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Performance and Emission Characteristics of CI Engine with Modification in Fuel Injector

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Abstract**:** ***Work has been carried out using four stroke single cylinder diesel engine with retrofit attached with fuel injector and at optimum injection pressure 210 bar and 230 BTDC. The main purpose of using retrofit is to achieve HCCI (Homogeneous charge compression ignition) with which emissions can be reduced. Four Variants of retrofits were used and with V-cut type retrofit it was found that there is reduction in toxic emission like CO and NO but there was slight increase in HC emission when compared with normal fuel injector. Engine performance was compared with normal injector and injector with V-cut and it was found that Break thermal efficiency was increased by 0.25% at full load and 1.53% at 80% load and specific fuel consumption decreased by 0.01%.***

Keywords: Fuel Injector, HCCI, Retrofit, Emissions.

I. INTRODUCTION

The Diesel engine is a very hot cake topic for most of the researchers since from decades. Many experimental works are being carried out to reduce emissions because most of the toxic emissions are released from these engines. Most of the air borne diseases is occurred because of these toxic emissions. In this view many researchers are working towards reducing emissions. In this connection fuel injector plays a vital role since fuel sprayed from fuel injector. Different types of fuel injector are available with different nozzle hole sizes and with varying number of holes. But if the numbers of holes increase it leads to more fuel consumption which will increase specific fuel consumption. The present work has been carried out with four variants of retrofit.

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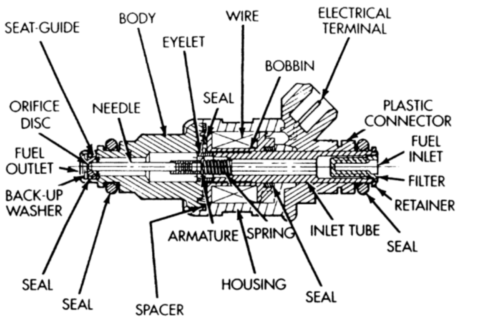


Fig-1: Figure shows parts of fuel injector.

II. LITERATURE SURVEY

1. W Ethan Eagle et al. has been experimentally investigated on spray behavior from multi hole nozzle, since spray pattern and spray break up length is important to know for further improvements in engine efficiency and even reducing emissions this investigation was carried by high speed imaging of diesel spray from injector employed in the CRDI system. The fuel injector nozzle had 4 holes aligned on a radial plane with diameters of 90, 110, 130 and 150 lm. Fuel was injected at room temperature at chamber densities of 17.5, 24.2, and 32.7 kg/cub-m and FIP was varied from 1000, 1500 and 2000 bar. From the results it was observed that the spray diffusion information showed significant variation in the spray geometry at past times and the greatest penetration distance did not occur along the spray centerline during the transient period of injection.
2. F Ruiz et al. This paper involves the investigation of design and working conditions of the engine on fuel flow and its atomization and even fuel properties were also been investigated. The plain-orifice and swirl atomizers were investigated and compared with each other. It was observed that atomization was obtained but there was more flow rate. Correlations are obtained for discharge coefficient and spray angle for fuel injection as a function of 8 different dimensionless variables. Because of this more flow rate it was recommended to go for improved design of fuel injectors.
3. M E McCracken et al. This paper is basically focused on the swirl motion of fuel being injected which is quite important parameter too since it effects mixing of fuel jets, heat release, emissions and overall engine performance

which can be effected by the swirling action / swirl flow field so in this paper it is been investigated that how these parameters effect by varying levels of swirl flow fields most favorable level of swirl for each geometry that results from a balance between increased jet surface area & hence, mixing rates & utilization of air in the chamber. The split injections may have a greater role in determining the mixing properties than spray-spring interactions as regards the fraction of the fuel injected in the multiple events and other features of the injection profiles.

4. Nithya Mahottamananda Jayapal et al. This paper is focused on the atomization of the fuel by swirl injectors since swirling motion spreads the fluid due to the effect of the centrifugal force and spread out in the form of a hollow cone liquid sheet as the fluid leaves the exit orifice. Experimental investigation of plug type swirl injector at varying injection pressure resulted in decrease in breakup length, the spray cone angle and increase in volume flow rate, while in turn there is decrease in the discharge co-efficient with low FIP, break up length is less for plug type swirl injector which is important spray characteristic required in combustion chamber of hybrid rocket.

5. Avinash Kumar Agarwal et.al has been conducted experiment focusing on the emission and performance characteristics of single cylinder diesel engine by varying the parameters like injection timing (SOI-start of injection) and injection pressure (FIP-Fuel injection pressure). In observation at lower FIP and advanced spark timings gave good ROHR (rate of heat release) in early combustion stages, BTE (brake thermal efficiency) was also increased with reduction in exhaust gasses. CO and HC emissions were reduced however the NOx emissions were increased.

Most of the researchers worked in the field of increasing the number of nozzle holes, varying injection pressure, split injection, pilot injection method. With all these literature survey it is found that with one are the other methods toxic emissions can be reduced like CO, HC and NO. But gap is identified from the literature survey that none of the researchers worked in the modification of fuel injector. In this view this paper is made with modification in the fuel injector.

III. METHODOLOGY

- Designing various profiles of retrofit using solid edge software.
- Use of D2 alloy steel for manufacturing retrofits.
- Modifying fuel injector in order to fit the retrofits.
- Experiments were conducted with various designed retrofits.

IV. EXPERIMENTAL SETUP

Engine Details
Diesel Engine
Power 3.50 kW
1500 rpm
Single Cylinder
Four stroke
Constant Speed
Water Cooled
Cylinder Bore 87.50(mm), Stroke Length 110.00(mm), Connecting Rod length 234.00(mm) Compression Ratio 18.00, Swept volume 661.45 (cc)

Fig-2: Figure shows four experimental setup

V. FUEL PROPERTIES

Density at 20°C (kg/m3)	0.829
Boiling point (°C)	260
Pour point (°C)	-1
Mole weight	200
Cetane number	45
Latent heat of vaporization (kJ/kg)	620
Auto ignition temperature(°C)	320
Viscosity at 30°C (MPa)	3.35

VI. RETROFIT MODELS

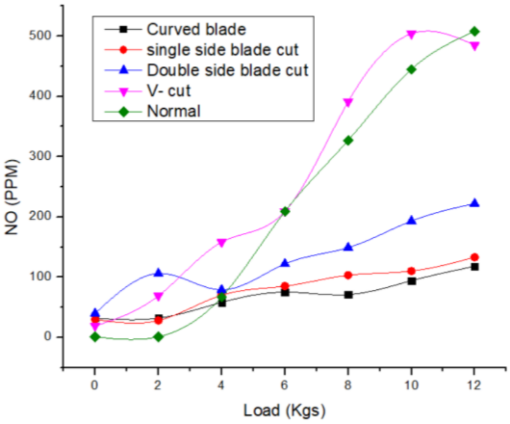
Fig-3: Single side blade cut model

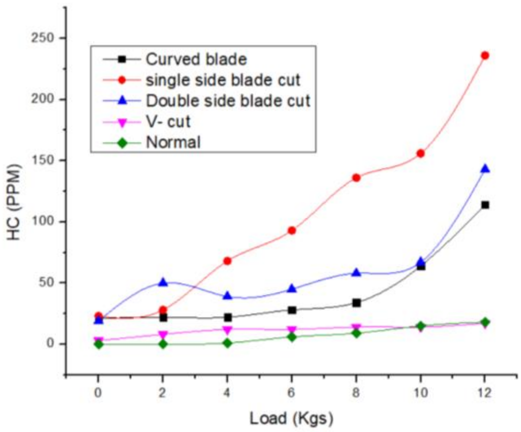
Fig-4: Double side blade cut model

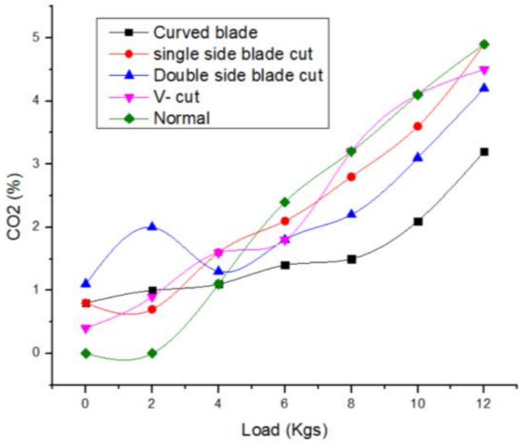
Fig-5: Curved blade cut model

Fig-6: V-cut model

VII. RESULT AND DISCUSSION

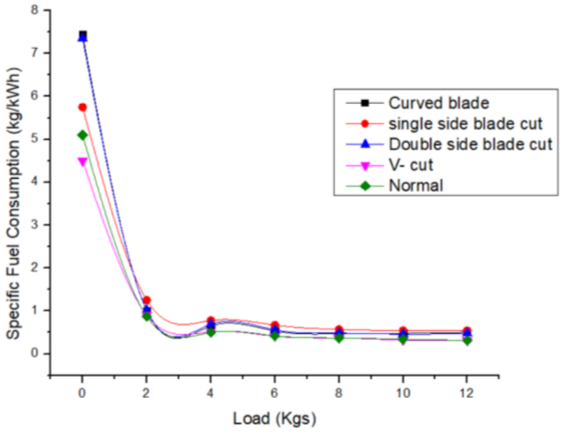


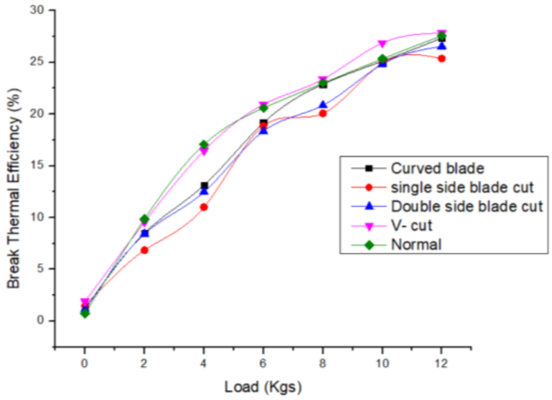


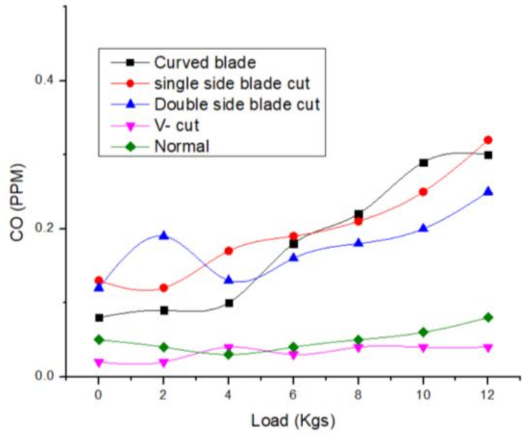


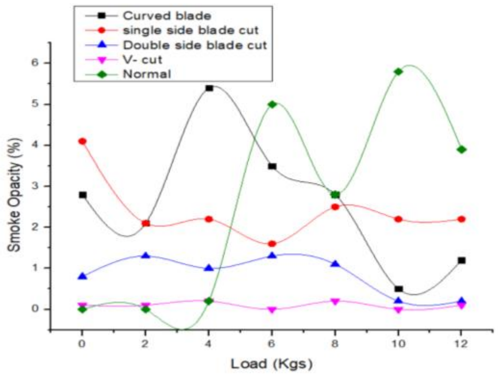
VIII. CONCLUSION

- BTHE increased by 0.25% at full load and 1.53% at 80% load with V-cut retrofit.
- CO emission decreased with V-cut retrofit.
- HC emission decreased with V-cut retrofit.
- NO emission decreased with curved blade retrofit.
- SFC decreased with V-cut retrofit.
- Smoke Opacity decreased with V-cut retrofit.









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