iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** V **Month of publication:** May 2020

DOI: http://doi.org/10.22214/ijraset.2020.5052

Design and Analysis of Automobile Exhaust Assembly

Saharsh Srivastava[1], Shubham Yadav[2], Chhavi Sharma[3], Anshul Kaushal[4], K. S Srikanth[5]
[1, 2, 3, 4, 5]*School of Mechanical Engineering, Galgotias University(Greater Noida, 201306)*

Abstract: Main emphasis of this study is to Design and test an automobile exhaust assembly comprising of an exhaust manifold and a muffler, by means of CAD modelling software. Existing engines are required to have additional engine power and are also obligatory to meet the strict noise emission standards. In an automobile the exhaust assembly plays an essential role in dropping the sound of the automobile. In order to sustain a desired noise level and easy-going ride, the modes of a muffler need to be analysed. The design of exhaust manifold enacts an essential role on efficient combustion and emission reduction of engine. Here flow and modal analyses of the virtual model will be carried out to finalize the mode shapes, stresses and deformations of exhaust muffler using CAE analysis and comparison of the exhaust gas back pressures and its velocities at altered operating load condition of engine will be done.

Keywords: Muffler; Emission; CAE analysis; Design; Backpressure

I. INTRODUCTION

The exhaust system was created to eliminate exhaust fumes from the engine and to break up the sound waves of various frequencies by its structure. An Exhaust is generally a piping joined to the engine to direct Exhaust gases away from a regulated combustion inside an engine or stove. The whole structure carries burnt gases from the engine and contains one or more exhaust pipes. The exhaust system of an automobile comprises of an Exhaust Manifold, Exhaust Pipes, Muffler and The Tail Pipe.

Gases from the engine cylinders are accumulated by an exhaust manifold and deliver it into one pipe and leaves it out to atmosphere. The pressure needed to be developed by the engine to withstand or overpower the resistance of the exhaust system in order to eject the exhaust gases into the atmosphere is identified as engine exhaust back pressure. Engine pumps the gas by compressing it to a slightly high pressure to overcome the flow hindrances in the exhaust system. Hence engine does the extra mechanical work to compress the exhaust gases to a higher pressure which in turn rises the fuel consumption of engine. Many researchers **[5, 6]** have done their research works on this field to reduce the emission from exhaust manifold. PL. S Muthaiah and Hessamedin Naeimi **[7, 8]** has analysed and then modified the exhaust manifold using CFD by varying the size of conical manifold with the help of grid mesh and so it kept a check on backpressure. After analysis when the outcomes were equalled for the two models, it is discovered that the modified gives low backpressure in comparison with other base model which confirms the improvement in the efficiency of the engine. Hong Han-Chi and Siddaveer Sangamad **[9, 10]** analysed the flow of exhaust gas from two distinct modified exhaust manifold with the aid of CFD. To accomplish the optimal geometry for the low backpressure they have analysed two different exhaust manifolds, one with base geometry and the other with altered geometry. In the altered model of the exhaust manifold the outlet is at the centre of the exhaust manifold where as in base model of the exhaust manifold the outlet is at the side of the first inlet. Two dissimilar exhaust manifolds have undergone analysis in the work. After analysis when the results were compared for the two models, it was found that the modified gives low backpressure in comparison with other base model which ensures the improvement in the efficiency of the engine.

Mufflers are usually found with exhaust systems. Substantially, the exhaust noise in terms of pressure is around 10 times all the other noises (structural noise) combined. So, the complication of slashing engine noise consists, mainly in attenuating exhaust noise. The muffler is engineered as a sound proofing device designed to decrease the loudness of the sound pressure formed by the engine by method of acoustic quieting. The universal rule of "more power, more noise" applies for majority of the such systems. Numerous such exhaust systems that use various designs and construction techniques are:

A. Vector Muffler
B. Spiral baffle Muffler
C. Aero Turbine Muffler

Experimental investigation of the heat transfer rates in exhaust ports was initially aimed at supporting thermodynamic engine cycle models, especially for engine turbocharger matching applications **[1]**. Those experimental findings were exploited in the computer model developed by Frank **[2]**, who also simulated manifold heat transfer by employing classical correlations applicable to curved pipes. Recently, one-dimensional transient models covering a variety of exhaust system designs have been presented [3, 4], presenting a model that was able to simulate real world heat transfer in exhaust systems of gasoline car sand is extensively employed in CAE investigations **[3]**. Experimental achievement of beneficial data for the valuation of heat transfer rates and their application in the enhanced design of numerous exhaust configurations forms the topic of the present paper.

II. DESIGNING OF EXHAUST SYSTEM

For designing and analysis of parts there are several software available in the market. A few of those are SOLIDWORKS, CATIA, ANSYS etc. From above software's, SOLIDWORKS had chosen in this work for design of exhaust. Figure 1 given below is the designed assembly of Exhaust.

A. Design Considerations

Existing day engines are needed to have more engine power and are also needed to meet the strict emission standards. To enhance exhaust system performance, many design specifications are required. A chimney aids as an exhaust pipe in a immobile structure. For the internal combustion engine, it is vital to have the exhaust system "tuned" for optimal efficiency.

B. Analysis

The ANSYS program was designed for engineers to make computer models or relocate CAD models of structures, products, components, or systems, put on loads or other design performance conditions and study physical responses such as levels of stress, distribution of temperature or the effect of vector magnetic fields and compile the results and it allowed them to make decisions faster. Here ANSYS aids them considerably by reducing the time engaged in design and manufacturing and as well as the costs around it, by providing engineers a great tool and that gives assurance to the designer, in the products they design. Figure 2-4 given below are the simulations performed on muffler and manifold.

III. EXHAUST GAS PROPERTIES

Exhaust gas is considered as an incompressible fluid operating at 230-280°C. The properties at these conditions are listed in Table 1.

IV. MUFFLER CONFIGURATION

Ideally, the muffler is designed with agenda of achieving desired noise. Putting more emphasis on this there has to be properties of both reactive and absorptive type muffler. Although, the performance mufflers have mixed properties of both as the main emphasis is not to get the desired sound but to obtain some moderate sound.

1) *Exhaust Piped Diameter:* In theory it is there, taking too large pipes can reduce low end torque because the increased gas velocity of a smaller pipe helps scavenging. Therefore, as a criterion, a 50.8 mm dual exhaust is good for a 3.5 litres engine, a 57.2 mm diameter is sufficient for up to 5 litres engine, while a 63.5 mm exhaust is good for highly tuned 6 litres engine. A 76.2 mm exhaust is usually good for high performance engines.
2) *Effects of Increased Back Pressure:* Increasing the back pressure of the engine leads to, increase in the rate of fuel consumption, PM & CO emissions and the temperature of exhaust. Taking this into account, the engine has to compress the exhaust gases to a higher pressure which requires additional mechanical work and/or less energy obtained by the exhaust turbine which can affect intake manifold boost pressure and mechanical efficiency of the engine.

V. RESULTS AND DISCUSSIONS

A. The model of manifold is designed and results were analysed through CFD Post processing. In the model of exhaust manifold, it is examined that due to the divergent-convergent shape, the outlet velocity is higher. It is noticed that by designing the exhaust manifold by decreasing the straight length of the outlet the exhaust velocities are significantly raised. Figure _ gives the turbulence kinetic energy contour of the model.
B. Design of the muffler is done by means of Solidworks.
C. Modelling of muffler is done with proper dimensions.
D. Analysis is performed to finalize the mode shapes and stresses and deformations in the muffler using CAE analysis.

VI. CONCLUSION

The Exhaust System is designed and analysed, Here flow and modal analyses of the virtual model has been carried out to finalize the mode shapes, stresses and deformations of exhaust muffler using CAE analysis and this design of engine manifold is considered because it has reduced turbulence energy, back pressure and also increased exhaust velocity and volumetric efficiency and by reduction in size of muffler the manufacturing cost of muffler can also be decreased. Due to reduction in the muffler size the need of space is also less.

REFERENCES

[1] 2011, Shi wu, DongkaiJia, YuntongJia. Structural Design & Testing Study of Truck Muffler. 2011 International Conference on Electronic & Mechanical Engineering and Information Technology ©2011 IE

[2] 2011, Jun Chan and Xiong Shi. CFD Numerical Simulation of Exhaust Muffler. 2011 Seventh International Conference on Computational Intelligence and Security. © 2011 IEEE. DOI 10.1109/CIS.2011.321

[3] 2010, Wang jie and Dong-pengVue. The Modal Analysis of Automotive Exhaust Muffler Based on PROE and ANSYS. 20IO 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE). 2010 IEEE

[4] 2013, Takashi Yasud, Chaoqun Wu, Noritoshi Nakagawa, KazuteruNagamura. Studies on an automobile muffler with the acoustic characteristic of low-pass filter and Helmholtz resonator. Applied Acoustics 74 (2013) 49–57. 2012 Elsevier Ltd.http://dx.doi.org/10.1016/j.apacoust.2012. 06.007

[5] Seenikannan P., Periyasamy V.M. and Nagaraj P. 2008. "An experimental analysis of a Y section exhaust manifold system with improved engine performance". International Journal of Product Development 6: 50-56.

[6] Kutaiba J.M. AL-Khishali, Dr. Mahmoud A. Mashkour & Ehsan Shamil Omaraa. 2010. "Analysis of Flow Characteristics in Inlet and Exhaust Manifolds of Experimental Gasoline Combustion in A VCR Engine". Eng.& Tech. Journal. 28: 1416-1431

[7] Muthaiah PL. S, Dr. M. Senthil Kumar, Dr. S. Sendilvelan.2010. "CFD Analysis of catalytic converter to reduce particulate matter and achieve limited back pressure in diesel engine", Global journal of researches in engineering - A: Classification (FOR) 091304, 091399, 10: 1-8.

[8] Hessamedin Naeimi, Davood Domiry Ganji, Mofid Gorjivadirad and Mojtaba Keshavarz, 2011. "A Parametric Design of Compact Exhaust Manifold Junction in Heavy Duty Diesel Engine Using Computational Fluid Dynamics Codes" Thermal Science 15:1023-1033.

[9] Hong Han-Chi, Huang Hong-Wu, Bai Yi-Jie, 2012. "Optimization of Intake and Exhaust System for FSAE Car Based on Orthogonal Array Testing" International Journal of Engineering and Technology 2: 392-396.

[10] Vivekanand Navadagi, Siddaveer Sangamad, 2014. "CFD analysis of exhaust manifold of multi cylinder petrol engine for optimal geometry to reduce back pressure" International journal of engineering research & technology 3: 92-97.

FIGURES AND TABLES

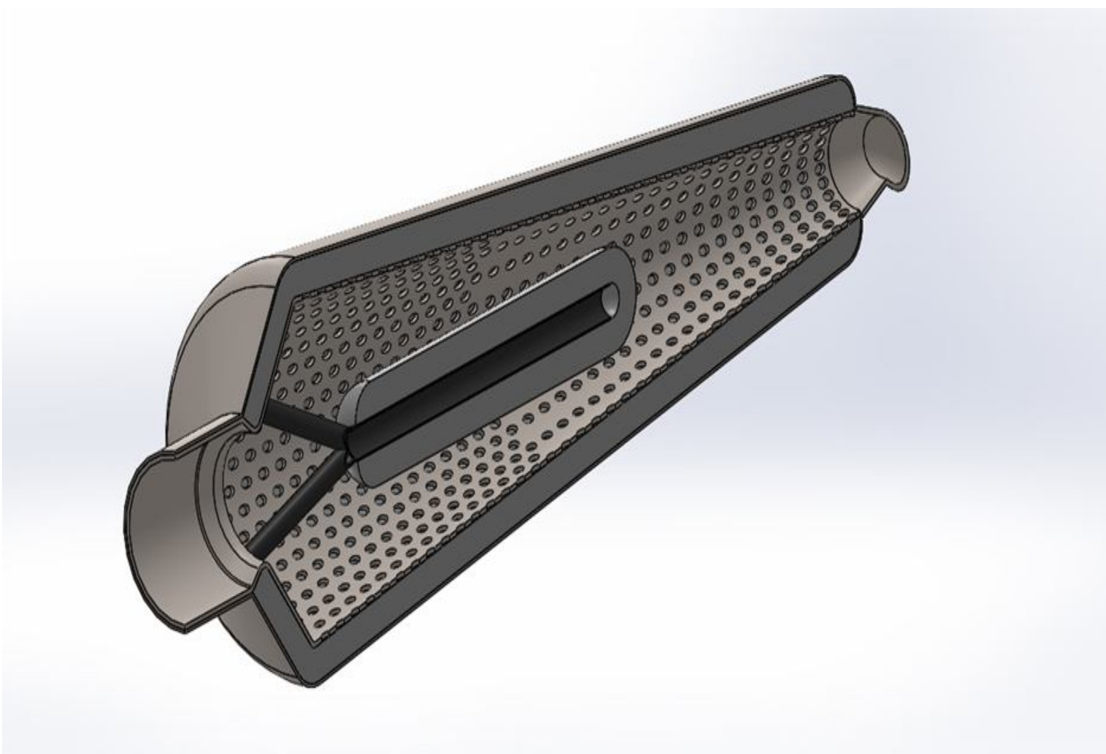


Fig. 1 Design assembly of the exhaust muffler (Sectional View)

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

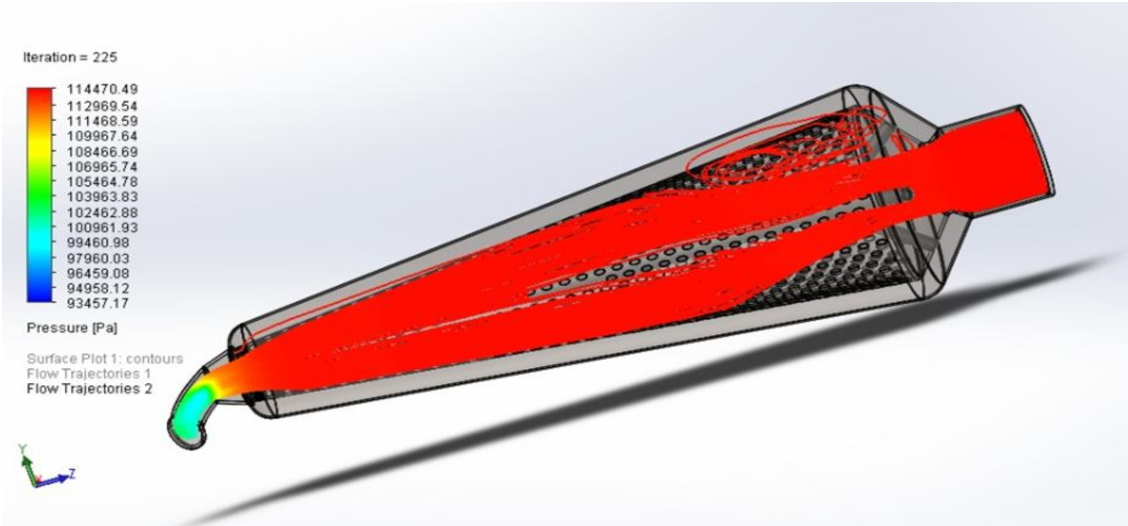


Fig. 2 Detailed Pressure Distribution of Exhaust Muffler

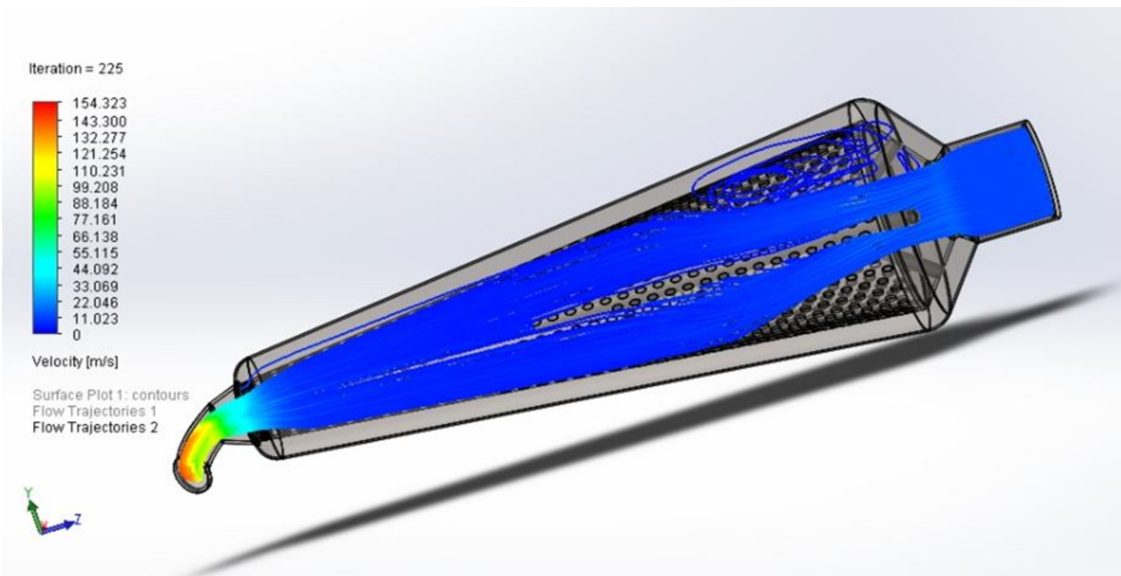


Fig. 3 Detailed Velocity Distribution of Exhaust Muffler

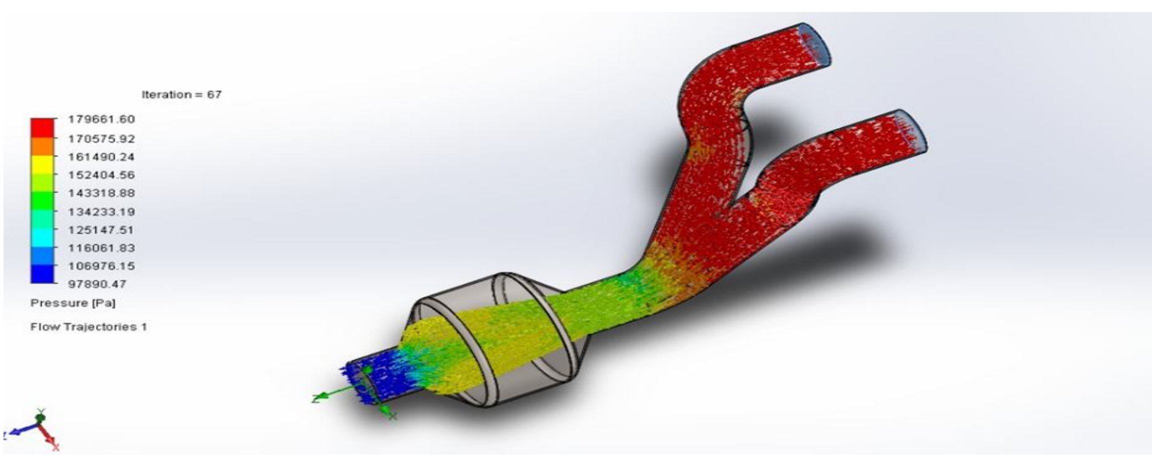
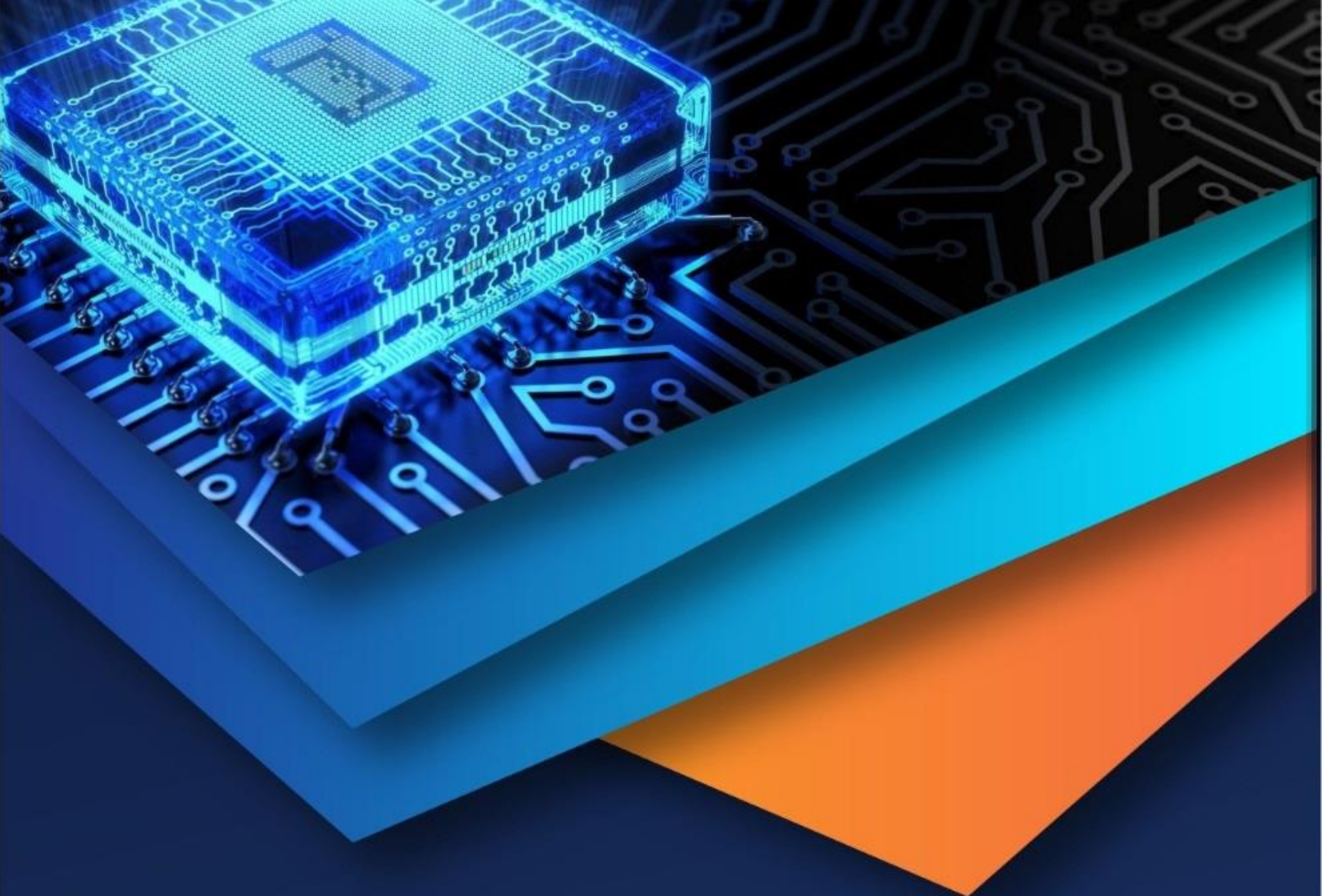


Fig. 4 Detailed Pressure Distribution of Exhaust Manifold

Table 1

Density (kg/m3)	1.0685
Viscosity (Pa-s)	3.0927 x 10-5
Specific heat (J/kg-K)	1056.6434
Thermal conductivity (W/m K)	0.0250



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY