

# Analysis of exhaust manifold to improve the engine performance

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## Abstract

The aim of the work is to analyze the performance of the engine exhaust manifold. Because the engine exhaust manifold is a significant factor in the engine performance. In this work the manifold design is prepared with the help of CAD software and it is analyzed by the ANSYS. This CFD and thermal analysis also done to check the performance of the redesigned exhaust manifold. The aim of CFD simulations performed to investigate the volumetric efficiency behaviour of an exhaust.

**Keywords:** Engine Performance, Exhaust Manifold, Emission and Fuel Consumption.

## 1. Introduction

The mounted exhaust manifolds on top of the cylinder head of the engine collect the gas exhausted from the engine, and sends it to a catalyst converter. The performance of the Engine depends upon the design of the exhaust manifold. Principally, the efficiency of the emission and fuel utilization are strongly related with the exhaust manifold. The rising and falling temperature causes fatigue due to less thermal efficiency of manifold leading to the fracture. A thorough attention has been determined on the low cycle thermal fatigue by accelerated laboratory tests and by FEM or analytical methods for evaluating life performance of the exhaust manifold under a cyclic thermal loading. Designs that do not add to a smooth flow were very typical in early on. The reverse force built up was a large amount greater than before the work done by the redesigned piston at the exhaust stroke. Huge amount of remaining gases stay in the compression chamber and, as a consequence, the temperature increases. Sometimes when working tough the manifold glow red-hot. The materials used like asbestos, a highly heat withstand able fibrous silicate mineral, to guard paintwork. At the moment, exhaust manifold designs have been distorted totally to get better in comparing with previous configurations, designers have move towards up with altered designs that decrease the flow opposition by using a lot enhanced pipe layout and increasing the average exhaust velocity of the gases, which improve the power output.

## 2. Literature Survey

Gomez et al. [1] developed a model that Exhaust manifold crack beginning Thermo mechanical Fatigue (TMF) are frequently seen on extremely loaded engines due to rising marketplace difficulty for presentation and emissions. Due to utmost gas temperatures that in a quantity of instance are already above 1000°C. A variety

of studies are published more than the last few decades concerning the recognition of these critical areas, which comprise taking into account kinematic and isotropic hardening, creep in material

modelling and deliberation of plasticity, creep and oxidation in life span modelling. Deger et al.

[2] have analysed the fast advance in simulation technology making it possible to model complex geometrical shapes by using CAD and material behaviour and load cases to analyze the connected deformations and stresses.

[3] Has analysed lessening of design and development of cycle time can be achieved by sinking the number physical and virtual prototypes. Perceptive the structural performance in the initial phase of design can help to decrease the virtual prototypes in the evaluation time. The engine Exhaust Manifold is a compound system induced to Thermo mechanical loads.

[4] The research article deals with a new method to deal with an Exhaust manifold failure during physical testing on an engine test bed. Rezaei et al. [5] has analysed most of internal combustion engines have multiple heat shields that have been installed on the exhaust manifold to keep away from the heat transfer to upper engine parts, such as the valve cover. In some engines, this part fails due to the fracture and causes engine noise and other failure. In this research the heat shield failure occurs due to engine vibration loads has been analysed by using experimental and FE technique. The results of the optimised heat shield in this field show two of the primary resonance frequencies of heat shield.

Bin zou et al. [6] has analysed the contact of temperature significance on exhaust manifold modal analysis is analyzed in his study. First, the temperature field data are taken from the CFD software and then heat transference process is analyzed in FEM software with the boundary conditions of temperature field. The incident among vibration mode and cold and thermal modals are classified and the results are predicted. The manifold design is influenced by temperature to a greater extent.

## 3. Important Parameters

To design the Exhaust manifold we should consider all the parameters and geometric constraints. The dimensions of the manifold which include the parameters such as length, diameter, and shape essential for a triumphant design. Multiple shapes are

engaged by using circular and oval pipes in the exhaust manifold design. The advantage of using circular pipes is the increased cross sectional area when compared to Oval pipes thus increasing flow distribution. The manifold pipes can be designed. Angular pipes with higher inclination will amplify the flow resistance. As high speed engines emits more exhaust gases with high speed which requires superior diameters pipes. On the contrary, low speed engines require lower diameter pipes. The pipe length is a critical design criterion as to get better performance in the available space. Long pipes are required to reduce exhaust speed of the exhaust and to expand the gases. Also long pipes reduce residual gases formation inside the the cylinder thus improving the power and efficiency of the Engine.

**4. Methodology**

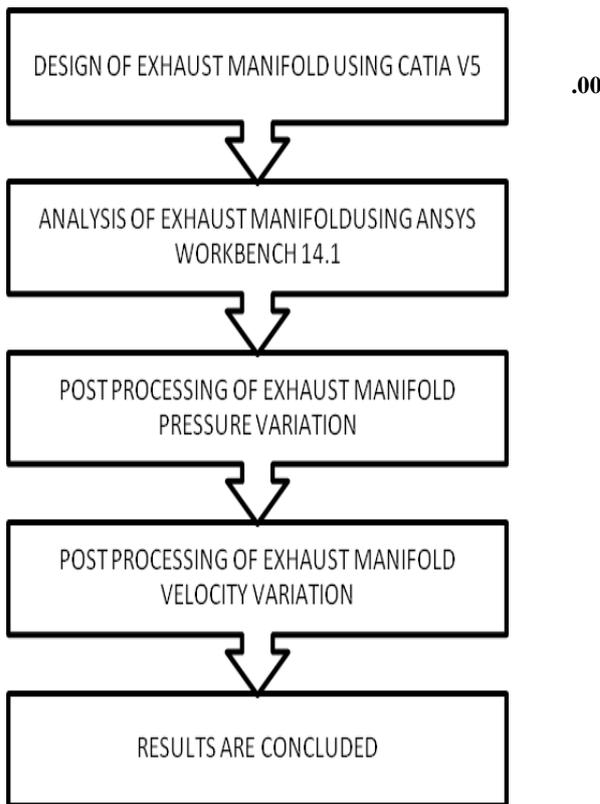


Fig. 4: Methodology

- The analysis of the manifold with the CFD to check the mass flow rate and velocity of the manifold.
- From the CFD results we will gather the thermal results which are taken as the input for the thermal analysis which is steady state thermal analysis or transient type.
- So we will make detail study about the CFD analysis over the exhaust manifold and as well the thermal analysis of the manifold to check the failure of the thermo mechanical on the removal of the structural weakness.

**4.1 2 Design of Exhaust Manifold**

The following figures 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6 shows the two dimensional and 3 dimensional Exhaust manifold design components.

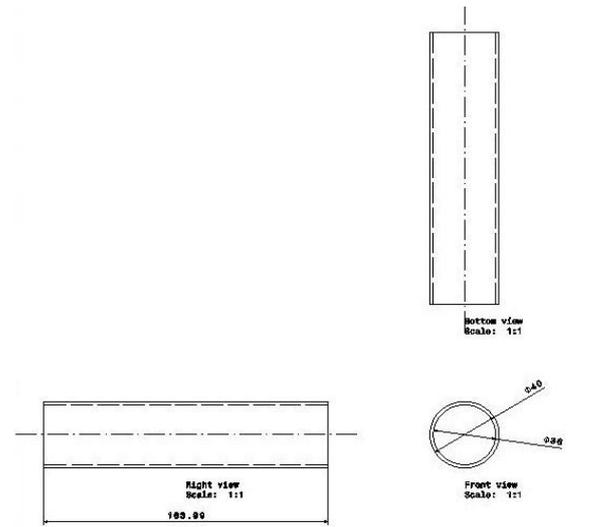


Fig. 4.1: Design of Pipe

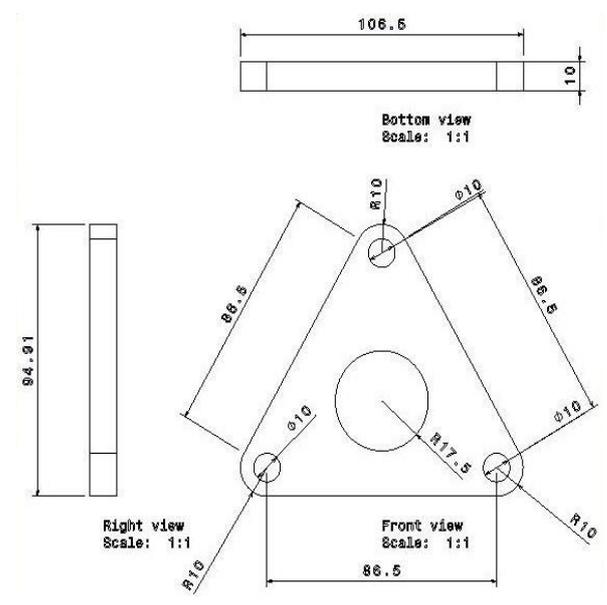


Fig. 4.2: Design of Clamp

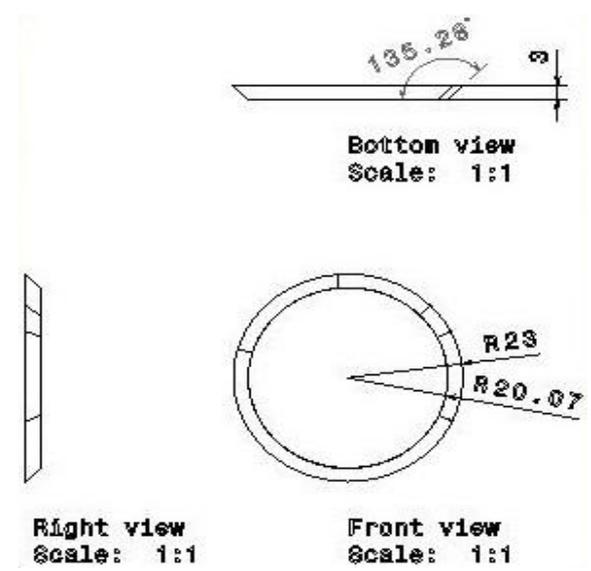


Fig. 4.3: Design of Ring



## 6. Conclusion

The research work concludes that due to the inclination angle in the manifold pipe, We can see a pressure drop transversely the outlet exhaust pipe which leads to increase in volumetric efficiency across the manifold and reduce the flow resistance of the fluid causing increase of the engine power and ultimately the engine performance would be improved.

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