Design and Analyse of Intake Manifold of Four Cylinder Engine

Shreyash Sable[1], Dr. J.G. Khan[2], Dr. S.P. Trikal[3]
[1]*ME Student, (AMMSD), Mechanical Engg Dept, Shri Sant Gajanan Maharaj College of Engineering, Shegaon*
[2]*Associate Professor, Mechanical Engg Dept, Shri Sant Gajanan Maharaj College of Engineering, Shegaon*
[3]*Professor, Mechanical Engg Dept, Shri Sant Gajanan Maharaj College of Engineering, Shegaon*

Abstract **- In automotive technology, an intake manifold is the component of an engine that transports the air-fuel mixture to the engine cylinders. The main purpose of the intake manifold is to evenly distribute the combustion mixture to each intake port of the engine cylinder and to create the air-fuel mixture unless the engine has direct injection. This review paper mainly focuses on the Design of the Intake Manifold for better efficiency. With the Change of the existing model with the proposed design and by changing the Material to show less Heat transfer to get better Fuel Burning and directly resulting in the greater efficiency of the Car. In this paper, I have studied some papers and also gone through the basics of my topic from various books to understand the phenomena.**

Index Terms **- Intake Manifold, Computational Fluid Dynamics (CFD), Plenum, Runner.**

INTRODUCTION

The engine of a car needs air for the combustion process in the cylinders. Air Intake Manifold has an important role in getting a desirable amount of air into automobile engines by improving combustion efficiency and reducing air pollution. The main purpose of the intake manifold is to evenly distribute the combustion mixture to each intake port of the engine cylinder and to create the air-fuel mixture unless the engine has direct injection. Even distribution is important to optimize the volumetric efficiency and performance of the engine, the two most desirable techniques were found to increase the volumetric efficiency, and they are intake manifold design and variable valve timing Technology for intake and exhaust valves. The design of the variable valve timing technology is quite complex and expensive to produce, and it offers quite less scope of research, thus almost every researcher and automotive industry is focused on the improvement of the intake manifold.[1]

IC engines produce air pollution emissions as a consequence of the uneven distribution of combustible air to the engine and incomplete combustion of the air-fuel mixture. The principal products of the process are carbon dioxide, water, sulphur, black carbon, and some unburnt hydrocarbons, which is produced due to lesser amount of air-fuel ratio supplied to the engine, and the additional products of the combustion process include nitrogen oxides, which is produced due to excess amount of air-fuel ratio supplied to the engine. The amount of air is only one parameter that produces emission. Thus, it is needed to design a manifold that delivers the appropriate amount of air to the combustion chamber.[2]

The entirety of the air cycle will affect the volumetric efficiency of the engine. How the air travels before it enters the engine and after it leaves the engine, has a large impact on how well that engine performs.

LITERATURE SURVEY

By using the CFD analysis, the authors had performed an investigation of the flow pattern, within the intake manifold [2]. As a result, each model shows the variation with the experimental results. For better accuracy and predictability, it is important to analyze the model using transient flow conditions inside Intake Manifold with throttle conditions. Furthermore, for future validations high calibrated sensors should be

used to improve the accuracy of experimental data obtained.

In this paper, the authors studied the major effect on a vehicle's engine performance, noise, and pollutants [3]. The authors described the design and manufacture of an intake system for a 600cc YAMAHA ZF engine. By using FIBER REINFORCED POLYMERS, the geometry of the intake system has been redesigned to result in reduced weight. As a result, it improved charge distribution and increased torque through a wide RPM range when compared to its traditionally-manufactured aluminum counterpart. Incorrect air-fuel ratios can lead to excessive exhaust gas temperatures, pre-ignition detonation, causing components such as head gaskets and pistons to fail. The new manifold is aimed at tackling these issues by supplying a uniform amount of air to all four cylinders. 3D modeling is done using Solid-Works and the internal flow distribution will be calculated.

The authors performed an investigation of the effect of intake runner length on the performance characteristics of a four-cylinder compression ignition engine with an electronically controlled fuel injector [4]. The works on Analytical calculations for Runner diameter and plenum length and also Generating the model using CAD software. By using the CAE Analysis, they determined the vibrations and localization of thermal stresses. As a result, they concluded that intake geometry made a conside5rable impact on outlet velocity. The main impact is on the volumetric efficiency of the engine which ultimately affects the torque and power produced at a different engine speed.

The author performed an analysis of the flow-through intake manifold of four cylinder spark ignition engine[5].During the studied author used parameters likes the pressure, velocity, and flow characteristics inside the runner with cases:- All runners open, 1st & 3rd runners' open and 2nd & 4th runners open. As a result, the author noticed the different velocity distributions in different cases.

The authors have designed the new intake manifold by using CATIA software [6]. In this works, the authors mainly focus on the material of Intake Manifold. They completed the thermal analysis of Aluminum and Cast-Iron material of the Intake Manifold. As a result, they observed that Cast Iron has better thermal quality than Aluminum material.

After reviewing the work of different authors as above it can be concluded that intake geometry considerable impact on engine performance. The main impact is on the volumetric efficiency of the engine ultimately affects the torque & power produced at different engine speeds. It will need to Analyse the pressure and velocity of the incoming air-fuel mixture in plenum volume at different parameters and boundary conditions. Redesign of intake manifold plenum chamber and the runner can be done to get maximum engine performance and will Eliminate the risk of unburnt Hydrocarbons. Max heat will be used inside the manifold itself thus giving the better burning capacity. Hydrocarbons will not cause Smoke and the smoke-free system will not increase pollution.

PROBLEM STATEMENT

The primary function of the intake manifold system was to transport combustion air to the cylinder. Specifically, the primary design goal was to distribute the air evenly to each intake port, as doing so improve the engine's ability to efficiently produce torque and power. The geometric design of the intake system affects the volumetric efficiency of the engine, and thus directly affects the performance of the vehicle. The construction of the intake system has a major influence on how the engine performs at various RPMs. The challenge, therefore, was to optimize the design of the intake system and remap the fuel injection system. To achieve the primary design goal of distributing equivalent amounts of air to each cylinder, there are several objectives to consider when designing an intake system:

- Minimize pressure loss, as pressure loss results in a decrease in output power.
- Maintain equal static pressure distribution in the plenum, as this will cause the cylinders to pull the same vacuum, thus leading to even flow in each cylinder.
- Minimize bends and sudden changes in geometry, as these geometric effects can cause pressure loss.
- Maximize air velocity into the cylinder, as this provides a better mixture of fuel and air, which results in better combustion and performance.
- To select optimum plenum size according to the engine to the maximum mass flow rate to improve the volumetric efficiency.

OBJECTIVE OF DESIGN

- Study of Existing model of an Intake Manifold.
- Study and analyze of Propose Design of Intake Manifold.
- Compare the thermal condition existing and propose manifold
- Development of a CAD model for newly design intake manifold model
- Analyze the pressure and velocity of the incoming air-fuel mixture in plenum volume at different parameters and boundary conditions.

PROPOSED METHODOLOGY

To achieve the best intake manifold of the engine, a methodology is proposed as given below: [7] [4]

- Analysis of Problem and research for solution
- Design and Analysis of the proposed model by using the software.
- Comparing the results newly design model.

1] Analysis of Problem and research for solution
After a detailed analysis of the system, the problem is defined. Unburnt fuels are emitted as Hydrocarbons in Nature. The heat releasing in the environment leaves more and more unburnt hydrocarbons from Fuel. For a solution Change the inlet of Manifold and Design and Change the Material of Manifold.

2] Design and Analysis of the proposed model by using the software.
Software to be used:

- CATIA

CATIA software (Computer-Aided Three-Dimensional Interactive Application) is selected for drafting and design of the model. CATIA functionality is growing with each release; it will be the program that does it all. CATIA delivers innovative technologies, for maximum productivity and creativity from the concept to the final product. It is the leading-edge technology starting with its product concept, through design, assembly, testing, manufacturing, and modeling to its rendering capabilities.

ANSYS
For analysis of the model, ANSYS is selected. In this analysis, two terms are used CFD and CFX.

CFD - Computational fluid dynamics (CFD) is the use of applied mathematics, physics, and computational software to visualize how a gas or liquid flows as well as how the gas or liquid affects objects as it flows past.
CFX- Ansys cfx is a high-performance computational fluid dynamics (CFD) software tool that delivers reliable and accurate solutions quickly and robustly across a wide range of CFD and multi-physics applications.

3] Comparing the results newly design model.
Comparison between the results of the Velocity Counters in CFD and CFX and with the Pressure Counters in CFD and CFX rig data. Analysis of the results and recommendations some suggestions to improve the performance of the intake manifold.

Design Theory
Various design theories have been suggested throughout the history of intake, manifold development. The basic layout of the fuel injection manifold will be determined by its application. Imperfect geometry of the plenum and runners causes the pressure and velocity losses. These losses affect on the volumetric efficiency, performance of the engine and it cause high air pollutant emission. After change in geometry in intake manifold we have a new proposed model by CATIA software as shown in below fig.

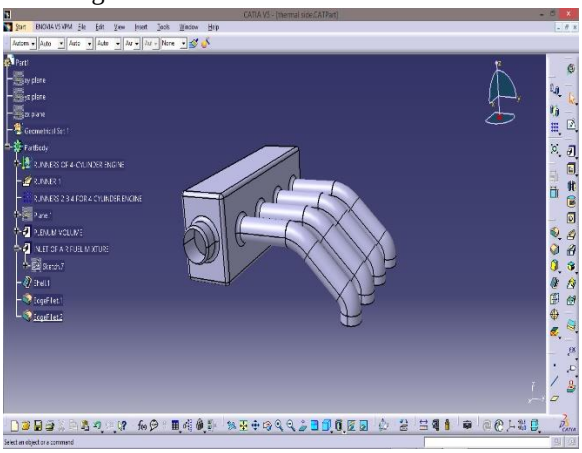

Fig: New Proposed Model of Intake Manifold

CFD ANALYSIS RESULTS OF NEW PROPOSED MODEL

1)Velocity counter

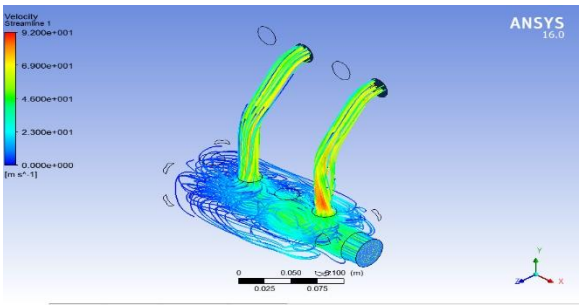

Fig: Velocity Counter for Runner 1 And 3

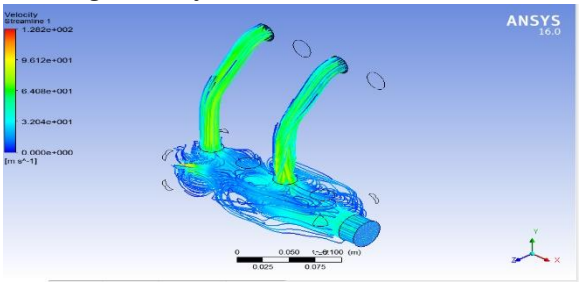

Fig: Velocity Counter for Runner 2 And 4

2)Pressure counter

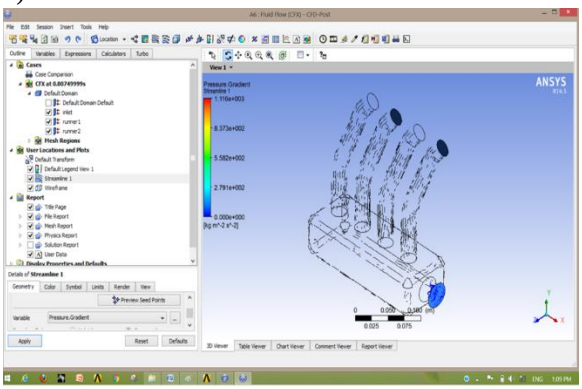

Fig: Pressure Counter for Runner 1 And 3

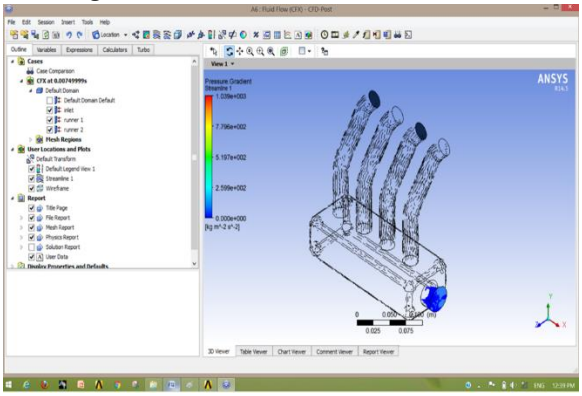

Fig: Pressure Counter for Runner 2 And 4

RESULT AND DISCUSSION

1)Velocity counter

	Runner 1and 3 (m/s)	Runner 2 and 4 (m/s)
Existing model	9.17e+001	9.068e+001
Proposed model	9.20e+001	1.282e+002

2)Pressure Counter

	Runner 1and 3 (m/s)	Runner 2 and 4 (m/s)
Existing model	4.399e+002	1.255e+003
Proposed model	1.116e+003	1.039e+003

CONCLUSIONS

Based on this extensive research work, it concluded that there are pressure and velocity losses in existing model. Therefore, it effect on the volumetric efficiency and performance of engine and have a more pollutant emission. After Analysis of proposed model it seen that there is decrease in pressure and velocity losses. So it helps to increase in volumetric efficiency, performance of engine and reduction in pollutant emission.

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