Intake System of Formula SAE Car: A Proposed Model

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Abstract– This paper proposed the restrictor geometry to achieve a maximum air flow with minimum pressure drop to improve engine performance of a FSAE car. Formula SAE competition has imposed a rule of including a 20 mm (0.787 inches) restrictor in the intake manifold allowing all the air flow to the engine through this single restrictor whether it may be a single cylinder or multi-cylinder engine. Due to 20 mm restrictor rule, the designed intake of 390CC engine is reduced. This drastic change reduces the air flow to the engine thereby controlling its power output.

Keywords: - Runner, Plenum, Air Restrictor, Throttle Body.

I. INTRODUCTION

The purpose of this project is to design a custom intake manifold for a Formula SAE race car. Formula SAE is a student level competition which is organized by the Society of Automotive Engineers. This Competition was started in 1978. The moto behind this competition is to contract a student design team to develop a small Formula style Race car. This competition is conducted in various parts of the world and about 92 universities participate every year from all over the world.

Formula SAE competition has imposed a rule of including a 20 mm (0.787 inches) restrictor in the intake manifold allowing all the air flow to the engine through this single restrictor whether it may be a single cylinder or multi-cylinder engine. Engines used in this competition are limited to 610cc Gasoline engines with revolutions upto 12000 rpm having a power output of 110 HP. An IC engine requires proper air-fuel mixture for its efficient performance. Due to 20 mm restrictor rule, the designed intake of engine is reduced. This drastic change reduces the air flow to the engine thereby controlling its power output. The objective behind designing the intake system is to allow maximum possible air flow with minimum pressure drop.

II. LITERATURE REVIEW

To design and optimize an intake manifold for FSAE car with respect to presently designed systems. We referred papers. Pranav Anil Shinde [1] in his paper has optimized the air flow through the venturi with minimum pressure drop and optimum velocity. He performed analytical calculations based on standard results to get maximum air flow rate and CFD tool is used to calculate minimum pressure drop across the restrictor by varying converging and diverging angles of venturi. Singhal, A., & Parveen, M. [2] in his paper found the optimum solution to achieve maximum possible mass flow rate of air is to minimize the pressure loss through the flow restriction device. From the experimental data gathered through the numerous simulations, values for the converging and diverging angles of venturi were fund out. Logan M. Shelagowski and Thomas A. Mahank [3] in a report had dissected the entire system into sub-components, looking into the determining engineering principles behind their designs, and the compromises and trade-offs for certain components. The report looks into two essential tools that are used to analyze and verify the design.

Ryan Hardo &Christopher B. Williams [4] performed the analysis of internal flow through the intake using CFD software. They observed from the analysis that the pressure lost through the restricting cross-section was recovered through the expansion cone, resulting in high static pressure air in the plenum. It was observed that the design should have sufficient length after the restricting cross-section to recover the lost pressure. Claywell M., Horkheimer D., Stockburger G. [5] the authors found that the Conical-Spline Intake Concept offers the best performance. This intake concept offers an order of magnitude improvement in the variation of cylinder-to-cylinder volumetric efficiency with consequent improvements in ease of tuning and acoustic noise emission control. In addition, it has the lowest total pressure drop along the diffuser of all the concepts evaluated.

III. PROPOSED METHODOLOGY

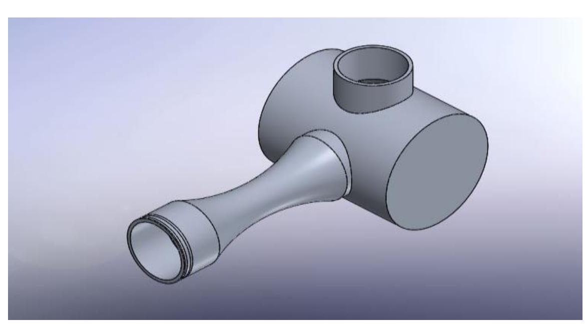

Figure 1: CAD-Model

Figure 1 shows proposed CAD-Model. The construction consists of a plenum which is a reservoir of air from which the engine cylinder will draw air from. The air to this reservoir is replenished from throttle body, restrictor and intake runner. Intake runner is the part which connects the outlet of plenum to the intake of engine cylinder. It delivers air from intake manifold to the engine. The intake manifold has a restrictor placed at its inlet as mandated in the FSAE rules. It correlates the amount of air which can be drawn in by the cylinders to allow maximum volumetric efficiency. Throttle body is a valve placed at the entrance of air intake system used to control the behaviour of engine. It is directly connected to the throttle pedal via a steel braided cable. Air filter is placed at the entrance of throttle body to ensure flow of clean air.

IV. DISCUSSION

We have referred papers in the literature review. Various views from the study of different topics have been discussed. Pranav Anil Shinde performed study on air flow through venturi and found the maximum possible air flow to the engine without any losses due to friction and turbulence. The values of converging and diverging angles for maximum recovery of pressure were calculated. Singhal, A., & Parveen, M. have summarized the mass flow chocking and velocity of air flow through the restrictor. They performed flow analysis through restrictor by considering another values of converging and diverging angles. Logan M. Shelagowski and Thomas A. Mahank carried a test on flow bench over a range of different pressures. Good correlation was observed between the simulations and experiments. Ryan Hardo &Christopher B. Williams observed that the pressure lost through the restricting cross-section was recovered through the expansion cone, resulting in high static pressure air in the plenum.

Claywell M., Horkheimer D., Stockburger G., described the Conical Spline Intake concept for improvement in volumetric efficiency in engine with ease of tuning and acoustic noise emission control.

CONCLUSION

The selection of restrictor design is one of the most important factors before its application in to the intake system. The flow curves should be properly analyzed for achieving maximum volume flow at the same pressure and with controlled power output. The entire intake system should be optimized to reduce pressure loss and improve engine performance. These improvements will include flow balancing, which indicates intake runner length to optimize engine performance.

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