IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Study Of The Thermal Properties Of A Component Of An Automobile Exhaust Manifold

Venuprasad K G [1], Manjunatha [2], Anand A [3]

[1] Lecturer, Department of Mechanical Engineering, Government polytechnic K R Pete, Karnataka, India.
[2] Lecturer, Department of Mechanical Engineering, Government polytechnic Hiriyur, Karnataka, India.
[3] Senior Scale Lecturer, Department of Mechanical Engineering, Government School of Mines KGF, Karnataka, India.

ABSTRACT :

In this work, a sectional model of the exhaust manifold was investigated with the goal of reducing the amount of heat that is lost via pipe insulation by making use of a variety of different insulating materials. The thermal resistance of the exhaust manifold was increased by using four different types of insulating materials in order to decrease the amount of heat that was lost inside the manifold. A discretization and modeling process was performed on the insulating material model. The thermal and structural features of the discretized model have been prepared for evaluation, and they have been presented to the model. An input that is provided to the analytical model is the heat flux from the exhaust gas. The difference in temperature and the amount of heat lost were both considered outputs. The present analysis allows for the conclusion that the use of these four materials will result in a reduction in the amount of heat that is lost via the exhaust manifold.

Keywords: Thermal Property, Discretized Model, Exhaust Manifold, Automobile Element.

1. INTRODUCTION

Some of the most significant main transportation businesses are the automotive and energy industries. For example, the internal combustion engine is employed in a variety of disciplines. Productivity, pollution, engine durability and design, the selection of materials and automobile components, and the fatigue life of the heat transfer effect are all important considerations. The heat that is generated by the engine cooling system is also a factor that contributes to the need of enhancing the performance of the engine. It is helpful to have an understanding of the process by analyzing the exhaust gases that are present in the exhaust system of the engine that is used for temperature monitoring. It is necessary to empty the gas engine while maintaining a very high speed and a high power level. Outgoing gas silencer in the exhaust system of the automobile exhaust, exhaust system, which is thermal, vibration and fatigue caused by cracks in the muffler in the exhaust system, which led to the disruption of the high temperature of the combustion chamber, the hot parts of the exhaust system in order to study heat transfer analysis to improve the performance of the machine.

The following is a list of the many kinds of insulating materials that were employed in this study.

1.1. Insulation Made of Fibrous Materials

Composed of air that has been meticulously divided into interstices by fibers of very small diameter, which are often joined together mechanically or chemically to produce hollow cylinders, boards, and blankets to be used in construction. An example of this would be mineral fiber and fiber glass.

1.2. Cellular Insulation: Insulation may be formed of boards, blankets, or hollow cylinders, and it is composed of air or another gas that is encased in a foam of stable small bubbles. Elastomeric foam and polyurethanes are two examples of such materials.

1.3. Granular Insulation: Air or another gas is contained between the crevices between the microscopic grains that make up this substance, which may be found in the form of blocks, boards, or hollow cylinders. To provide just one example, calcium silicate.

2. MATERIAL PROPERTIES

Table.1. Properties of Steel used.

Material	Value	Unit
Density	7.9E-09	tonne/mm^3
Young's Modulus	2.1E+05	MPa
Poisson's Ratio	0.3	
Co-efficient of thermal expansion	1.2E-05	mm/mm-K
Thermal conductivity	0.0253	W/mm-K

Table.2. Properties of Silica used

Property	Value	Unit
Density	2.42E-09	tonne/mm3
Young's Modulus	7.3E+04	MPa
Poisson's Ratio	0.165	-
Co-efficient of thermal expansion	5.5E-07	mm/mm-K
Thermal conductivity	1.7E-05	W/mm-K

Table.3. Properties of Glass wool used.

Property	Value	Unit
Density	5.1E-10	tonne/mm3
Young's Modulus	5.5E+03	MPa
Poisson's Ratio	0.3	-
Co-efficient of thermal expansion	4.8E-06	mm/mm-K
Thermal conductivity	4E-05	W/mm-K

Table.4. Properties of Plastic foam used.

Property	Value	Unit
Density	6.72E-10	tonne/mm3
Young's Modulus	3.6E3	MPa
Poisson's Ratio	0.21	-
Co-efficient of thermal expansion	7E-05	mm/mm-K
Thermal conductivity	3E-05	W/mm-K

3. VEHICLE SPECIFICATIONS

For the purpose of this study, the engine specs of the Mitsubishi Pajero have been used. Listed here are the specifics of the vehicle's specs in its entirety.

Table.5. Vehicle Specifications

Sl. No.	**Brand**	**Mitsubishi**
1.	Model	Pajero
2.	Generation	Pajero IV
3.	Engine	3.8 i V6 24V MIVEC (250) 5-doors
4.	Power	250 HP/6000 rpm.
5.	Maximum speed	200 km/h
6.	Acceleration 0 - 100 km/h	10.8 sec
7.	Seats	7
8.	Length	4900 mm.
9.	Width	1875 mm.
10.	Height	1870 mm.
11.	Wheelbase	2780 mm.
12.	Model Engine	Mitsubishi 6G75
13.	Position of engine	Front, longitudinal
14.	Engine displacement	3828 cm^3
15.	Torque	329 Nm/2750 rpm.
16.	Fuel System	Multi-point injection
17.	Position of cylinders	V engine
18.	Number of cylinders	6
19.	Bore	95 mm.
20.	Stroke	90 mm.
21.	Compression ratio	9.8
22.	Number of valves per cylinder	4
23.	Fuel Type	Petrol (Gasoline)

4. CAD AND MESHED MODEL

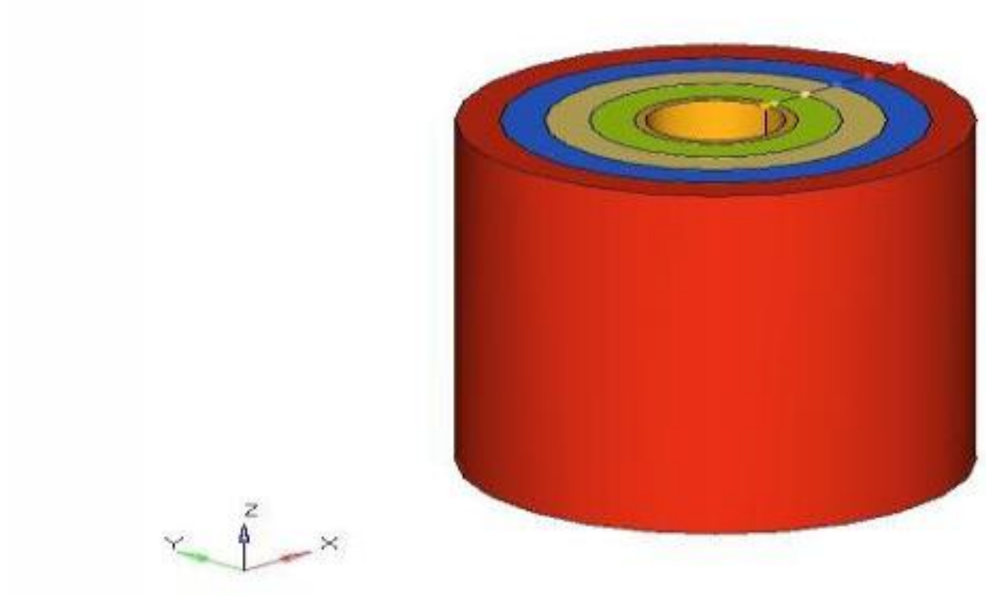

Fig.1. CAD Model of the exhaust manifold section

As can be seen in the picture, this computer-aided design (CAD) model was developed using CATIA version 5. During the modeling phase, the dimensions that were selected in the step that came before this one have been used. It indicates that a steel pipe is situated in the heart of the model, and that four distinct kinds of insulating materials—specifically, silica, glass wool, polyurethane foam, and plastic foam—have been modeled around the steel pipe by modeling them around it. The millimeter is the unit of measurement that is used for all of the measurements.

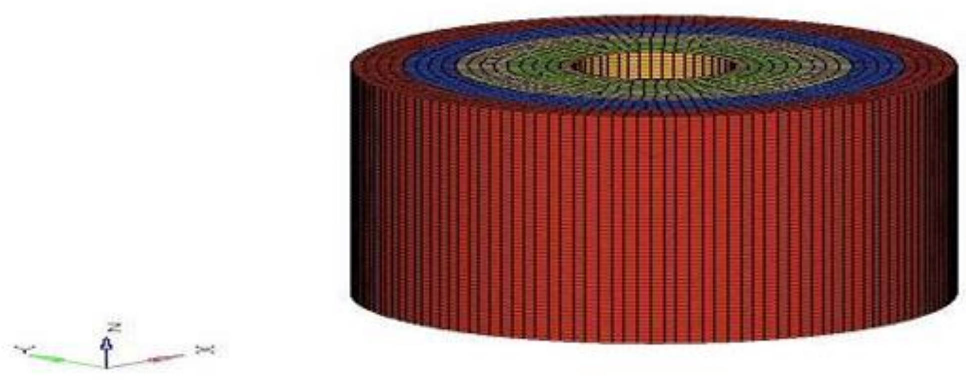

Fig.2. FE Model of the Exhaust manifold section

Meshed result of Exhaust Manifold section.

Total No of Nodes- 444081, Total No of Elements -439200

Fig.3. FE Model of the steel pipe

Meshed result of STEEL section

Total No of Nodes- 20748, Total No of Elements -20520.

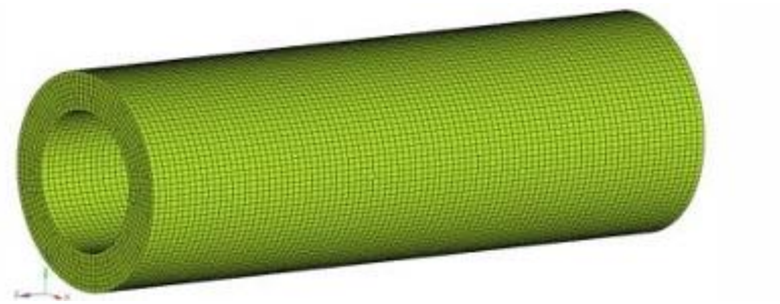

Fig.4: FE Model of Silica insulation

Meshed result of SILICA section

Total No of Nodes – 71890, Total No of Elements – 64260

Fig.5: FE Model of Glass Wool Insulation

Meshed result of Exhaust Manifold section

Total No of Nodes- 104468, Total No of Elements – 92700

Fig.6: FE Model of PUF insulation

Total No of Nodes-133770, Total No of Elements -117900

5. THERMAL LOADING AND BOUNDARY CONDITIONS

The thermal boundary conditions as well as the load that was applied to the model are shown in the visual representation that can be seen below. The heat flux that was calculated in the previous part has been applied to the inner radius of the steel pipe, and the BCs have been applied to the edges of the model that are on the outside. Both of these applications have been completed. This example provides a close simulation of the action of the exhaust gases that are moving through the steel exhaust manifold part of the exhaust system.

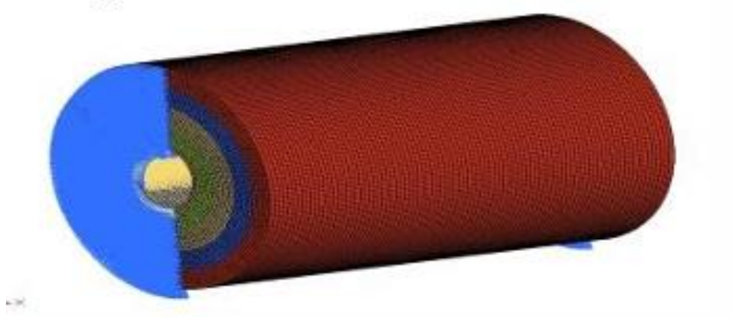

Fig.8: Thermal Loads and Boundary conditions of the exhaust manifold section

6. RESULTS AND DISCUSSION

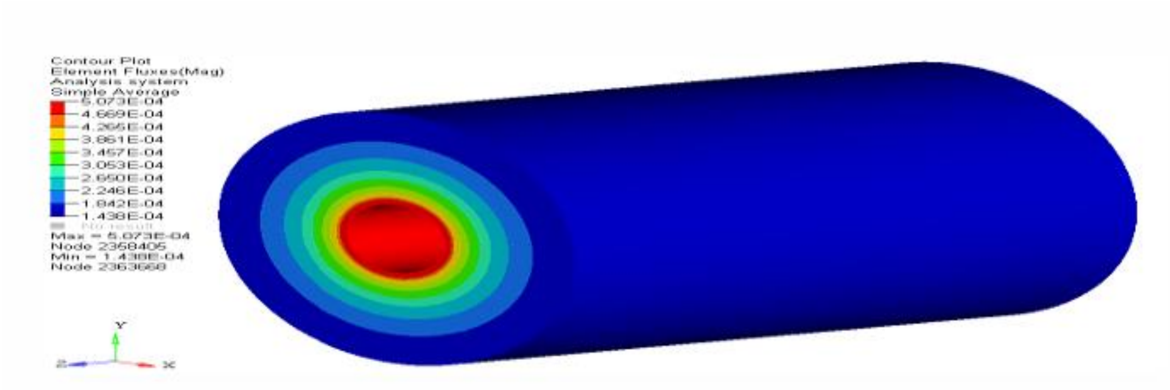

Fig.11: Variation of heat flux in the exhaust manifold section

The figure that is shown above provides a visual representation of the heat flux distribution in the part of the exhaust manifold. According to the findings of the observation, the maximum heat flow occurs inside the steel pipe as a result of the presence of exhaust fumes, and this flux decreases as the pipe moves closer to the atmosphere. Out of all the parts of the pipe, the outer surface of the pipe segment has the lowest heat flow of any of the segments. This illustrates that the flow of heat is diminishing as a consequence of the fact that the thermal conductivity of the insulating materials is changing on a regular basis.

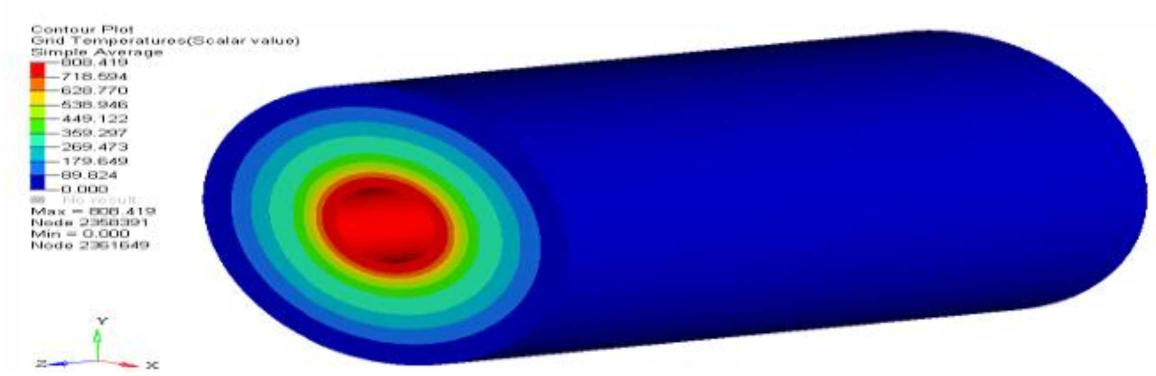

Fig.12: Temperature distribution in the exhaust manifold section

The picture that can be seen above depicts a temperature distribution in the section of the exhaust manifold that goes through the exhaust system. Because of the exhaust gasses that are moving through the steel pipe, the inner wall is being forced to attain its peak temperature. The construction of the steel pipe is to blame for this situation. The temperature swings from high to low, with a high value of 808.4 degrees Celsius when it is close to the steel pipe and a low value of around 35 degrees Celsius when it is on the surface of the insulation that is exposed to the environment.

7. CONCLUSIONS

Based on the outcomes of the present investigation, the following conclusions may be derived. Based on the thermal loads that are put on the manifold section, it can be concluded that the temperature distribution is constant and stays within the parameters of the insulating materials. In the model, the heat flux that is created as a result of thermal loads is seen to decrease, displaying a high value in the center of the insulation and a low value at the outermost part of the insulation itself. Based on the pressure that is being applied to the steel pipe, it can be deduced that the displacement is negligible and does not have any effect on the performance of the pipe. Due to the fact that the stress in the pipe segment is below the yield limit of the materials, it is safe for operation under the conditions that have been stated.

REFERENCES

1. Balashanmugam, P., Elakiya, E., and Sharma, S., "Performance analysis on a turbocharged two wheeler engine", International Journal of engineering research and science and technology, Vol. 2(4), pp.29-41, 2013.
2. Dattatray, D. G., Shinde, V. B., Kulkarni, S. S., "Thermal analysis for motor bike exhaust silencer for ensuring reduction in hot spots through design enhancement", International Journal of Advanced Engineering Research and Studies, Vol. II/ IV, pp.134-137, 2013.
3. Durat, M., Parlak, Z., Kapsiz, M., Parlak, A., "CFD and experimental analysis on thermal performance of exhaust system of a spark ignition engine", Journal of Thermal Science and Technology, Vol. 33(2), pp.89-99, 2013.
4. Ghazikhani, M., Hatami, M., Ganji, D., Mofid, G., Behravan, A., Gholamreza, S., "Exergy recovery from the exhaust cooling in a DI diesel engine for BSFC reduction purposes", Energy, Vol. 65, pp.44-51, 2014.
5. Gogineni, P., Gada, V., Suresh Babu, G., "Cooling Systems in Automobiles and Cars", International Journal of Engineering and Advanced Technology, Vol. 2(4), pp.688-695, 2013.
6. Jayanth, T., Arun, M., Murugan, G., Mano, R., Venkatesan, J., "Modification of Two Stroke I.C Engine to Reduce Emission and Fuel Consumption", International Journal of Engineering and Technology, Vol. 2(1), pp.42-47, 2010.
7. Kandylas, I. P., Stamatelos, A. M., "Engine exhaust system design based on heat transfer computation", Energy Conversion and Management, Vol. 40, pp.1057-1072, 1999.
8. Kar, K., Roberts, S., Stone, R., Oldfield, M., "Instantaneous Exhaust Temperature Measurements Using Thermocouple Compensation Techniques", SAE paper 2004-01-1418.
9. Liu, X., Deng, Y. D., Chen, S., Wang, W. S., Xu, Y., Su, C. Q., "A case study on compatibility of automotive exhaust thermoelectric generation system, catalytic converter and muffler", Case Studies in Thermal Engineering, Vol. 2, pp.62–66, 2014.
10. Martins, J., Brito, F. P., Goncalves, L. M., Antunes, J., "Thermoelectric energy recovery with temperature control through heat pipes", SAE paper 2011-01-0315.