Emission characteristics of modified inlet poppet valve

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Abstract. In the case of a diesel engine, air is very important for increasing and decreasing engine parameters. On IC engines, air enters through an inlet valve passage, which is more critical. This is a promising combustion strategy for achieving homogeneity that combines the benefits of both SI and CI engines. Turbulence must be created in engines to achieve homogeneity, and as a result, swirl flow will be activated in the ignition chamber. In light of the stream properties of air streaming in different structures of the CI engine’s air inlet channel, many types are available to create swirl flow for enhancing engine efficiency and lowering emissions. The advantages of an HCCI engine is that it produces low NOx emissions by burning a lean mixture of charge. Working in cylinder with emission in exhaust gas are HC, CO, CO2 and NOx of CI engine, this is based on chamber pressure, temperature, loss of heat transfer on chamber surfaces, and working in cylinder with HC, CO, CO2 and NOx of CI engine. Changes to the inlet route must be performed to create turbulent conditions in order to improve IC engine characteristics. Turbulent will improve the uniformity of the air/fuel mixture at all ignition chamber entry points. This research is aimed at lowering emissions by modifying the inlet poppet valve of a four-stroke single-cylinder diesel engine. For modified inlet poppet valves of HC, CO for modified (masking) inlet poppet valve (4M), and CO2 for modified (masking) inlet poppet valve (4M), emission levels are lowered (2M).

1. Introduction

In a normal diesel engine, complete combustion is achieved by creating turbulence flow, which generates swirl, but in the case of an existing diesel engine, fuel burned will be incomplete combustion due to low swirl (in the case of an I.D.I.C.I engine, having a high swirl rate has both advantages and disadvantages) [1]. There are several methods for creating swirls in the chamber, one of which involves masking. The flow of air in the passage is disrupted by masking. Because of the disturbance in the air flow that enters the cylinder, the flow of air swirl will improve [2]. On the inlet poppet valve, masking is performed.

2. Literature survey

Conduction on diesel engine performance by varying the flow of air during inlet valve opens. Investigation has done by analysis in CFD and by experimenting on 4S 1S D.I. diesel engine. Based on the results obtained from the experimental work ηth is low in case of incomplete combustion engine due to less rate of air swirl compare to increased swirl rate by using modified inlet vale, it has...
improved from 20% to 28%. The emissions are reduced in case of modified inlet valve by complete combustion in the chamber. Optimizing flow of air at inlet to the engine cylinder can be done [1]. Inlet manifold is important for efficient usage of air which is entering into the cylinder. HCCI engine is achieved by inducing swirl with help of turbulence created in the CC. there are different designs for flow of air in characteristics of flow, volumetric efficiency in diesel engine is obtained by changing the design of inlet manifold. To improve in HCCI can be done by selecting masking and vane enhancement. Based on the development, the parameters like reduced emissions and complete combustion helps to achieve HCCI [2]. Moving the air in a turbulence flow is caused due to rotational flow within 4S 1bore D.I fuel engines. Obtained by using various design of intake system. With the rapid combustion and improving in efficiency takes place because of high quality of swirl. Difficulties of Flame propagation is caused due to high turbulence gives too much transfer of heat from hot gases to the walls of the cylinder. There are different parameters like modified piston, modified head and modified inlet passage are used to obtain a swirl in the engine. Due to swirl in the cylinder it helps to generate best mixture quality between fuel and air for atomization [3]. Importance of this investigation is to improve the engine parameters of diesel engine by using air enhancing equipment. Different types of air enhancing equipment are available to increase the engine efficiency are by turbocharger, length of stroke, pressure of injection, A/F ratio and supercharger etc. From the observation, consumption of fuel is reduced by 9.09% at full load in case of 5 vanes of nozzle comparing with conventional engine. NoX are less in case of 4 vanes nozzle is 17.18% at full load comparing with conventional engine. Density of smoke is reduced to 12.58% at full load comparing with conventional engine in 6 vanes nozzle [4]. Engines which are operating on bio fuel, GVST equipment can be used is to create a good flow of air quality inside the engine cylinder. In order that improves the combustion η in C.I engines. To know the effect of GVST equipment CFD analysis is performed by using a 3D model. TKE and velocities are comparatively good comparing with other type inlet passage. Height of the vane is divided to equal number of vanes on the runner radius of intake of GVST model. Observation of this work is to find out the optimize height of vane at 350˚ of twist with 4 vanes are arranged perpendicularly. Comparing with the standard model and GVST types, GVST0.20R gives better output like velocities, kinetic energy of turbulence and pressure [5].

3. Models of Inlet poppet valve

Conventional inlet poppet valve which are used for single cylinder four stroke diesel engine. Valves in an IC engines plays vital job in engine gasp, pressures, execution and life span. It doesn't make a difference if an engine has 2, 3 or more valves for every chamber independent of petroleum or diesel type since all the valves work similarly i.e., open and close at definitely right minutes, to forestall pressure misfortunes and to permit unhindered progression of air into the chambers and hot gas to leave the chambers. It is made up of HSS material.

![Figure 1. Conventional Inlet poppet valve [1].](image)
4. 3-D model of Modified inlet poppet valve

Modified inlet valve of 2 masks and 4 masks. Mask is tilted at an angle of 45° and place at 90° on opposite sides of inlet valve. By using CATIA software. Its thickness and height are 2mm. Mask which is added on the back of valve radius without intersecting the valve seating. Such way that modification is created [6].

![Figure 2](image1)

**Figure 2.** Modified (masking) Inlet poppet valve (2M) [6].

![Figure 3](image2)

**Figure 3.** Modified (masking) Inlet poppet valve (4M) [6].

5. Fabrication of Modified Models of inlet poppet valves

In this type of design there is a combination of 2 small pieces called mask which are opposite to each other at 90° angles. 4 pieces called mask which is opposite to each other at 90° angles. Mask is made up of material i.e. mild steel with 2mm height and thickness. Fastening is done by brazing process [6].

![Figure 4](image3)

**Figure 4.** Modified (masking) Inlet poppet valve (2M) [6].
6. Diesel Engine Experimental Setup

The setup consists of single cylinder, four strokes, VCR (Variable Compression Ratio) Research engine connected to eddy current dynamometer. It is provided with necessary instruments for combustion pressure, crank-angle, airflow, fuel flow, temperatures and load measurements. These signals are interfaced to computer through high speed data acquisition device. The setup has stand-alone panel box consisting of air box, twin fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and piezo powering unit.

6.1 Specifications of Engine Setup

Lab view based Engine Performance Analysis software package ‘Engine soft’ is provided for performance evaluation on the given specifications of engine setup. A computerized Diesel injection pressure measurement is also provided. Table 1 provides the specifications of the engine set up.
Table 1: Specifications of Engine Setup.

| Specification          | Value                      |
|------------------------|----------------------------|
| Make                   | Kirloskar                  |
| Power                  | 3.50kW                     |
| Speed                  | 1500 rpm                   |
| No. of Cylinder        | 1 (Single Cylinder)        |
| No. of Stroke          | 4-Stroke                   |
| Type of Cooling        | Water Cooled               |
| Fuel                   | Diesel                     |
| Cylinder Bore          | 87.50mm                    |
| Stroke Length          | 110mm                      |
| Connecting Rod Length  | 234mm                      |
| Compression Ratio      | 18.00                      |
| Swept Volume           | 661.45cc                   |

6.2 Emission Test Setup

Five gas analyser setups are used for measuring the emission levels of diesel engine. Emissions parameters are CO, HC, CO\textsubscript{2} and NO\textsubscript{x}. Figure 7 shows the emission level measurement set up.

![Figure 7. AVL 5 gas analyser (Model AVL444N) [6].](image)

7. Results and Discussions

Transportation vehicle emissions are a major source of pollution, especially in urban areas. They are significant sources of both local urban pollutions such as NO\textsubscript{x} and HC with CO, as well as global greenhouse gas emissions such as CO\textsubscript{2}. The surface area of the combustion chamber may play a role in determining the amount of unburned hydrocarbons emitted. A circular shape has the smallest surface zone to volume ratio for a given volume and is thus ideal from the start. Graphs of HC, CO, CO\textsubscript{2}, and NO\textsubscript{x} emissions are obtained by plotting and compared with conventional and modified inlet poppet valves.
7.1 Hydrocarbons (HC):

Hydrocarbon emissions are made up of unburned fuels as a result of insufficient temperature near the cylinder wall. If the temperature is above 600 degrees Celsius and there is oxygen present, unburned hydrocarbons continue to react in the exhaust.

![Figure 8. Load vs. HC for Conventional Fuel.](image)

It is observed that in figure 8, 22.22 % of HC is reduced for Modified (masking) Inlet poppet valve (4M) when compare to conventional inlet poppet valve at maximum loading condition. For 50% and 100% loading the percentage of unburnt fuel is less for modified valve (2M & 4M) than conventional valve, due proper mixture of air and fuel.

7.2 Carbon monoxide (CO):

Carbon monoxide is produced by incomplete combustion, which occurs when the oxidation process does not complete completely. Carbon monoxide is a colourless, odourless gas.

![Figure 9. Load vs. CO% for Conventional Fuel.](image)

It is observed that in the above figure, 32.72 % of CO is reduced for Modified (masking) Inlet poppet valve (4M) when compare to conventional inlet poppet valve at maximum loading condition. For 50%
loading, the percentage of incomplete combustion is less for conventional valve, modified Valve (4M) than for modified valve (2M) due to less oxidation process. During 100% loading, the percentage of incomplete combustion is less for modified Valve (2M & 4M) than conventional valve that is because of more oxidation process occurred.

7.3 Nitrogen oxides (NOx):

Air, mainly composed of oxygen and nitrogen, is initially drawn into the combustion chamber, then, it is compressed. Nitrogen oxides results from the engine cylinder temperature. As the cylinder temperature increases reflects an increase in NOx.

![Figure 10. Load vs. NOx for Conventional Fuel.](image)

It is observed from figure 12 that 21.05 % of NOx is reduced for Modified (masking) Inlet poppet valve (2M) when compare to conventional inlet poppet valve at maximum loading condition. For 50% and 100% loading the percentage of NOx is reduced for Modified valve (2M & 4M) than conventional valve. Due to increase in surrounding cylinder temperature for conventional valve.

7.4 Carbon dioxide (CO2):

Carbon dioxide (CO2) has the largest rate among the greenhouse gases, and it is the main reason of global warming. As CO2 increases, that indicates the complete combustion taken place. It is product of CO which gives to CO2.

![Figure 11. Load vs. CO2% for Conventional Fuel.](image)
It is observed from figure 10 that 17.60% of CO₂ is reduced for Modified (masking) Inlet poppet valve (2M) when compared to conventional inlet poppet valve at maximum loading condition.

8. Conclusion

The final conclusion for the current study were drawn from exhaustive investigation on the use of inlet poppet valves in diesel engines with modified inlet poppet valve designs. Diesel engine emissions are decreased by using redesigned inlet poppet valves with maximum loads. Based on the reduction in percentage of emissions, air/fuel mixture formations are noticed better with improved input poppet valves.

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