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CFD and Thermal Analysis of Exhaust Manifold and Exhaust Header for a 6 Cylinder Inline Engine: A Review

Shaikh Usama[1], Yuvraj Palav[2], Zayyan Shaikh[3], Saddam Ansari[4]
[1, 2, 3, 4]*Automobile Department, Mumbai University*

Abstract: ***Exhaust Manifold and Exhaust Header is one of the important additives of IC engine for enhancing the volumetric performance. The volumetric performance of the engine may be expanded with the aid of using decreasing the backpressure and growing the exhaust pace with inside the exhaust manifold and header. These studies examine the float via unique fashions of exhaust manifold and exhaust header the use of CFD and Thermal evaluation for a 6 cylinder inline engine. The layout of exhaust manifold is changed to get gold standard geometry. The evaluation consequences of fashions are as compared for returned stress and pace of exhaust fuel line. By evaluating the consequences of fashions the lower in returned stress is located which make sure development in volumetric performance of the engine.***
Keywords: Exhaust Manifold, Exhaust Header, CFD Analysis, Thermal Analysis, 6-Cylinder Inline Engine

I. INTRODUCTION

An exhaust manifold and exhaust header collects the exhaust gases from a couple of cylinders into one pipe. It is connected downstream of the engine and is most important relevance in multi- cylinder engines wherein there are a couple of exhaust streams that need to be amassed right into a unmarried pipe. In the prevailing paintings ,the overall performance of the 4-stroke 6 cylinder inline engine exhaust manifold and exhaust header has been analysed. When an engine begins off evolved its exhaust stroke, the piston movements up the cylinder bore, reducing the entire chamber volume. When the exhaust valve opens, the excessive stress exhaust fuel line escapes into the exhaust manifold or header, developing an exhaust pulse comprising 3 predominant parts: The excessive stress head is created with the aid of using the big stress distinction among the exhaust with inside the combustion chamber and the atmospheric stress outdoor of the exhaust machine. As the exhaust gases equalize among the combustion chamber and the atmosphere, the distinction in stress decreases and the exhaust pace decreases. This paperwork the medium-stress frame factor of exhaust pulse. The closing exhaust fuel line paperwork the low stress tail factor. This tail factor may also to start with suit ambient atmospheric stress, however the momentum of the excessive and medium stress additives reduces the stress with inside the combustion chamber to a decrease than atmospheric level. This quite low stress enables to extract all of the combustion merchandise from the cylinder and induct the consumption fee all through the overlap duration while each consumption and exhaust valves are partly open. The impact is called scavenging. Length, cross-sectional area, and shaping of the exhaust ports and pipe works impacts the diploma of scavenging impact.

II. LITERATURE REVIEW

A. Seenikannan P., Periyasamy V.M. and Nagaraj P

They Analysed a Y section exhaust manifold system experimentally to improve engine performance. This paper investigates the effect of using various models of exhaust manifold on CI engine performance and exhaust emission.

B. Yasar Deger, Burkhard Simperl, and Luis P. Jimenez

They had done CFD-FE-Analysis for the Exhaust Manifold of a Diesel Engine aiming to determine specific temperature and pressure distributions. The fluid flow and the heat transfer through the exhaust manifold were computed correspondingly by CFD analyses including the conjugate heat transfer.

C. Dr. Kutaiba J.M. AL-Khishali, Dr. Mahmoud A. Mashkour & Ehsan Shamil Omaraa

They made an approach to estimate of flow characteristic in inlet and exhaust manifolds of internal combustion engines using a four-stroke variable compression ratio single cylinder gasoline engine. In the experimental work, the compression ratio was varied from 7 to 11 at variable speed with constant throttle opening, where engine performance was obtained.

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D. Scheeringa K

They studied analysis of Liquid cooled exhaust manifold using CFD. Detailed information of flow property distributions and heat transfer were obtained to improve the fundamental understandings of manifold operation. A number of computations were performed to investigate the parametric effects of operating conditions and geometry on the performance of manifolds.

E. Gopal P., Senthil Kumar T. and Kumaragurubaran B

They conducted experimental analysis of flow through the exhaust manifold of a multi cylinder Petrol engine of a contest engine of 20 hp at maximum speed of 2000 rpm and then analysed using FLUENT.

F. K.S. Umesh, V.K. Pravin and K. Rajagopal

The CFD analysis and experimental verification of effect of Manifold geometry on volumetric efficiency and back pressure for Multi Cylinder SI Engine.

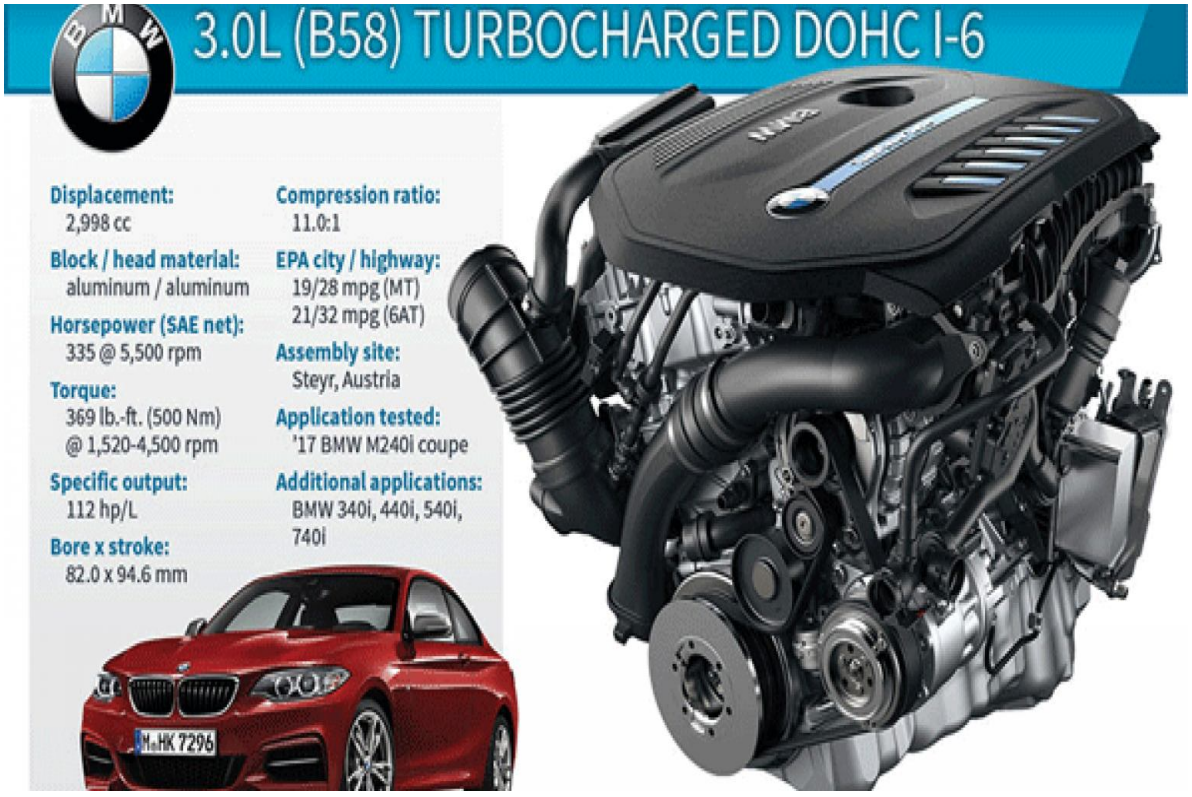
III.6-CYLINDER INLINE ENGINE

You may also have heard that a group of the carmakers are returning to 6-cylinder engines organized in-line. Jaguar Land Rover additionally introduced that they once more be setting inline 6-cylinder engines into its vehicles and SUVs , phasing out its V6 petrol cars with inside the process.

But why this engine , with each the V6 and I6 displacing an equal 3.zero Litres , will you even be aware the extrude from in the back of the wheel?. This query additionally implies to those following at Mercedes-Benz ,which has additionally made a transfer from V6 to I6. How can arranging 6-cylinder In line could make a distinction in the front V6. However they do convey surprizing adjustments.

An I6 is greater subtle than V6 with a few displacement. In reality because of this motive is why the Jaguar Land Rover determined to transfer. Each cylinder in an I-6 that present process a combustion stroke is balanced out with the aid of using every other cylinder that present process induction stroke , Now because of this balanced movement of piston there may be little or no vibration generated with the aid of using an I-6.The I-6 with a Turbocharged can correctly take the location of V-eight in lots of cutting-edge vehicles. The I-6 are less complicated in layout and makes it clean to keep as compared to V-6.

The first-rate examples of I-6 is the BMW B58 3.zero litres.



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IV. EXHAUST MANIFOLD

In car engineering, an exhaust manifold collects the exhaust gases from a couple of cylinders into one pipe. The word manifold comes from the Old English word manigfeald (from the Anglo-Saxon manig [many] and feald [fold]) and refers back to the folding collectively of a couple of inputs and outputs (in contrast, an inlet or consumption manifold supplies air to the cylinders). Cast Iron is usually used as manifolds fabric. Thermal evaluation needs to be achieved to start with to calculate the temperature distribution, warmness switch, thermal gradients and thermal flux. This is accompanied with the aid of using pressure evaluation, to understand the thermal stresses.

V. EXHAUST HEADER

Headers are one of the simplest bolt-on add-ons you could use to enhance an engine's overall performance. The aim of headers is to make it less difficult for the engine to push exhaust gases out of the cylinders.

When you study the 4-stroke cycle in How Car Engines Work, you could see that the engine produces all of its strength all through the strength stroke. The gas with inside the cylinder burns and expands all through this stroke, producing strength. The different 3 strokes are vital evils required to make the strength stroke possible. If those 3 strokes eat strength, they're a drain at the engine.

During the exhaust stroke, an amazing manner for an engine to lose strength is via returned stress. The exhaust valve opens at the start of the exhaust stroke, after which the piston pushes the exhaust gases out of the cylinder. If there may be any quantity of resistance that the piston has to push in opposition to to pressure the exhaust gases out, strength is wasted. Using exhaust valves instead of one improves the float with the aid of using making the hollow that the exhaust gases journey via larger.

In a everyday engine, as soon as the exhaust gases go out the cylinder they grow to be with inside the exhaust manifold. In a 4-cylinder or eight-cylinder engine, there are 4 cylinders the use of the identical manifold. From the manifold, the exhaust gases circulate one pipe towards the catalytic converter and the muffler. It seems that the manifold may be an essential supply of returned stress due to the fact exhaust gases from one cylinder building up stress with inside the manifold that influences the following cylinder that makes use of the manifold. The concept in the back of an exhaust header is to take away the manifold's returned stress. Instead of a not unusual place manifold that every one of the cylinders share, every cylinder receives its personal exhaust pipe. These pipes come collectively in a bigger pipe referred to as the collector. The person pipes are reduce and bent so that everyone is the identical period because the others. By making them the identical period, it ensures that every cylinder's exhaust gases arrive with inside the collector spaced out similarly so there may be no returned stress generated with the aid of using the cylinders sharing the collector.

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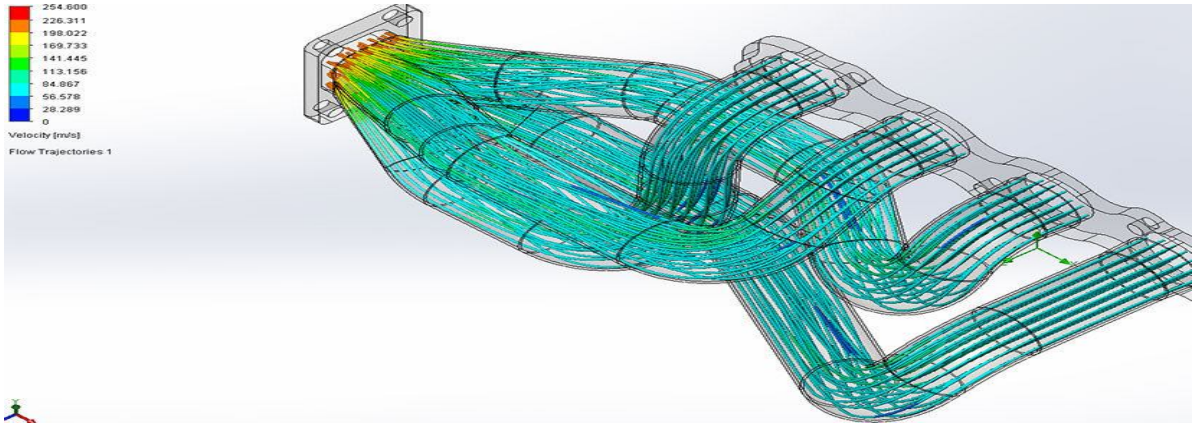
VI. CFD ANALYSIS

Now , why CFD evaluation is achieved at all?. Computational Fluid Dynamics is an engineering device used to stimulate the movement of the fluid in a machine. It is utilized by many industries of their improvement paintings to examine, optimize & confirm the overall performance of the layout earlier than steeply-priced prototypes & bodily tests.

Now, the CFD is executed at the exhaust manifold to regular its float traits together with stress ,pace, & temperature. Due to this evaluation, the stress distinction & the speed distinction among each the modals may be decided effortlessly via unique contours or graph.

This evaluation may be achieved at the Ansys Fluent 2021R1 Software.

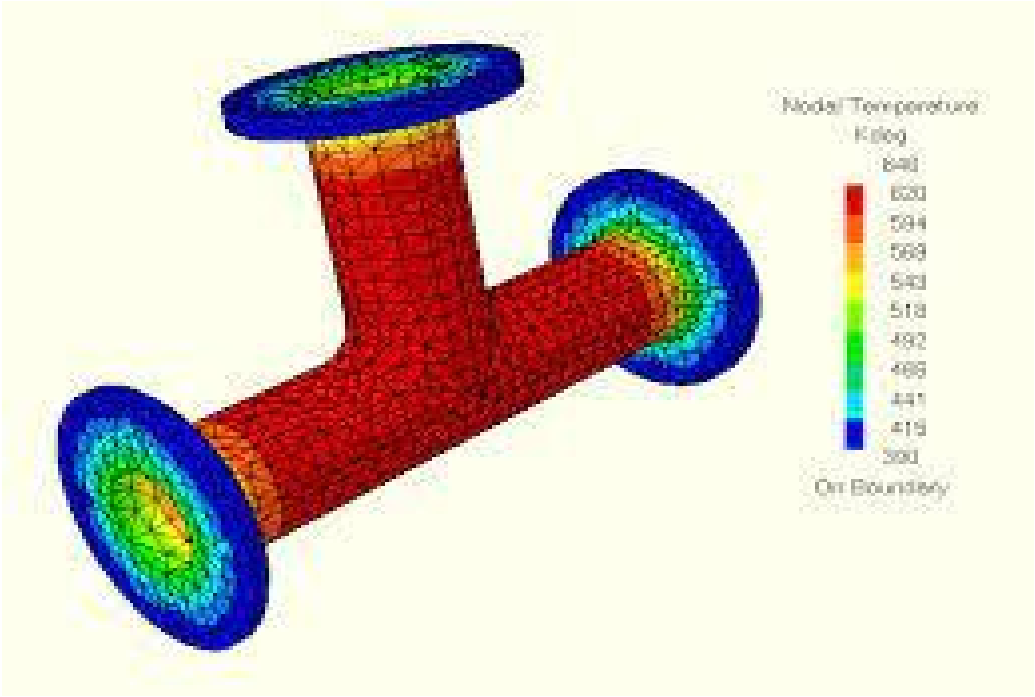


VII. THERMAL ANALYSIS

Thermal Analysis is usually used for characterizing fuel line-strong reactions or decompositions of solids. It is approach used to investigate the time and temperature at which bodily adjustments arise while an item is heated .We will use the thermal evaluation so as to test that how lots warmness can the fabric of manifold and header can sustain.

This research the results of extrude so one can have at the overall performance of a product. Now why will we want thermal in this undertaking because the exhaust manifold & header may be beneath regular warmness we are able to want to understand what adjustments takes location at the fabric of header & manifold. This will even assist us to understand if the fabric of the header and manifold is ideal or bad. Ansys Software may be used to perform the all of the operations .

Ansys 2020R1(FLUENT)



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VIII. CONCLUSIONS

A. It is vital to take into account that any increment with inside the exhaust manifold and header floor will growth the warmth loss.
B. Flow evaluation may be executed , the manifold and header fashions are analysed beneath identical boundary condition.
C. Results of each the fashions are as compared to every different.
D. The float is made green with the aid of using reducing the returned stress with inside the newly changed version as a result growing the volumetric performance of the engine.
E. Due to which we are able to come to understand which one of the following is higher Exhaust Manifold or Exhaust Header.

IX. FUTURE SCOPE

A. Flow behaviour and pace of the exhaust gases in the pipe may be analysed with the aid of using engaging in Computational fluid dynamics with a view to assist to optimize the layout of exhaust manifold.
B. Use of Stainless metal will increase the corrosion and Thermal Mechanical Fatigue (TMF) resistance
C. of the exhaust manifolds. Hence thermal and structural evaluation with Stainless metal may be achieved.
D. Life prediction of the exhaust manifold layout may be achieved for the identical working situations.
E. The exhaust manifolds may be both forged or fabricated.
F. Thermal and CFD evaluation may be achieved to expect the failure of the exhaust manifold synthetic with the aid of using unique methods.

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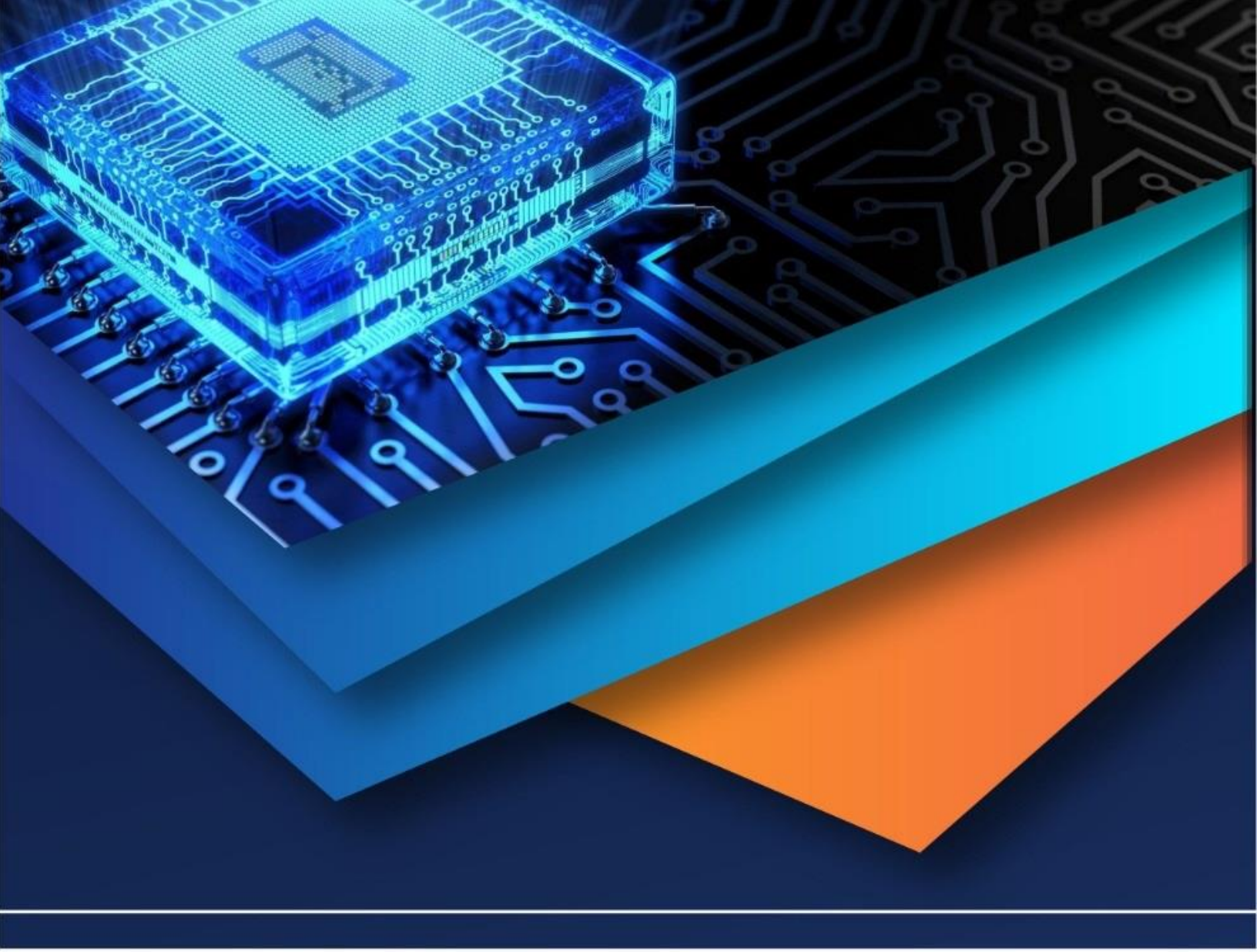

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