

## Design and Analysis of Exhaust Manifold

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### Abstract

The exhaust manifold system is mounted on the cylinder head of the engine. It is associated with the catalyst converter at the other end. The emitted gases transmitted from the chamber come out at temperatures of about 800 °C and with pressures extending from 100 to 500 kPa. The exhaust manifold system is exposed to high temperatures and weights which will lead to thermo mechanical failure. Redesigning an exhaust manifold by determining Thermal stresses and deflections exhibited under various operating conditions with different materials and temperatures. The objective is to ensure the suitability of the design for a particular material from the view point of reliability and serviceability. Defects in existing manifold are cracks usually occur due to prolonged exposure to extreme temperatures, defects in casting and Heat cycling. High end cad cam software such as Unigraphics and Ansys is used for modeling and analysis. The 3d Model of exhaust manifold is subjected to thermal and structural loads and results are tabulated according to the procedure for the Exhaust manifold.

*Keywords: Thermal Stresses, Unigraphics, Ansys, Manifold, Materials.*

### 1. Introduction

Exhaust manifold gets the exhaust gases comes out from chamber and goes to condition. The generally collected with chamber. Cast iron is material utilized for ventilation systems. Components to be considered during the plan and improvement of ventilation system [1]. The exhaust manifold is a piece of a diesel motor that can be required to gather fumes gases from the chamber head and send it to the gases gadget. Gases wholesaler assumes a key job in the general effectiveness of an engine device. Particularly, the emanation productivity and gas utilization are nearly connected to the ventilation system. The gatherer can throw or produced using a somewhat light cloth. The reason for the exhaust manifold is the procurement and conveyance of these fumes gases from the chamber with no less pressure. Exhaust manifold are exhausted because of warm strain and disfigurement because of temperature dispersion, heat collections or scattering, and different related warm extent [2-4].

The point of our analysis is to discover exactness fabric by evaluating thermal strain and deformation prompted by mapping the temperature on one of the sorts of substance for the rough terrain diesel motor ventilation system. In this endeavor, we are examining the rough terrain diesel motor ventilation system. In the underlying advance, FEM analysis were made on the issue by utilizing first-request tetrahedron detail and the blending test was cultivated by assistant weight, affirmation of the top decision. Warm assessment in the subsequent advance to decide the temperature map, heat slipping, and normal heat switch characteristics.

The outcomes are successively utilized as a contribution to the computation of stress, stress and miss happening, and affirm whether the segment geometry addresses a specific issue for conductivity. Info estimations of the temperature are assembled through test testing of the assessment remarks. The trial estimations of the temperature flow were attempted with the delayed consequences of the FEA steady warm examination. The ventilation framework is a bit of an inside engine that assembles fumes gases from more than one chamber into one channel. Numerous ventilation frameworks are made of cast iron or nodular iron. Some are made of hardened steel or overwhelming steel[5-8].

VVRLS Gangadhar et al., 2017, done an assessment, in which a current model of an engine Exhaust Manifold is shown in 3D displaying programming. Warm investigation is accomplished for the two models utilizing various materials copper, Nickel, Stainless steel and manganese. Investigation is done in ANSYS. By watching the warm investigation results, the warmth motion (i.e) heat move rate is more for Copper when contrasted and different materials. The warmth move rate is marginally less for altered model than unique model [9].

KanupriyaBajpai et al., 2017, in their work, the presentation of a four-stroke four cylinder gasoline engine exhaust manifold have been investigated utilizing three distinct powers - fuel, liquor, and LPG for the estimation of stream traits, warm characteristics, and least back weight. The complex demonstrating is done in Creo2.0 followed by lattice and examination in ANSYS[10].

P Sylvester Selvanathan et al., 2017, examined the arrangement of a ventilation framework to develop the significance of various factors related with arranging a exhaust manifold by looking at different existing plans utilizing Computational Fluid Dynamics[11].

Puneetha C G et al., 2015 thoroughly explores four unique models of exhaust silencer and wraps up the best arrangement for least weight drop. Back weight was gotten subject to the stream field examination and was furthermore differentiated and all silencer plan. Virtual reenactment for back-pressure testing is performed by Computational Fluid Dynamic (CFD) examination using Acusolve CFD. Restricted Element (FE) model age of the silencer structure is performed using Hyper Mesh as the preprocessor. The auxiliary work is displayed utilizing 2D shell components, wherein the interior cylinders with fine punctured openings are considered[12].

MarupillaAkhilTeja et al., 2016, In general engine execution of an engine can be gained from the right arrangement of engine vapor structures of motor fumes frameworks. As to severe emanation enactment in the car area, there is a need plan and create reasonable burning chambers, bay, and outlet complex. Ventilation system framework is one of the critical parts which impact the engine execution. Course through a ventilation framework is time subordinate concerning wrench point position. In the ebb and flow research work, numerical examination on four-chamber oil engine with two ventilation framework running at reliable speed of 2800 rpm was inspected [13].

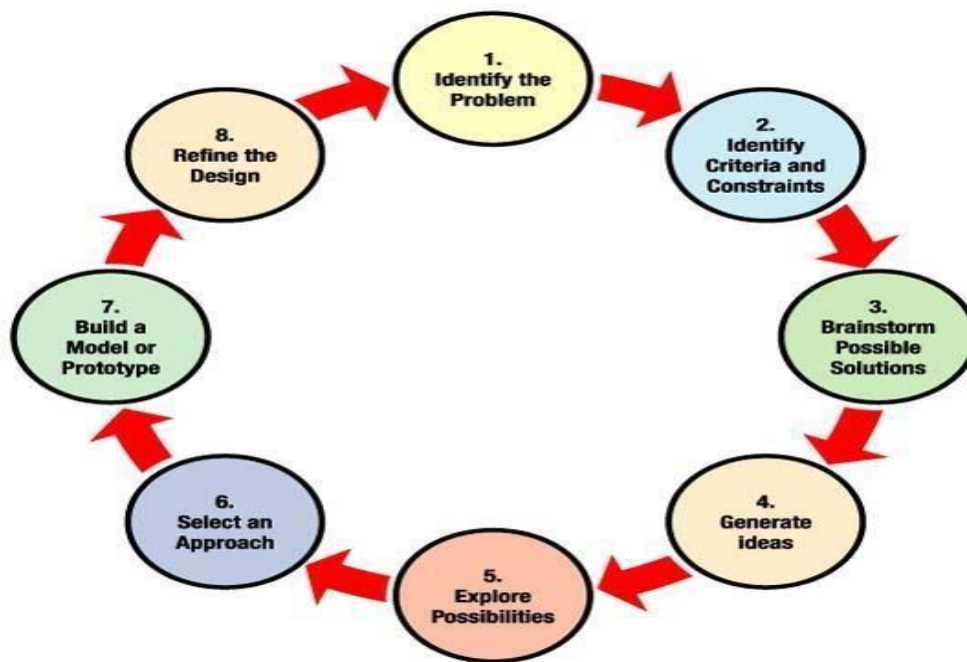
V. Ashok Kumar et al., 2016 focused on CFD and warm assessment with different weights (2, 6,12,14,16 and 18 kg). Warm examination accomplished for the ventilation system by cast iron, tempered steel, silicon nitride& zinc oxide. In this proposition the CFD investigation to decide the warmth move rate, mass stream rate, constrain drop and warm examination to decide the temperature circulation, heat motion with various materials. 3D displayed in parametric programming Pro-Engineer and investigation done in ANSYS [14].

## 2. Methodology and Modeling

This article aims in redesigning an exhaust manifold by deciding Thermal burdens and diversions showed under different working conditions with various materials and temperatures. Perform coupled flied investigation on the ventilation system for compel burden and warm burden to discover pressure and redirection. Perform warm investigation on the complex framework for heap of warm. Common frequencies mode shape and there mass co operations are plotted. Most extreme diversion and stress are determined at top reaction.

### 2.1 Computer Aided Design (CAD)

Computer-aided design(CAD), also known as computer-aided design and drafting (CADD), is the utilization of computer0systems to aid the creation, change, examination, or improvement of a structure. PC helped drafting depicts the way toward making a specialized drawing with the utilization of program. Computer aided design programming is utilized to expand the efficiency of the creator, improve correspondences nature of configuration, improve communications0through documentation, and to make a database for assembling. Computer aided design yield is frequently as electronic documents for print or machining tasks. Computer aided design programming utilizes either vector based illustrations to portray the objects of conventional drafting, or may likewise create raster illustrations demonstrating the generally speaking appearance of designed objects.

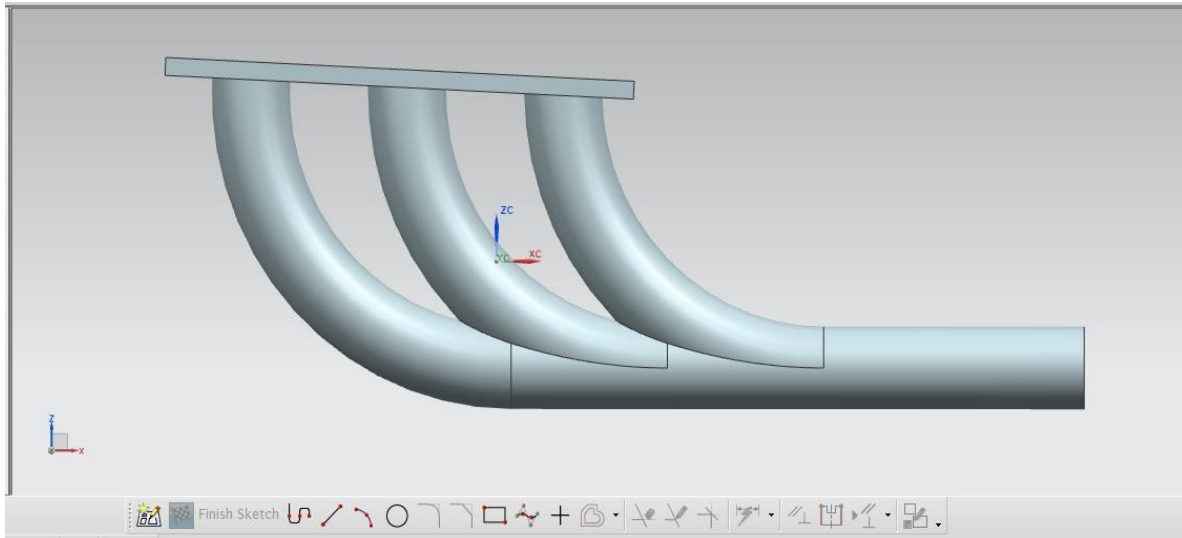


**Figure 1. Methodology**

As in the manual drafting of specific and building drawings, the yield of CAD must pass on information, for instance, materials, techniques, estimations, and versatilities, as demonstrated by application-express shows. PC supported plan may be used to setup twists and figures in two-dimensional(2D) space;or curves, surfaces, and solids in three-dimensional(3D) space.

PC supported structure is a critical mechanical workmanship extensively used in various applications, including vehicle, shipbuilding, and avionics undertakings, present day and auxiliary arrangement, prosthetics, and some more. PC helped configuration is moreover commonly used to convey PC vivacity for frivolity sin movies, publicizing and concentrated manuals. The front line all inclusiveness and force of PCs suggests that even smell containers and chemical holders are

organized using techniques tremendous by planners of the 1960s. Because of its tremendous money related criticalness, CAD has been a huge principle stimulus for investigate in computational geometry, PC graphics(both gear and programming), and discrete differential geometry. PC helped configuration showing shows of ventilation framework as in Figure 2.



**Figure 2. Front view of exhaust manifold**

### **3. Finite Element Analysis of Exhaust Manifold**

The Basic thought in FEA is that the body or structure may be divided into smaller parts of constrained estimations called "Restricted Elements". The primary body or the structure is then considered as a social affair of these parts related at a predetermined number of joints called

"Hubs" or "Nodal Points". Direct limits are picked to deduce the evacuations over each restricted segment. Such acknowledged limits are assigned "shape limits". This will address the migration with in the part in regards to the expulsion at the centers of the segment.

The Finite Element Method is a numerical instrument for comprehending standard and fractional differential conditions. Since it is a numerical apparatus, it can take care of the intricate issues that can be spoken to in differential conditions structure. The uses of FEM are boundless as respects the arrangement of pragmatic structure issues. Due to high cost of computing power of years gone by, FEA has a history of being utilized to tackle complex and cost basic issues. Old style techniques alone generally can't give sufficient data to decide the protected working constraints of a significant structural building development or a car or an airplane. In the ongoing years, FEA has been all around used to take care of basic designing issues.

The divisions, which are intensely depended on this innovation, are the car and aeronautic trade. Because of the need to satisfy the extraordinary needs for quicker, more grounded, proficient and lightweight cars and airplane, makers need to depend on this procedure to remain serious.

FEA has been utilized routinely in high volume creation and assembling enterprises for a long time, as to get an item configuration wrong would be impeding.

For instance, if an enormous maker needed to review one model alone because of a hand brake configuration issue, they would wind up supplanting up to not many millions of hand brakes. This will cause a heavier loss to the company.

Structural analysis contains the arrangement of physical laws and science required to consider and predicts the conduct of structures. The subjects of helper examination are planning doodads whose uprightness is decided by and large reliant on their ability to withstand loads; they generally incorporate structures, scaffolds, airplane, and boats. Basic investigation merges the fields of mechanics and components similarly as the various disappointment hypotheses. From a hypothetical point of view the essential objective of auxiliary investigation is the calculation of deformations, internal forces, and stresses. In structural analysis of modified exhaust manifold, we have to apply structural and thermal loads. The bolts are arrested in all Dof, and pressure load 500000Pa is applied inside of the exhaust pipes temperature distribution is applied as Thermal loads on modified exhaust manifold from the thermal analysis.

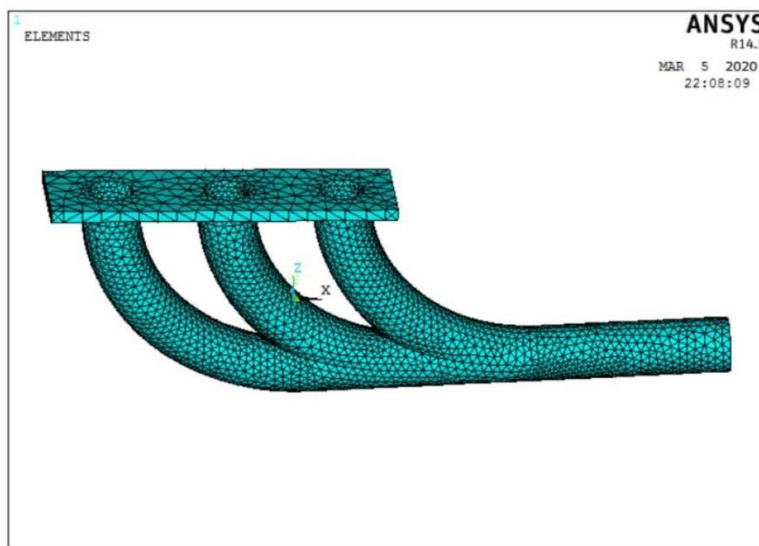


Figure 3. Mesh model of Exhaust manifold

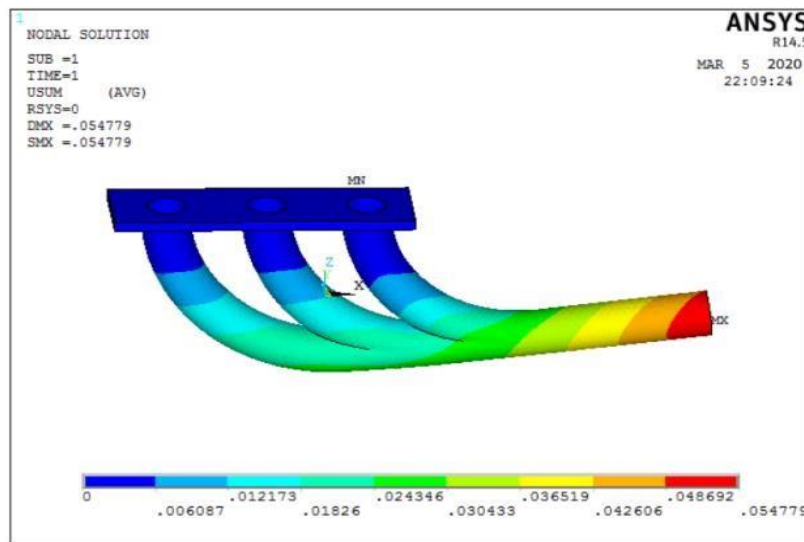


Figure 4. Nodal displacementson exhaust manifold.

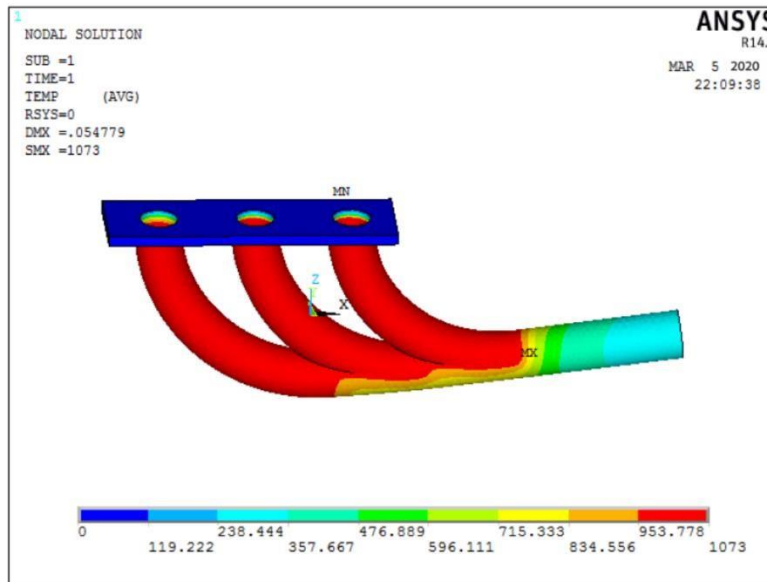


Figure 5. Temperature distribution on exhaust manifold.

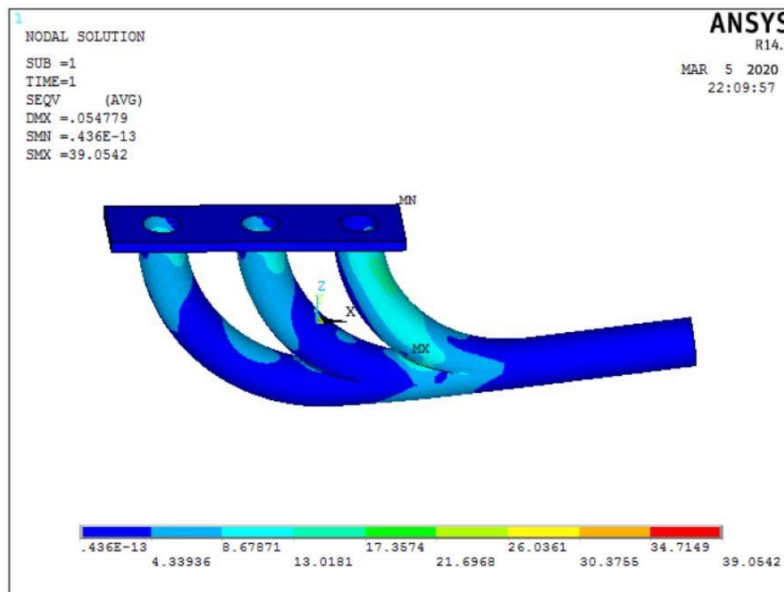


Figure 6. Von Mises stress of exhaust manifold.

The bolting locations are arrested in all Dof for modified exhaust manifold. Thermal analysis is done to find the temperature conveyance on the altered ventilation system. These temperatures are applied as the body stacks in the structure analysis. The Max Deflection 0.054mm observed on the exhaust manifold for operating loading conditions. The Max Avg. VonMises Stress observed 39.05Mpa on the segway assembly for operating loading conditions. And the Yield strength of the materials cast iron is 600Mpa.

#### 4. Conclusions

In this paper examined couple field examination of exhaust manifold system at most extreme temperature and weight condition by utilizing aluminum and castiron materials. Thermal vonmisesstress observed 141.29Mpa on the segway gathering for working stacking conditions.

What's more, the Yield quality of the materials Aluminum is 180Mpa. Here 21.5 % stress less framed for Aluminum that of yield quality. Thermal vonmises stress observed 39.05Mpa on the segway get together for working stacking conditions. Also, the Yield quality of the materials cast iron is 600Mpa. Here 93.49 % stress less shaped for Cast iron that of yield quality. Compare both results, cast iron formed less thermal stresses during loading conditions on manifold.

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### **Conflict of interest**

None of the authors have any conflicts of interest to declare.

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