International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 12 | Dec 2018 www.irjet.net p-ISSN: 2395-0072

Review on An Innovative Approach to Study the Thermal Performance of Muffler Heat Shield for Hero Xtreme 200R Bike.

Sachin P. Chinchole[1], Prof. R.R. Borse[2], Prof. R.Y. Patil[3], Prof. J.G. Patil[4]

[1]Student, M.E. Mechanical (General), S.G.D.C.O.E. Jalgaon, Maharashtra, India.
[3]H.O.D, Department of Mechanical Engineering, S.G.D.C.O.E. Jalgaon, Maharashtra, India.
[2,4]Professor, Department of Mechanical Engineering, S.G.D.C.O.E. Jalgaon, Maharashtra, India.

Abstract - *In combustion engines, due to different strokes of the combustion cycle, pressure pulses are generated inside the exhaust system. An exhaust system is usually a piping used to guide reaction exhaust gases away from the controlled combustion inside an engine. The entire exhaust system conveys burnt gases from the engine and includes one or multiple exhaust pipes. This study intends to optimize the topology of the exhaust system of a passenger car engine for the required pressure pulses. Firstly, a suitable exhaust system for the small utility passenger vehicle is designed using system sizing design calculations and modeled using SOLIDWORKS. Then, CFD analysis of the small passenger vehicle exhaust system is performed using ANSYS. Finally, optimized design solution is obtained using Design of Experiments to find out the best suited topology for the applicable exhaust system. The optimized design will be validated by experimental verification for the fulfillment of purpose. CFD work in the area of pressure reduction has given the guideline to reduce the existing pressure drop up to 13 % by making small changes in the perforated pipe in the design.*

Key Words: *Exhaust system, Heat Shield, CFD, ANSYS.*

1. INTRODUCTION

Heat shields protect an object or gaseous area from heat. More specifically, in many applications heat shields attempt to limit conductive, convective, and or radiant heat transfer. Conductive heat transfer refers to the transfer of heat across a medium, whether the medium is solid or fluid. Convective heat transfer occurs between a moving fluid and a surface of an object. Radiant heat transfer occurs when excited atoms emit electromagnetic radiation, which travels from the heat source to a distant object. One method used to protect against the transfer of heat is to place a barrier, such as a sheet of metal, which is generally thermally conductive material, between the heat source and the protected object or gaseous area. A surface of the barrier exposed to the heat source may reflect some indirect heat, but it also absorbs some of the heat.

It is known in the automotive industry that various components within the vehicle generate large amounts of heat which must be shielded from other components in the vehicle.

Heat shields are planned to shield a section from holding excess high temperature either by scattering, reflecting basically holding the hotness. In an auto controlled by an inward smoldering engine, the exhaust system from the engine ventilation framework to the tailpipe is the best creator of hotness after the engine itself. The surfaces of the parts that truly pass on the exhaust gasses can attain to temperatures up to around 900°C. Since a drain frequently passes close essential and thermally sensitive sections, it is especially basic to shield the fragile parts and modules from high temperature. Also Heat shields are used for cooling the engine mount vents. When a vehicle is running at high speed there is enough ram air to cool the engine compartment under the hood, but when the vehicle is running at lower speeds or climbing an inclination there is a need of insulating to the engine heat to get transferred to other parts around it, e.g. Engine Mounts. With the help of proper thermal analysis and use of heat shields, the engine mount vents can be optimized for the best performances.

1.1 Types of Muffler Heat Shield

Automotive heat shield are classified into two main types

1. The rigid heat shield
2. The flexible heat shield

1.2 Heat Shield Applications

The most important functions of thermal management in motor vehicles present for protecting the sensitive vehicle components from the effect of heat and for providing optimal thermal comfort for the occupants. Heat shielding products are generally custom designed for effective management of radiant, convective and conductive heat from the front side to the back side of a vehicle.

Major Application Areas Are follows

- Exhaust manifold heat shields.
- Catalytic converter heat shields.
- Turbocharger heat shields.
- Starter motor heat shields.

2. LITERATURE SURVEY

[1] Prof. Ganesha B. B., Mr. Bharath M. N. (September 2017), presented a paper on "Design and Thermal Analysis of Motor Bike Exhaust Silencer- A Review" The hot gases which generate from combustion of fuel passes

through the exhaust system of the automobile as they form the passage for the hot gases and released to the atmosphere, Hence they are subjected to very high temperature. The uniform heat distribution over the entire exhaust system is important for ensuing enhanced life of elements in the subsystem. The problem identified for this dissertation work is to assess the uniform heat flow along the passage of hot gases and design the passage or passage surface such has to minimize the harmful effects of hot-spots over the length of the silencer, especially at the outer body of silencer.

[2] Dhirajkumar K. More, Dr. Prashant D. Deshmukh, R.O.Gawande (June 2016) presented a paper on **"Thermal Analysis of Two Wheeler Exhaust Silencer using Computer Aided Engineering"** The exhaust system of automobile is exposed to high temperatures as it creates the passage for the hot gases releasing while combustion of fuel. There are many important areas to be focused during design phase of exhaust silencer in order to get the uniform heat distribution over the entire exhaust system which consequently enhanced life of the exhaust system elements. The problem recognized for the proposed study was to assess the flow of heat during the passage of hot gases and design the passage in such a way so as to minimize the dangerous effects of hot-spots over the length of the silencer, especially at the front end mating with the exhaust manifold.

[3] Kunchala Krishna, Roktutpal Borah, (Oct 2016), presented a paper on **"Analysis of diverse material for optimum exhaust heat shielding effect in an engine".** In this study, firstly, thermal analysis done on engine protect Heat shielding system, made of aluminium silicon alloy and steel alloys and MgO–ZrO2 material. The results of Heat shielding systems materials are compared with each other. The effects of materials on the thermal behaviors of the Heat shielding systems are done. Aluminium alloy, zirconium, steel alloy heat shields will be more and more integrated into innovative solutions for Engine encapsulations to reduce fuel consumption and polluting emissions while treating noise at its source are discussed as future scope.

[4] Jagdeesh H.K., Manjunatha K, Mahesh reddy (Nov 2015), presented a paper on **"Numerical and Experimental Investigation on Thermal Behavior of Exhaust Heat Shield".** In this project the three main concepts of heat transfer, i.e. conduction, convection and radiation is used to find the heat transfer happening in the exhaust heat shield. An attempt to optimization is made. The Project mainly focuses on thermal behavior of the exhaust heat shield. In this project they mainly concentrated on temperature distribution in the Heat shield for various modes of heat transfers i.e. conduction, convection and radiation. The temperature distribution was also shown through the real time prototype demo. The FEM results exhibit the temperature distribution happening in the heat shield. The dynamic behavior of the component is found by doing Modal analysis. The natural frequency found safe enough to fit in to automobile assembly.

[5] I. P. Kandylas, A.M. Stamatelos (Dec 1998), presented a paper on **"Engine exhaust system design based on heat transfer computation".** This paper summarized the current status of knowledge regarding phenomena of heat transfer in automobile exhaust systems. Experimental data from steady and transient heat transfer measurements in automotive exhaust systems is presented also analyzed by means of a computer model by covering all the exhaust piping configurations such as single wall, double wall with insulation or air gap. The heat transfer model with complementary codes, which simulate the transient behavior of exhaust after-treatment devices is presented in this paper e.g., particulate traps or catalytic converters may support an efficient methodology for design optimization of exhaust systems.

[6] Mahesh S. Vasava, P. V. Jotaniya (Jun 2015), presented a paper on **"Heat Transfer Analysis in Automotive Exhaust System using Liquid Jet Cooling".** This paper studied the analysis of the heat transfer in automobile exhaust system by using designed liquid jet cooling device. Analysis Heat transfer in automotive exhaust pipe is carried out using liquid jet cooling device. From the study it is understood that the heat transfer in exhaust system is important for the designing of exhaust system components. Corrosion on exhaust pipe and silencer can be controlled by temperature of exhaust system. Back pressure generated in exhaust pipe can be controlled by limiting exhaust temperature which can improve the efficiency of silencer and exhaust pipe. By controlling the exhaust gas temperature, life span of catalytic converter can be improved. It is also reported that liquid jet cooling device can control the engine and exhaust gases temperature.

[7] S. Rajadurai1, M. Afnas, S. Ananth, S. Surendhar (March 2014), presented a paper on **"Materials for Automotive Exhaust System".** In this paper effect of additives such as Ti, Mo, Mn and Si to the base steel material for various parts of exhaust system are presented. Materials which are generally used for conventional applications and special applications are described in detail. Properties of the materials mild steel, stainless steel and aluminized steel are also compared. Applications of special materials like Inconel, Fe Cr Alloy, 18CrCb and A286 are also discussed in detail in this paper. The chemical, physical and mechanical properties of the materials which are required for the exhaust system are being considered in depth. They also explained effect of additives to the base material.

[8] M. Rezaei (Feb 2013), presented a paper on **"Experimental and finite element vibrational analysis of exhaust manifold heat shield".** In this paper, the failure of a heat shield due to vibrational loads of the engine has been investigated using the finite element method and experimental methods. Since heat shields have been made from thin shells, their analysis can be done in the vibrational field of plates. The analysis of the investigated heat shield in this field shows that two of the first resonance frequencies of heat shield are in the range of the engine speed and locations

of heat shield cracks are at the maximum deflection positions.

[9] Bin Zou, Yaqian Hu, Zhien Liu, Fuwu Yan and Chao Wang (Aug 2013), presented a paper on **"The Impact of Temperature Effect on Exhaust Manifold Thermal Modal Analysis".** The impact of temperature effect on exhaust manifold and the modal analysis is performed in this study. Firstly, the temperature effect is mapped by using the CFD software and then heat conduction process is studied in FEM software with the temperature field boundary conditions. Finally the modal analysis which considers temperature effect also is done. The frequency and the vibration mode in between cold modal and thermal modal's are compared here. The result showed that temperature has a very great influence on the manifold mode and it is much valuable for product design.

[10] P. Srinivas, Venkata Ramesh Mamilla, G. Lakshmi Narayana Rao, Sowdager Moin Ahmed (June 2016), presented a paper on **"Design and Analysis of an Automobile Exhaust Muffler"**. Here dynamic modal analyses were carried out to determine the mode shapes, stresses and deformations of a designed exhaust muffler using CAE analysis. Design and analysis of muffler guard is carried out in solid works software. Modeling of muffler is done with proper dimensions. It was concluded from CAE results that Double expansion chamber gives better results as compared to single expansion chamber. Loss in Transmission of double expansion chamber is 42.48 which is more than the requirement and much satisfactory. Future scope discussed, the muffler which we are going to create that is little big in size. So, the size of muffler can be minimizing to a proper size which can be suitable for the motorcycle. Also there is a scope for calculating the back pressure. Also because of size reduction of muffler the manufacturing cost of it can also be reduced. Due to reduction in the size of muffler the space requirement is also less.

[11] Dragos Tutunea, Madalina Calbureanu, Lungu Mihai (June 2016), presented a paper on **"Computational fluid dynamics analysis of a resistance muffler".** Resistance muffler is the basic device for attenuation of the exhausted noise of engines used in present analysis. In this paper, a resistance muffler was designed for automobile industries. The Computational Fluid Dynamics (CFD) method was used to analyze the effect which the internal flow field has on the performance of the muffler. With this method pressure distribution in the muffler is simulated and predicted the pressure loss by this. The integrated performance of design and construction of muffler has been advanced. Conclusion drawn, The simulations give valuable information regarding the velocity field, pressure field, density field and temperature field of the exhaust muffler. This is important because it saves time and many in the production process through the identification of eventual problems before the exhaust muffler is build.

[12] Dattatray Dilip Giripunje, Prof. Dr. Vilas B. Shinde, Swapnil S. Kulkarni (Sept 2013), presented a paper on **"Thermal analysis for motor-bike exhaust silencer for ensuring reduction in hot spots through design enhancement".** The problem identified for this proposed dissertation work was for assessing the heat flow during the passage provided for hot gases and design the passage so as to minimize the harmful effects of hot-spots over the total length of the silencer, especially at the front end mating with the exhaust manifold. Comparison of the data determined by analysis i.e. the computational approach or methodology with the physical laboratory experimentation would be a good pointer to validate the design. The design is validated as the geometry of the silencer yields a result that displays a good match within the analysis and the physical experimentation.

Most of the researchers have carried out their study for thermal analysis of the exhaust silencer. Their main focus was to study the effect of temperature on the exhaust silencer also have performed structural and vibrational analysis. Some of the researchers have worked on material optimization for exhaust systems. But very less focus is given on the analysis of muffler heat shield. So we can see there is huge scope to study the thermal performance of muffler heat shield and its optimization.

3. METHODOLOGY OF THE PROPOSED WORK

The working steps that will be involved in this proposed work can be as follows

1. Study of the two wheeler exhaust system and heat dissipation behavior of the exhaust gases by conduction, convection and radiation from manifold to exit from muffler.
2. Study of the various symptoms of heat shield failure and its effects.
3. Study of the various CFD and FEA methods.
4. Design of heat shield for two wheeler exhaust muffler.
5. Modeling of heat shield in ANSYS.
6. Finite element analysis of heat shield using ANSYS.
7. Finite element analysis of heat shield for various modes of failure by vibration using ANSYS.
8. CFD analysis of the heat shield for thermal loading and its behavior under thermal overloading and overload temperature.
9. Suggesting optimized heat shield for better structural and thermal efficiency to achieve desired objective.
10. Comparison of results of optimized heat shield with previous design.

CONCLUSION

In our literature survey we studied that the analysis of exhaust silencers is focused by many researchers by using various methodologies. So there is a scope for the study of performance of muffler heat shield. We will be performing

CFD and FEA on muffler heat shield and optimizing it for better performance.

REFERENCES

1. Prof. Ganesha B. B., Mr. Bharath M. N. "Design and Thermal Analysis of Motor Bike Exhaust Silencer- A Review" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 6 Issue 09, September – 2017.

2. Dhirajkumar K. More, Dr. Prashant D. Deshmukh, R.O.Gawande "Thermal Analysis of Two Wheeler Exhaust Silencer using Computer Aided Engineering" International Journal of Engineering Technology, Management and Applied Sciences (IJETMAS) June 2016, Volume 4, Issue 6, ISSN 2349-4476.

3. Kunchala Krishna, Roktutpal Borah, "Analysis of diverse material for optimum exhaust heat shielding effect in an engine", IJEMMS (Sep-Oct,-2016), Issue- V-1, I-2, SW-11, ISSN-2320-7884 (Online).

4. Jagdeesh H.K., Manjunatha K, Mahesh reddy, "Numerical and Experimental Investigation on Thermal Behavior of Exhaust Heat Shield", International Journal of Innovative Science, Engineering & Technology(IJISET), Vol. 2 Issue 11, November 2015,ISSN 2348-7968.

5. I.P. Kandylas, A.M. Stamatelos "Engine exhaust system design based on heat transfer computation", Laboratory of Applied Thermodynamics, Mechanical Engineering Department, Aristotle University of Thessaloniki, Thessaloniki, Greece, Energy Conversion & Management 40 (1999) 1057-1072.

6. Mahesh S. Vasava, P. V. Jotaniya, "Heat Transfer Analysis in Automotive Exhaust System using Liquid Jet Cooling", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 6, June 2015, ISSN (Print): 2347-6710, ISSN(Online): 2319-8753.

7. S. Rajadurai1, M. Afnas2, S. Ananth3, S. Surendhar, "Materials for Automotive Exhaust System", International Journal of Recent Development in Engineering and Technology, Volume 2, Issue 3, March 2014, ISSN 2347-6435(Online).

8. M. Rezaei, "Experimental and finite element vibrational analysis of exhaust manifold heat shield", Iran Society of Engine (ISE), The Journal of Engine Research, Vol. 26 (spring 2012), pp. 41-48.

9. Bin Zou, Yaqian Hu, Zhien Liu, Fuwu Yan and Chao Wang, "The Impact of Temperature Effect on Exhaust Manifold Thermal Modal Analysis", Research Journal of Applied Sciences, Engineering and Technology, 2824-2829, 2013 ISSN: 2040-7459; e-ISSN: 2040-7467, Maxwell Scientific Organization, 2013.

10. P. Srinivas, Venkata Ramesh Mamilla, G. Lakshmi Narayana Rao, Sowdager Moin Ahmed "Design and Analysis of an Automobile Exhaust Muffler", American Institute of Science, Industrial and Systems Engineering Vol. 1, No. 1, 2016, pp. 10-15.

11. Dragos Tutunea, Madalina Calbureanu, Lungu Mihai, "Computational fluid dynamics analysis of a resistance muffler", University of Craiova, Recent Advances in Fluid Mechanics and Heat & Mass Transfer, ISBN: 978-1-61804-183-8.

12. Dattatray Dilip Giripunje, Prof. Dr. Vilas B. Shinde, Swapnil S. Kulkarni, "Thermal analysis for motor-bike exhaust silencer for ensuring reduction in hot spots through design enhancement", International Journal of Advanced Engineering Research and Studies, II/ IV/July-Sept., 2013/134-137, E-ISSN2249–8974.