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# Effect of Inlet Air Swirl in CI Engines – A Review

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## ABSTRACT

*Air entering in an inlet manifold has more effect in an IC engine. With this a promising combustion strategy that combines the benefits of both SI and CI engines in order to get HCCI [Homogeneous charge compression ignition]. To get HCCI in an engine, turbulence has to be created and hence swirl will be induced in the combustion chamber. Different types are there to generate swirl and improve the efficiency of the engine and also reduces emissions. Inlet manifold are designed such way that to achieve the best volumetric efficiency. Based on the flow characteristics of air flowing in various designs of air intake manifold of ci engine. A volumetric combustion of lean mixture of charge is the advantage of HCCI combustion, leading to low $No_x$ emissions. That depends upon cylinder pressure, temperature, cylinder wall heat transfer losses, piston work and emissions such as CO, $CO_2$ & $No_x$ of CI engine in HCCI. One promising technology for improving ic engine efficiency is modified the inlet system to generate turbulence. Turbulence increases homogeneity of air fuel mixture in all starts of combustion chamber. Many efforts have been made by researchers toward enhancing the efficiency and emission reduction. This journal focuses upon generation of swirl by different types and along with relevance.*

***Keywords: Emissions, HCCI, Intake system, Performance, Swirl & Turbulence.***

## I INTRODUCTION

Automobiles are increasing day by day. Hence efficiency of IC engines need encouragement in future. Since they consume less fuel and significantly reduce polluting gases like carbon monoxide and unburned hydrocarbons. Increase in fuel consumption causes large outflow of foreign exchange. Environmental problems have prompted developing countries like India to search for suitable environmental friendly efficient engines or to find methods to reduce emissions from existing engines [1]. The main function of an air intake system is to supply the clean air to the engine with correct amount for the required air to burn in the combustion chamber. The intake system of an engine has three main functions. Its first and usually most identifiable functions are to provide a method of filtering the air to ensure that the engine receives clean air free of debris. Two other characteristics that are of importance to the engineers designing the intake system are its flow and acoustic performance [2].The CI engine yields high particulate and $No_x$ emissions. These effects may be attributed to their conventional combustion process. A hybrid combustion process called homogenous charge compression ignition [HCCI] equipped with advanced low temperature combustion technology has been gaining attention

from researchers [3]. The significance of the diesel engine performance parameters are geometrical properties. The term of efficiency and other related engine performance parameters. The engine efficiencies are indicated thermal efficiency, brake thermal efficiency, mechanical efficiency and volumetric efficiency. A wide variety of inlet manifold system geometries pattern used to accomplish this over the diesel size range [4].

**II Different types to achieve swirl or turbulence in CI engine:**

1. Intake manifold system
2. Piston bowl
3. Guide vane in air intake system
4. Inlet poppet valve

**1. Achieving swirl by intake manifold system:**

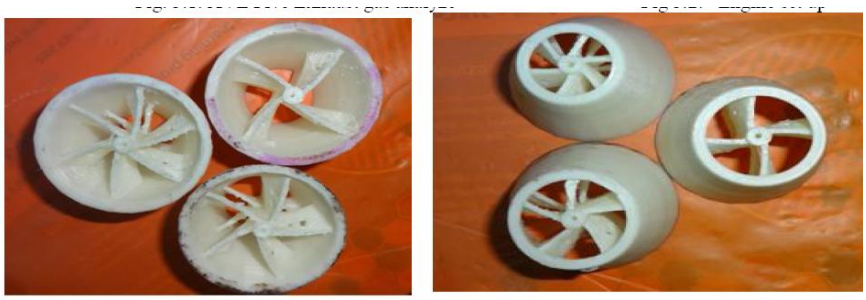

Fig.1: Vane nozzles in intake manifold system

Vane nozzle is inserted in intake manifold to study the Emission and performance characteristics on a single cylinder, 4-stroke, constant speed diesel engine at a compression ratio of 18. The vane nozzle made up of plastic material. The combustion and emission characteristics of single cylinder compression ignition engine with vane nozzle have been studied and compared to the standard normal engine. By using these vane nozzles for different varying loads. In this study come to know that from 0 to 18 Kilograms load the brake power is slightly increased in percentage for three vane nozzle when compared with normal engine. All most all vane nozzles are slightly increase in brake power when compared with normal engine. In five vanes nozzle there is a decrease in specific fuel consumption at full load compared with normal engine. At peak loads four vanes nozzle emits less NOx are decreased when compared with normal engine. The smoke density is reduced at peak loads when compared to normal engine for 6 vanes nozzle [5].

**2. Piston bowl**

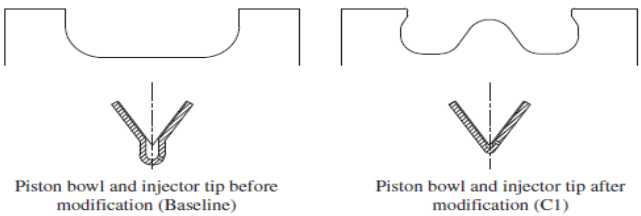


Fig.2: Modifications of normal engine

The present study concerns the effect of swirl induced by re-entrant piston bowl geometries on emissions in a diesel engine, and specifically focuses on a single cylinder, 7.5 kW constant-speed engine. The emission test of two configurations of the selected engine are studied. The second configuration which has a slightly re-entrant combustion chamber and a sac-less injector was found to yield lower emissions. In order to understand the effect of re-entrancy and injector change on emissions. The effect of chamber geometry and injector change was studied using unfired and fired simulations. Simulation of closed valve part of the cycle in the two configurations revealed that average swirl and turbulence levels around TDC of compression were higher for the baseline case than for the modified geometry. Increased surface area, presence of a large central projection and insufficient re-entrancy were identified as the reasons for the modified geometry yielding poor. Thus indicating scope for optimization of bowl geometry. Several piston bowl geometries with varying levels of re-entrancy and different heights of central projections were studied. A highly re-entrant piston bowl and without a central projection was found to be the best for swirl and TKE intensification around TDC. Combustion simulations was carried out using the selected geometry and injection timings were optimized to keep NOX levels below those of the baseline case. Depending upon the injection timing of CA BTDC was found to be optimum since it led to a reduction in NOX emissions and reduction in soot levels as compared to the baseline configuration [6].

## 3. Guide vane in air intake system

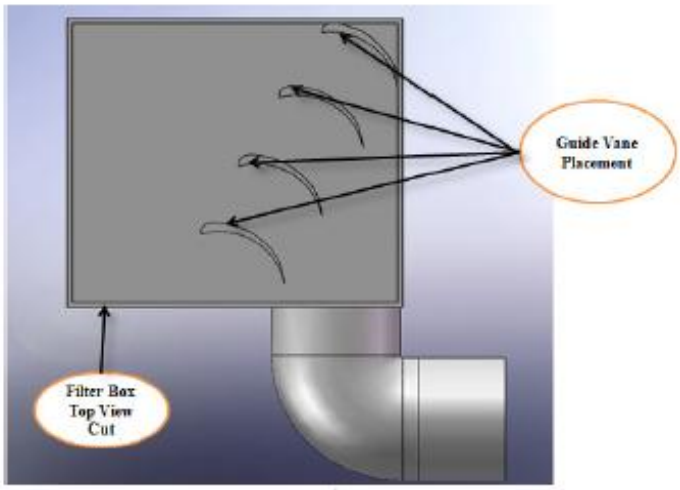


Fig.3: Positioning of guide vane in air intake system

Based on the study carried out that it can be fulfilled as when there is high pressure number enters the outlet pipe to the intake manifold this means that the pressure in the manifold is closer to atmospheric pressure. When the pressure drop is decrease air is being quite freely admitted to the engine, which in turn means that more air and fuel is being provided to it, which generates more power. Changes are incorporated in the design of the guide vane improved overall pressure drops for the rpm speed of 1000 to 7000. Effect of adding more guide vane position on the critical region may improve the design of AIS even further. Building duct that has more flow features that can guide the air [8].

**4. Inlet poppet valve**

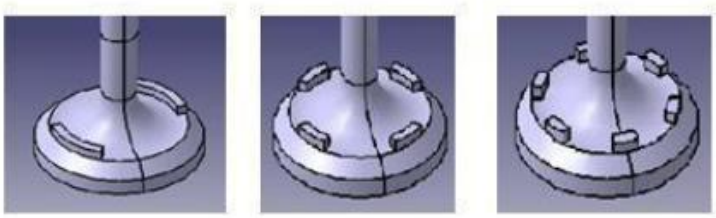

Fig.4: Masking on inlet poppet valve.

A study is carried out by optimization of inlet air can be done by means of masking on inlet poppet valves. SS material is used for manufacturing of masking and fins on valves. Masking on inlet valves may improves swirl rate and intern brake thermal efficiency of engine. Fins type of design on valve can also increase the swirl rate and better thermal efficiency. Pollution levels can be decreased with both valves when compared to conventional valve [7].

## III Conclusion

The extensive research work has been occurring in the field of ic engine. Enhancement has happened in the improvement of HCCI by choosing guide vane and masking. This outline given the spotlights on research did for development of the parameters like efficiencies and reduction in emissions. The consolidation of swirl in IC engine has advantages over the characteristics. The swirl generators have several advantages improvement in performance of engine, reduction in $No_x$ emissions and creates HCCI. The work is as yet to investigate the angles and restrictions of these equipment. So the research must focus on the advancement of such materials used for product having lower cost. One huge limitation is volumetric efficiency and weight of the product.

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