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L. Karikalan, M. Chandrasekaran, S. Ramasubramanian & P. Vivek

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INFLUENCE OF MODIFIED PENT ROOF COMBUSTION CAVITY ON DIESEL ENGINE PERFORMANCE AND EMISSION CHARACTERISTICS

Karikalan.L[1], Chandrasekaran.M[2], Ramasubramanian.S[3] and Vivek.P[4]

[1, 3] *Department of Automobile Engineering, VELS University, Chennai*
[2, 4] *Department of Mechanical Engineering, VELS University, Chennai*

e-mail ID: karilk2005@yahoo.co.in

Abstract: The utmost vital role of the IC engine burning chamber is to offer correct mixing of air and fuel in a little time to lessen the ignition lag phase, determines the quality of the combustion, performance and the exhaust emission characteristics. To attain this, a systematized air movement termed air swirl is offered to create high comparative velocity amongst fuel droplets and air. In this work, Engine piston head is modified to 6º angle at crown part and the engine performance and emission Analysis is carried out. Modified piston promotes speedier mingling between the inducted air and injected fuel and speeding up the combustion process. By modifying the Combustion Chamber we got the result of very less amount of NOx Emissions and moderate amount of Hydrocarbon and Carbon Monoxide emissions.

Keywords*:* Engine, Piston, Diesel, Biodiesel, Performance, Emissions

1. INTRODUCTION

In view of the ecological protection and the excessive insecurity in impending energy supplies, awareness is focussed on the sustainable use of energy bases and the energy conservation procedures. CI engines are widely used for satisfying energy demand of vehicles, power generation units in many industries, hospitals, CHP, residential sectors, commercial and institutional facilities. Main advantages of these are quick start ups, have good part load efficiencies, and highly reliable. However, diesel is a non-renewable energy source and takes millions of years for its formation. Indiscriminate extraction of fossil fuels and excessive consumption of them have steered to mitigation of conventional reserves [1,2]. The world is confronted with the twin crisis of fossil fuel depletion and environmental degradation and the situation is expected to exfoliate more in the coming years.

In a CI engine the straight burning chamber has been enhanced for burning of diesel, with development of mingling amongst fuel and air, and not biodiesel. Work related on any alteration of engine including burning chamber may be obligatory, since the possessions, vaporization and burning features of biodiesel are seemingly dissimilar from diesel. Hence it is anticipated that the burning chamber, particularly piston cavity might requisite to be enhanced in terms of mingling and burning of biodiesel and air mix. The current work intended at exploring the use of biodiesel resulting from Karanja Oil in a CI engine [3-5].

Conversely, the hitches with CI engine are its high Particulate Matter and Oxide of Nitrogen emissions. Normally, NOx is created when burning occurs at higher temperatures since the nitrogen enclosed in the air will too respond with the existing oxygen, and soot is formed as a consequence of imperfect burning when oxygen is inadequate or temperature is too little. One indication of decreasing NOx is to combine higher temperature burning gas by means of cold air in burning chamber as rapidly as possible, and calm down the resident higher temperature state. The combination of burning gas and cold air can be initiated by creating a swirl in the burning chamber. The movement in the burning chamber mostly rest on the contour of cavity. Therefore, the exhaust release can be condensed efficiently by crafting the geometry of burning cavity. A good combustion chamber design has to optimize the filling and emptying of the cylinder with fresh charge continuously over the engines operating speed and load range. Also creates the conditions in the cylinder for the air and fuel to mix thoroughly, get excited into a highly turbulent state and burning of the charge to be completed in the shortest possible time [6-8].

2. COMBUSTION CHAMBER

The CI engine combustion is generally influenced by the turbulence of air which is normally created by the combustion chamber design. Each and every combustion chamber design creates its own pattern of turbulence to offer proper mingling of air and fuel in a little time to reduce the ignition lag. Air swirl provided the combustion chamber produces high comparative velocity amongst fuel drops and air. When the fuel is introduced into the burning cavity, the spray cone disturbed owing to the air motion and turbulence. The onset of burning will source an additional turbulence that could be steered by the contour of the burning cavity. Swirl is generally utilized in diesel engine to encourage speedier mixing amongst the air and the fuel injected. Swirl is also utilized to hustle the burning process and in 2stroke engines. Squish is the term specified to the radially inner or crosswise motion that arises towards the completion of the compression when a portion of piston surface and cylinder head approaches closely each other [9, 10].

The factors to be considered for designing the combustion chamber:

- ❖ Heat loss to combustion chamber walls
- ❖ Fuel Injection pressure.
- ❖ Number, size, & arrangement of holes in the nozzle
- ❖ Fuel requirement: Ability to use less expensive fuels
- ❖ Utilization of air: Ability to use maximum amount of air in cylinder

3. METHODS AND MATERIALS

The pent roof chamber showed that during the intake process, strong tumbling vortices were generated by the jetting flow of the air around the inlet valves. Many researchers revealed that the pent roof combustion chamber design increases the air motion turbulence and improves the combustion process. In this work, a conventional piston with 87.5 x 110mm of the KIRLOSKAR TV-1 single cylinder diesel has been modified with a pent roof combustion chamber design with 6^0 and the figure is shown below.

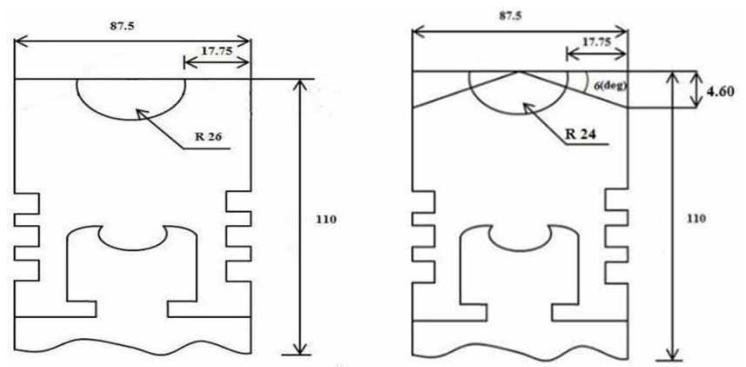

Figure 3.1(a) Conventional Piston 1(b) Modified Piston

Figure 3.2 Photo of Modified Piston

4. EXPERIMENTAL SETUP

Experimentation were conceded on a water cooled single cylinder diesel engine and the performance and pollutant features of the engine with Karanja B20 biodiesel blends were gauged and equated using the outcomes of diesel. The exhaust emissions were quantified by the AVL DIGAS 444 Exhaust Gas Analyser and AVL 437 make Smoke meter was utilized to size the smoke concentration.

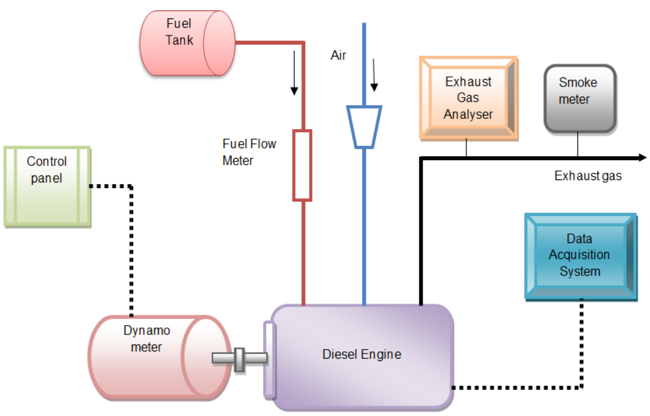

Figure 4.1 Experimental Setup Layout

TABLE-1 Engine Specifications

Make	Kirloskar TV-1
Power and Speed	3.5kW @ 1500rpm
Engine Type	Single Cylinder, DI and 4stroke
Compression Ration	16.5:1
Bore and Stroke	800 x 110mm
Loading Method	Eddy Current Dynamometer
Cooling Method	Water
Fuel Injection Pressure	200bar

The engine was started and run to achieve the stable condition and the engine load was increased gradually to maxi-mum recommended value. The applications of loads were 0%, 25%, 50%, 75%, and 100% respectively. The engine speed was constant at 1500 rpm. Fig. 2 demonstrates the experimental organization. For every load stages, the quantity of fuel consumption, crank angle, hydrocarbon (HC) emission, carbon monoxide (CO) emission and nitrogen oxides (NOX) emission were conceded and recorded the data for several loads. The diesel and biodiesel blends were tried at standard engine specification at normal injection timing 23^0 BTDC, injection pressure of 210bar with compression ratio of 16.5.

5. RESULTS AND DISCUSSIONS

5.1 Brake Power

Figure.5.1 displays the assessment of BP against the load for diesel and diesel with and without piston modification. The investigational results display that the BP increases progressively with diesel and biodiesel for both the unmodified and modified piston. The BP is less for diesel and biodiesel with modified piston by 5.9 and 3.1 respectively.

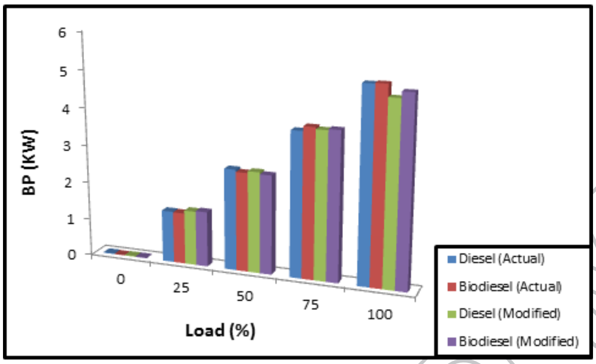

Figure 5.1 Load vs. Brake Power

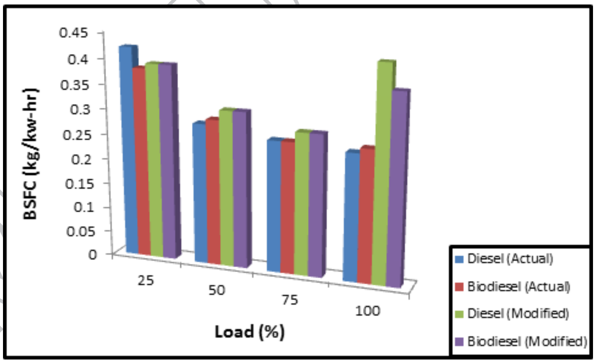

Figure 5.2 Load vs. BSFC

5.2 Brake Specific Fuel Consumption

Figure.5.2 displays the evaluation of BSFC against brake power at different loads for different fuel combination. The experimental outcomes show that the BSFC increases at 25% load for all the fuel combination but get reduced 75% load for all the fuel combination. The BSFC for diesel and biodiesel without piston modification is similar at 75% load and differs by 61.5% higher 42.3% higher at full load for modified piston.

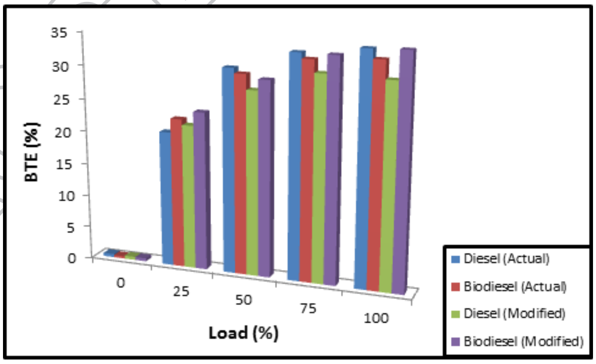

Figure 5.3 Load vs. BTE

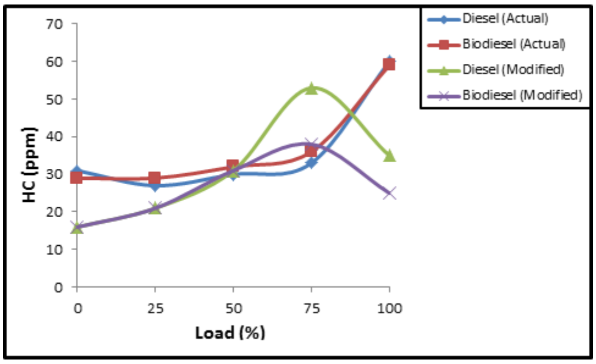

Figure 5.4 Load vs. HC

5.3 Brake Thermal Efficiency

Figure.5.3 displays the assessment of BTE against the load for diesel and diesel with and without piston modification. The investigational results display that the BTE declines by 8.1% with diesel and increases by 2.3% with biodiesel for modified piston but the BTE is same for diesel without piston modification and with modification.

5.4 Hydrocarbon Emissions

Figure.5.3 displays the comparison of HC release at different loads for diesel and biodiesel with unmodified and modified piston. The experimental results show that the Hydrocarbon emission decreases at 75% for biodiesel and also decreases at full load for both the diesel and biodiesel with modified piston. The HC emission at full load decreases by 41.6% for diesel and 57.6% for biodiesel with the modified piston. This is because of proper diffusion takes place at higher load, due to this it is clear that more amount of the HC emission reduces [11].

5.5 Carbon Monoxide Emissions

Figure.5.5 displays the comparison of CO release at different loads for both the diesel and biodiesel with unmodified piston and modified piston. The experimental results show that the CO release decreases with the modified piston for both the diesel and biodiesel. The CO emission at full load decreases by 5.4% for diesel and 9.8% for biodiesel with the modified piston. This may be due to the proper burning, which converts the **carbon monoxide molecules to CO_2 molecules.**

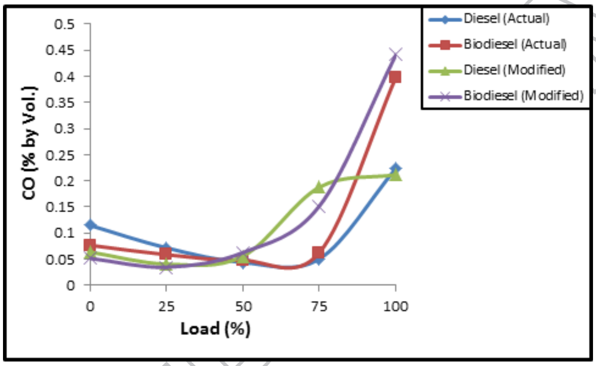

Figure 5.5 Load vs. CO

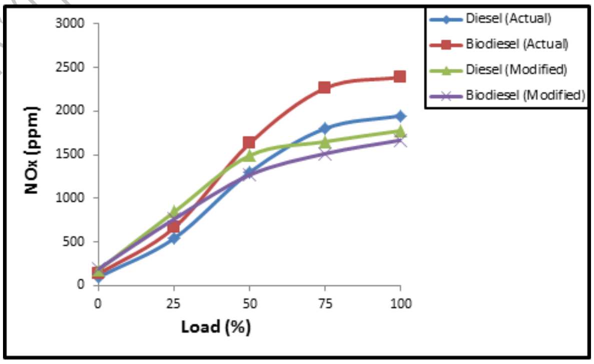

Figure 5.6 Load vs. NOx

5.6 Oxides of Nitrogen Emissions

Figure.5.5 displays the comparison of NO_X release at different loads for both the diesel and biodiesel with unmodified piston and modified piston. The experimental results show that the NO_X release decreases with the modified piston for both the diesel and biodiesel. The NO_X emission at 75% load decreases by 8.3% for diesel and 33.1% for biodiesel with the modified piston. The NO_X emission at full load decreases by 8.9% for diesel and 30.2% for biodiesel with the modified piston.

6. CONCLUSIONS

By modifying the engine piston head to 6º angle at crown part, we get the following:

- The SFC for diesel and biodiesel without piston modification is similar at 75% load and differs by 61.5% higher 42.3% higher at full load for modified piston.
- The BTE declines by 8.1% with diesel and increases by 2.3% with biodiesel for modified piston.
- The HC emission at full load decreases by 41.6% for diesel and 57.6% for biodiesel with the modified piston.
- The CO emission at full load decreases by 5.4% for diesel and 9.8% for biodiesel with the modified piston.
- The NO_X emission at 75% load decreases by 8.3% for diesel and 33.1% for biodiesel with the modified piston.

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