CFD Simulation of In-Cylinder Air Swirl by Modification in Piston Bowl

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***Abstract*— The purpose of study is to know the air swirl inside the combustion chamber through the CFD simulation of 4 stroke single cylinder Diesel engine. This helps to know the flow of air in the cylinder before conducting the experimental work. From this CFD simulation work, we can identify the behavior of air swirl. In this study, piston is modified to increase the physical phenomena inside the combustion chamber. The effect of redesigned bowl will have on CFD and the efficient operations of diesel engine for bulky applications. The configurations of modified piston bowl shall be the mainly significant component for the effect of air/fuel mixture. By changing the piston bowl like size, shape and area is well known to influence in chamber blending and number of cycles for better combustion process and engine performances. Model was designed by using CATIA and Configured AVL FIRE 2014.1 simulation in star ccm+.**

Keywords— Diesel Engine, modified Piston, CFD.

I. INTRODUCTION

Diesel engine is also called as C.I engine, which are generally used for transport, farming application and mechanical segments due to more fuel transformation efficiency with simple activity. The current C.I engine work with regular CN fuels got through raw petroleum. It is notable to world oil assets be constrained in addition to creation of unrefined petroleum is getting increasingly troublesome and costly. Then again, the pollutant includes unburnt hydrocarbon, CO, NO_x with soot emission can be managed by regulation in numerous nations. Swirl atomizes the air fuel flow by optimizing inside the engine chamber due to which intake motion can create more energy of kinetic during the cycle of operating. In conventional engine, close to optimum flow values are essentially well-known and included, along with so called motion of tumble and swirl.

II. LITERATURE SURVEY

P.Venkatesh et.al [1] experiment was performed on how to minimize emissions by modifying piston geometry. In DI engines, swirl can affect the air-fuel mixing phase. Swirl mixing with compression mixing improves the mixing in the combustion bowl. The amount of influence geometry has on the intake stroke is negligible, and geometry has very little effect upon the early part of the compression stroke. The brake thermal efficiency at a compression ratio of 17.5:1, at a pressure of 220 bar and at maximum load was found to be maximized.

Praveen A. Harari et. al [2] The research is about how air swirl affects engine efficiency, combustion, and emissions performance to help better mixing without the need for the turbulence, and the fact that it is controllable by the shape of the combustion chamber. Innovation in combustion chamber architecture is in high demand as with the emergence of new developments in automotive engines and fuel types. Combustion chamber is important in CI engines, since they are used in a wide range of applications.

K.S.Karunakar et. al [3] have simulated a diesel engine by implementing tangential grooves on the piston in an effort to boost through combustion. The project aims to create spinning motion in the compressed air in the combustion chamber by modifying the piston. The swirl motion that occurs in the combustion chamber leads to better mixing of the fuel and air which enables more efficient combustion.

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III. METHODOLOGY

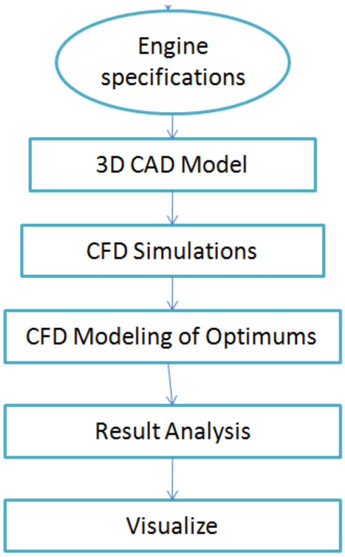


Fig. 1 shows Methodology

IV. ENGINE DETALIS

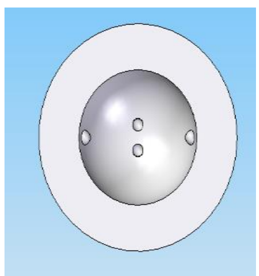
Water cooled, single cylinder, 4-stroke diesel engine	
Engine make	Kirloskar
Model	TV1
Power	5.2 KW
Bore Diameter	87.5 mm
Stroke length	110 mm
Speed	1500rpm
Compression ratio	17.5:1
Swept volume	661.45cc

Fig. 2 Shows engine details

V. 3D CAD MODEL DESIGN

The engine model studied by a typical single-cylinder diesel engine with combustion chamber on bowl shape piston. By using CATIA V-5 R18 software.

Conventional piston



Modified piston

Fig. 3 shows 3D cad model

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VI. CFD SIMULATION

A. Velocity distribution for Conventional piston

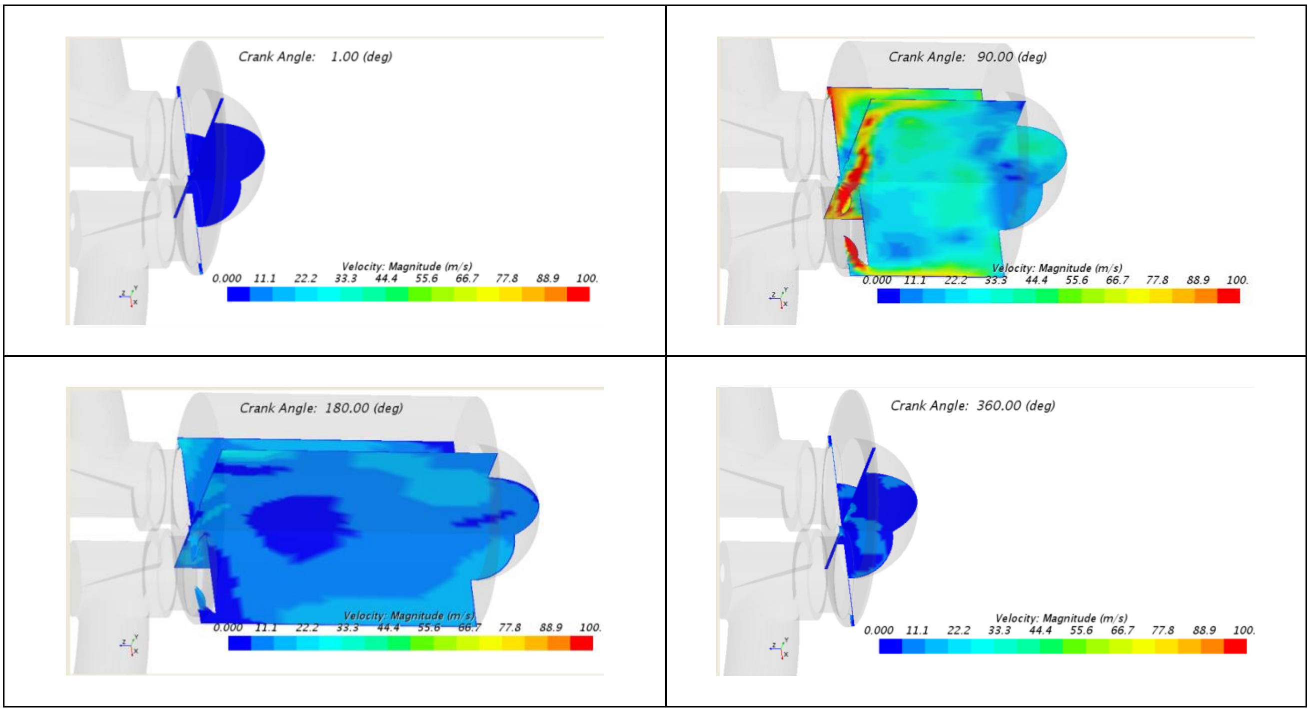

Fig. 4 shows Velocity distribution for Conventional piston at different angles

B. Velocity distribution for Modified piston

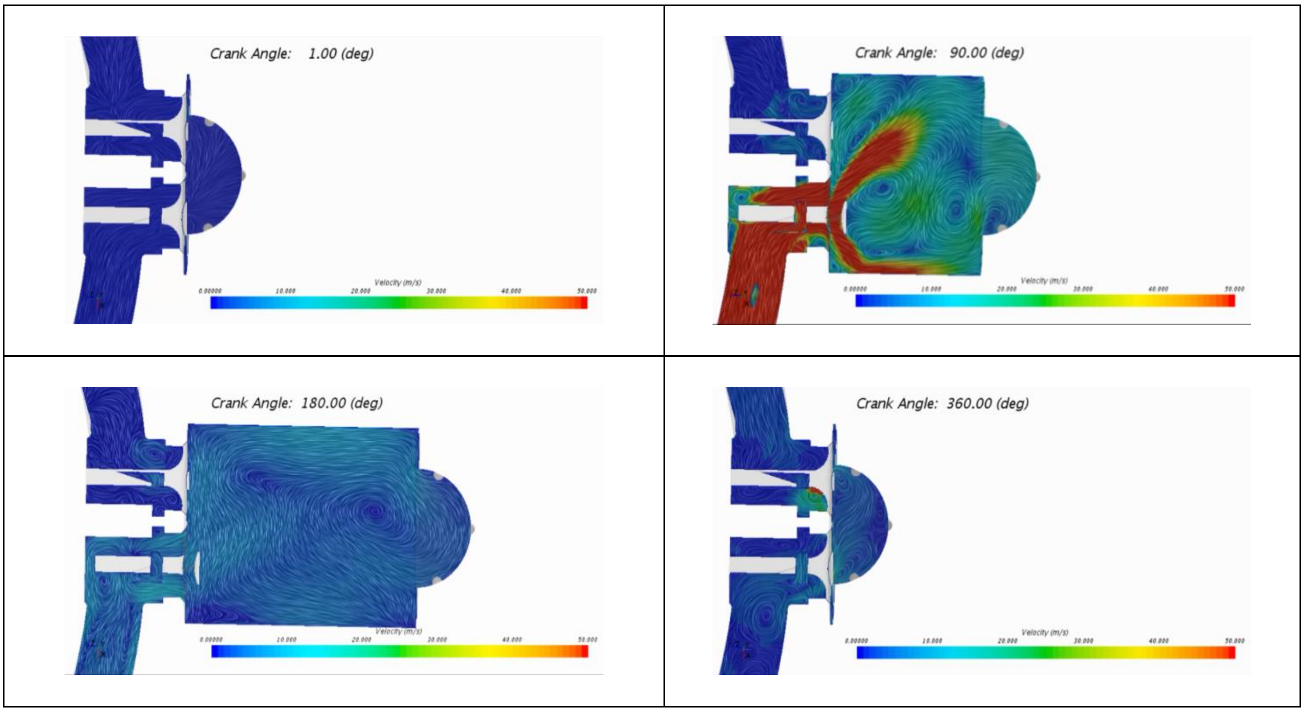

Fig. 5 shows Velocity distribution for modified piston at different angles

VII. RESULTS AND DISCUSSION

Air swirl Comparison of velocity distribution is made between conventional piston and modified piston at various crank angles such as 1^0,90^0, 180^0 and 360^0. Using FLUET tool star ccm+.

1. Velocity distribution at 90^0crank angle is high for modified piston when compare to conventional piston. Identified based on the color, red is more visible at 90^0 crank angle.
2. Velocity distribution at 180^0crank angle is comparatively high for modified piston when compare to conventional piston. Behavior of air swirl is visible based on green color at 180^0 crank angle.
3. Velocity distribution at 360^0crank angle is comparatively high for modified piston when compare to conventional piston. Behavior of air swirl is visible based on green color when piston moving towards Top dead centre.

This proves that more air swirl is created in the cylinder leading to more proper air-fuel mixture for complete combustion of fuel.

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