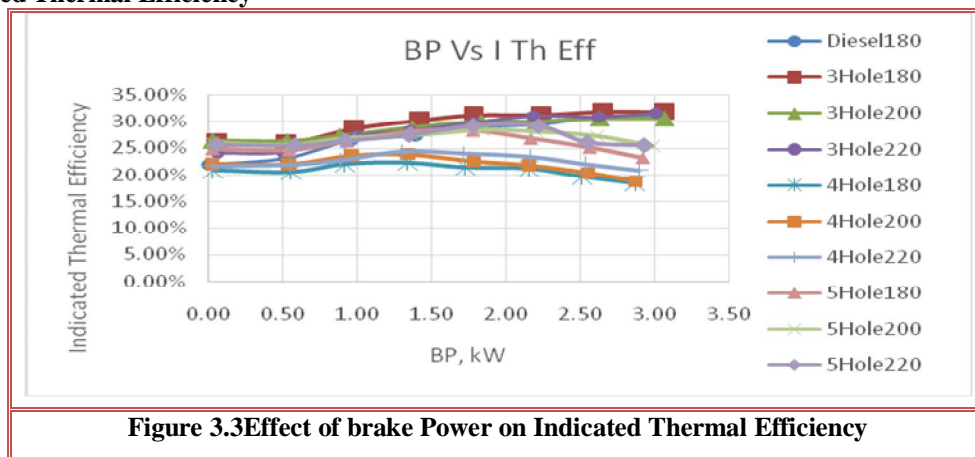


Fig.3.3 shows that the variation of indicated thermal efficiency by varying the brake power of the Compression Ignition (CI) engine by using Diesel at 180 bar with 3 Hole Nozzle and Palm stearin methyl ester biodiesel as an alternate fuel with at 180 bar, 200 bar, 220 bar using 3 Hole Nozzle, 4 Hole Nozzle, 5 Hole Nozzle respectively. The maximum Indicated thermal efficiency obtained for Palm stearin methyl ester Biodiesel at 220 bar with 3 hole Nozzle is higher than diesel fuel at 180 bar. Finally it is concluded that indicated thermal efficiency is increases with increasing brake power.

3.1.4 Mechanical Efficiency

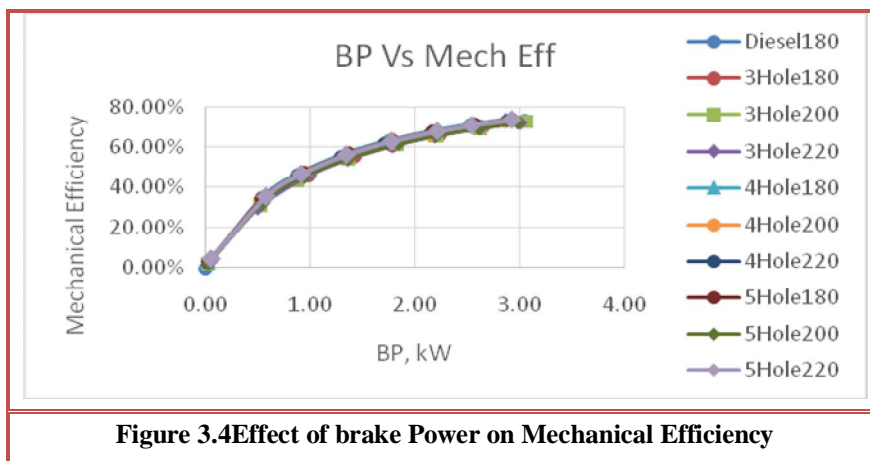


Figure 3.4 shows that the variation of mechanical efficiency by varying the brake power of the Compression Ignition (CI) engine by using Diesel at 180 bar with 3 Hole Nozzle and Palm stearin methyl ester biodiesel as an alternate fuel with at 180 bar, 200 bar, 220 bar using 3 Hole Nozzle, 4 Hole Nozzle, 5 Hole Nozzle respectively. From the fig. it is observed that the maximum Mechanical efficiency obtained is for palm stearin methyl ester is 73.94% at 220 bar with 3hole nozzle. Finally it is concluded that the Mechanical efficiency increases with increase in brake power.

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IV. CONCLUSIONS

Experiments are carried out to investigate the compression ignition engine performance by using Diesel at 180 bar with 3 Hole Nozzle with hemispherical piston and palm stearin methyl ester biodiesel as an alternate fuel with at 180 bar, 200 bar, 220 bar using 3 Hole Nozzle, 4 Hole Nozzle, 5 Hole Nozzle respectively with shallow depth chamber piston. The obtained data from experiments have been analyzed and subsequently the following important conclusions have been derived.

- The Brake Thermal Efficiency for palm stearin methyl ester biodiesel is more than diesel fuel and is about 1.18% at 220 bar with 3 hole nozzle.
- Mechanical Efficiency for palm stearin methyl ester biodiesel at 220 bar with 5 hole nozzle at is 73.92% and that of the Diesel is 73.32%.
- The specific fuel consumption decreases with increasing brake power which is proportional to load. The minimum Specific Fuel Consumption obtained for Diesel.
- The Brake Specific Fuel Consumption for Palm Stearin Methyl Ester (PSME) for shallow depth chamber piston at pressures of 180, 200, 220, bar is higher than diesel.
- It has been noticed that, Specific fuel consumption with 4 hole nozzle is much higher than that of, diesel with 3 hole nozzle.

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