

Experimental Analysis for Thermal Performance of Muffler Guard HERO XTREME 200R Bike

Sachin P. Chinchole¹, Prof. R.R. Borse², Prof. R.Y. Patil³

¹Student, M.E. Mechanical (General), S.G.D.C.O.E. Jalgaon, Maharashtra, India.

²Associate Professor, Department of Mechanical Engineering, S.G.D.C.O.E. Jalgaon, Maharashtra, India.

³H.O.D, Department of Mechanical Engineering, S.G.D.C.O.E. Jalgaon, Maharashtra, India.

Abstract - In automotive exhaust system the exhaust gases coming out from the engine are very high speed and high temperature from the silencer or muffler. So to maintain the temperature of muffler by using a cover mounted on it that is called muffler guard. Muffler guard are used to protect the component and human body touching over it. In this project to analysis the thermal performance of muffler guard by an experimental setup to understanding how to minimise the temperature of muffler guard for Hero XTREME 200R Bike. Design and modelling is done by using AUTOCAD and Nx software. In this paper to measure the temperature at certain point that means the muffler end such as big end, short end, bottom end and their respective drilled vertical and horizontal holes. We tried to validate the experimental results by plotting a graphs temperature vs. Muffler end.

Key Words: Muffler guard, Temperature in °C, Time, Muffler Guard Respective points and Ends.

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. As some of the heat is absorbed, the exposed surface becomes heated. One disadvantage of this prior art is that the conductive properties of the barrier cause the surface heat to flow through the barrier by way of conduction, ultimately heating the opposing or protected shield surface. The automotive exhaust system is exposed to high temperature as the hot gases passes through it. The uniform distribution of heat is needed to enhance life of exhaust system components. Controlling the exhaust gas temperature, higher performance of the engine can be achieved. Measuring the exhaust gas temperature from automotive exhaust system is useful to understand the engine processes. Due to the large amounts of heat given off by internal combustion engines, heat shields are used on most engines to protect components and bodywork from heat damage. In certain vehicle operating conditions, the exhaust system, as well as other components, produces heat in very different amounts over different lengths of time.

Because of these kinds of shields have been overdesigned becoming larger and heavier to account for such operating conditions.

2. RELATED WORK

[1] 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 paper work 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 Paper mainly focuses on thermal behavior of the exhaust heat shield Thermal Analysis is carried out with the boundary condition for a realistic working condition; Experimental test is carried out by using the prototype for a prescribed condition more than room temperature and the same thing is simulated by using the simulation software. In this paper 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 FEM results were extracted from ABAQUS a very strong tool for FEM. The FEM results are validated through some real time instruments which in turn build the prototype. The dynamic behavior of the component is found by doing Modal analysis. The natural frequency found safe enough to fit in to automobile assembly.

[2] S. Rajadurai¹, M. Afnas, S. Ananth, S. Surendhar (March 2014), presented a paper on "Materials for Automotive Exhaust System".

In this paper they explained effect of additives such as Ti, Mo, Mn and Si to the base steel material for various parts of exhaust system are presented. Materials for automotive exhaust system are discussed in detail. Materials used for conventional and special applications are described. Properties of mild steel, stainless steel and aluminized steel are compared. Applications of special materials such as Inconel, Fe Cr Alloy, 18CrCb and A286 are discussed in detail. The chemical, mechanical and physical properties of the materials required for the exhaust system are being considered in depth. The effect of additives to the base material is also explained.

[3] M. Rezaei (Feb 2013), presented a paper on "Experimental and finite element vibrational analysis of exhaust manifold heat shield".

In this paper they explained 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. The failure of the engine heat shield can be caused to the engine noise and melting of the cylinder head valve cover. The investigations show that the dominant load of this part is the vibrational load. In the investigated engine, the vibrational load has been considered in the design of the second heat shield, but due to some modifications on this engine such as changing the fuel system from the carburetor system to the injection system, the excitation frequencies of the engine have been changed and the heat shield has been resonated during the functional tests. The FEM and experimental results of one heat shield show that this part will resonate in two modes of the engine speed work. By increasing the thickness of the heat shield from 0.8 mm to 1.5 mm, the failure can be avoided according to the resonance of this part, in all ranges of the engine speed.

[4] 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".

In this paper they explained the impact of temperature effect on exhaust manifold modal analysis is analyzed in this study. Firstly, the temperature field is mapped from the CFD software and then heat conduction process is analyzed in FEM software with the temperature field boundary conditions. At last the modal analysis that considers temperature effect is done. The frequency and vibration mode between cold modal and thermal modal's are compared. The result shows that temperature has a great influence on the manifold mode and it is very valuable to product design.

3. METHODOLOGY

1. Study the basic model of muffler guard.
2. Select software for modification of muffler guard.
3. Design of muffler guard in AUTOCAD
4. Modelling of muffler guard in Nx software.
5. Structural changes such as cutting big end, drilled a vertical holes near to big end and horizontal holes at short end.

6. Measure the temperature at respective points by using Non-contact digital LASER infrared thermometer sensor gun for basic and modified model of muffler guard.

7. To compare the results of basic and modified model of muffler guard by plotting graphs.

4. DESIGN OF MUFFLER GUARD

Design of muffler guard basically depends on the following points:

4.1 According to shape and size of muffler guard-

Shape of muffler guard it will be depending on the design and ergonomic consideration of the muffler. Size of muffler guard is based on that means the shape of muffler is short, medium or long. The muffler pipe which is coming out from the exhaust system of an engine it has shape of curvature for a pipe. This type of curvature is to give a curve for muffler guard to design shape. The size of muffler guard is design as per length and width of muffler.

4.2 According to basis holes and slot of muffler guard-

Muffler guard is to be design on the basis of holes and slots such as circular, elliptical or rectangular. Hole size it means the diameter for circular, length and width dimensions for rectangular and shape (curve) for slots depending upon the heat transfer of muffler surface. The capacity of engine is maximum the heat is coming out from a exhaust is maximum due to minimize the temperature of both the surface of muffler and muffler guard the hole size is maximum up to 15mm or number of hole is more it is base on the capacity of engine. For the performance of heat transfer the number of holes, slots size is to be design as per capacity of engine.

4.2 According to basis of gap and thickness of muffler guard-

The muffler guard is fitted on the muffler by using a screws, rivets or bolts. The gap between the muffler guard and muffler is depending on the heat flow between the two plates that means one of the muffler and other one is muffler guard so that the gap is minimum up to 10mm or maximum up to 15mm is depends on the capacity of engine the capacity of engine is maximum the heat flow is maximum and vice versa. When the vehicle is moving slowly the air flow in the gap is slow and vehicle is moving fast the air flow in the gap is maximum. Therefore thermal performance is depending upon air flow between the gaps to minimize and to maintain temperature of muffler guard. Thickness of muffler guard is very important because of heat is transfer or released from muffler by convection. When the thickness of muffler guard is max also weight is more therefore the temperature effect will be occurs from the exhaust is not

better so thickness is as minimum as possible that temp distribution is very good and the engine performance. Thickness of muffler guard is basically taking 1mm to 2.5mm depending on the type of materials and the engine capacity of vehicle. Engine capacity is maximum the power will be more due to this the temperature of exhaust gases is increases the effect of temperature the muffler guard to be heated so to minimize the heating problem to max the heat transfer capacity thickness is considered.

5. MODELING OF MUFFLER GUARD

For modelling of muffler guard to draw in AUTOCAD software 2-D Drawing and 3-D drawing or modelling in Nx software.

1] 2-D DESIGN OF MUFFLER GUARD IN AUTOCAD SOFTWARE

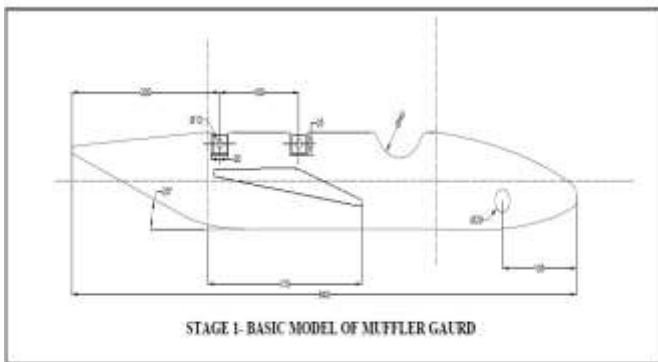


Fig-1- Basic Model of Muffler Guard

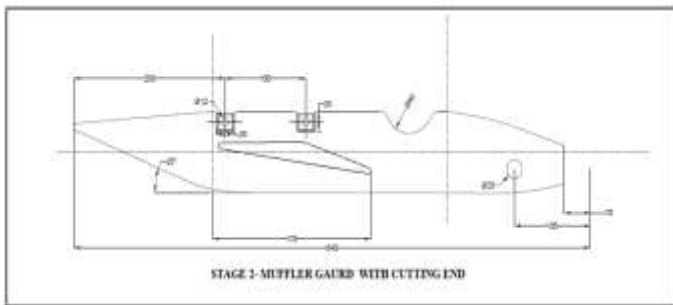


Fig-2- Modified design of muffler guard with Cutting Big End

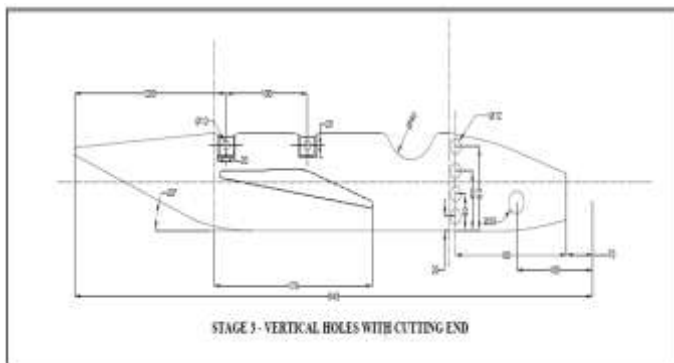


Fig-3- Modified design of muffler guard with Vertical Holes and Cutting Big End

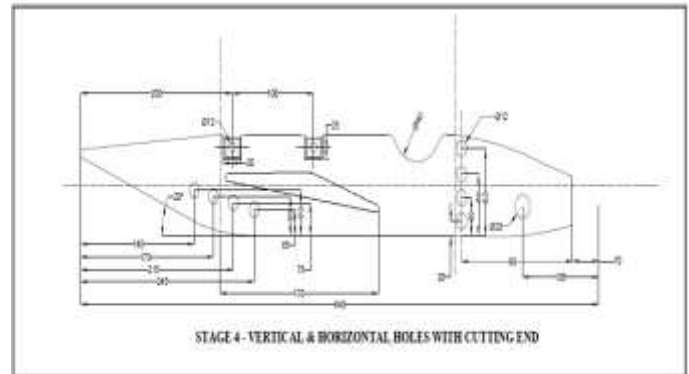


Fig-4- Final design of muffler guard with Vertical, Horizontal Holes and Cutting Big End

1] 3-D DESIGN OF MUFFLER GUARD IN NX SOFTWARE

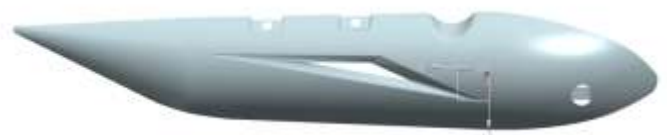


Fig-5- Basic Model of Muffler Guard



Fig-6- Modified design of muffler guard with Cutting Edge



Fig-7- Modified design of muffler guard Vertical Hole with Cutting Edge



Fig-8- Final Proposed design of muffler guard with Vertical, Horizontal Holes and Cutting Big End

6. EXPERIMENTATION

For experimental analysis to Measure the temperature of muffler guard by using Non-contact digital LASER infrared thermometer sensor gun for basic and modified model of muffler guard. For **Case-1** to take basic model of muffler guard mounted on bike silencer or muffler. To start bike for 20 minutes in idling condition or position and measuring the temperature at certain point are big end, bottom end and short end. Then after running bike for 20 minutes or average speed of 40 km/hr measure the temperature at points and repeated the same procedure for next after running bike for 20 minutes. After cooling the engine and silencer of bike then go for **Case-2** in which to take modified model of muffler guard with vertical, horizontal holes and cutting big end by replacing the basic model of muffler guard of bike. Then repeat the same procedure as case-1 in addition to this case-4 measure the temperature at number of vertical, horizontal holes and cutting big end line.



Fig-9- Experimental Setup

A) CASE-1 BASIC DESIGN OF MUFFLER GUARD

EXPERIMENTAL RESULTS

Table-1-Idling position for 20 min

| Muffler Guard End | Temperature (°C) |
|-------------------|--------------------|
| Big End | 70 |
| Bottom End | 85 |
| Short End | 80 |



Graph-1- Temperature vs. Muffler Guard End for case-1

Table-2-After running position for 20 min

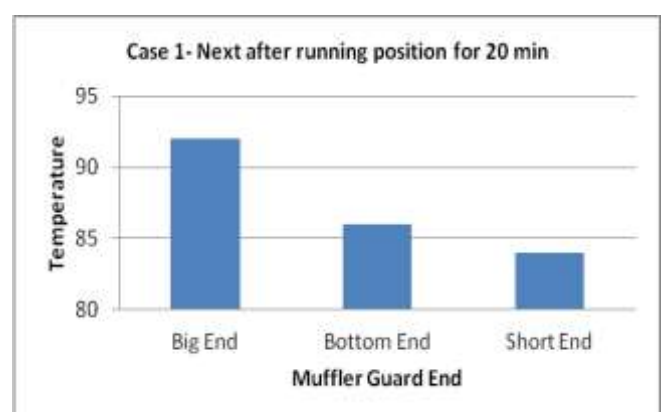
| Muffler Guard End | Temperature (°C) |
|-------------------|--------------------|
| Big End | 93 |
| Bottom End | 87 |
| Short End | 85 |



Graph-2- Temperature vs. Muffler Guard End for case-1

Table-3- Next After running position for 20 min

| Muffler Guard End | Temperature (°C) |
|-------------------|--------------------|
| Big End | 92 |
| Bottom End | 86 |
| Short End | 84 |



Graph-3- Temperature vs. Muffler Guard End for case-1

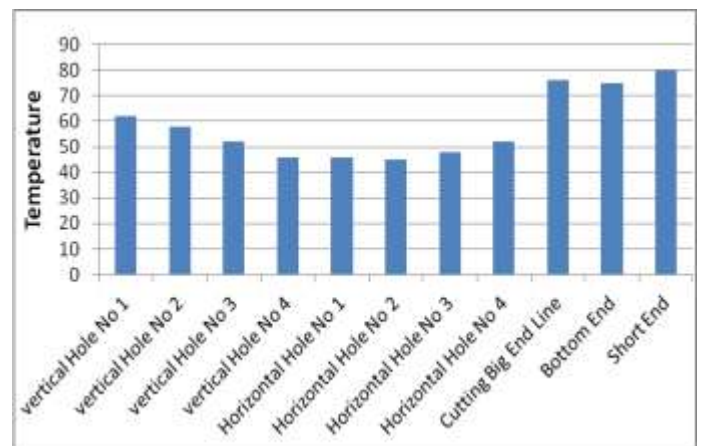
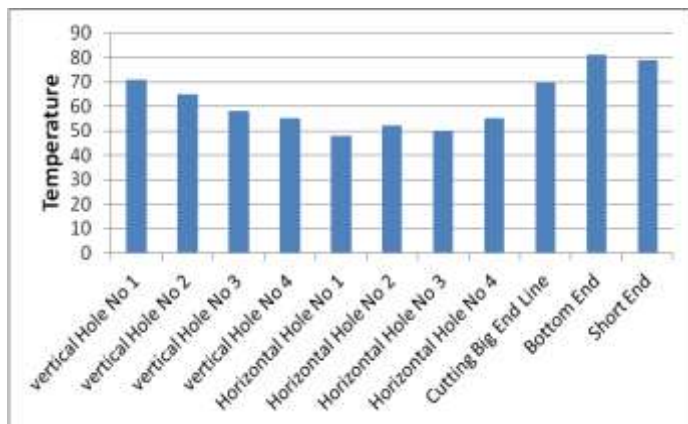
B) CASE-2 MODIFIED DESIGN OF MUFFLER GUARD

EXPERIMENTAL RESULTS

Table-4- Idling position for 20 min

| Muffler Guard Respective Points | Temperature (°C) |
|---------------------------------|--------------------|
| Vertical Holes | |
| Hole edge at no. 1 | 71 |
| Hole edge at no. 2 | 65 |
| Hole edge at no. 3 | 58 |
| Hole edge at no. 4 | 55 |
| Horizontal Holes | |
| Hole edge at no. 1 | 48 |
| Hole edge at no. 2 | 52 |
| Hole edge at no. 3 | 50 |
| Hole edge at no. 4 | 55 |
| Cutting Big End Line | 70 |
| Bottom End | 81 |
| Short End | 79 |

| | |
|----------------------|----|
| Hole edge at no. 1 | 46 |
| Hole edge at no. 2 | 45 |
| Hole edge at no. 3 | 48 |
| Hole edge at no. 4 | 52 |
| Cutting Big End Line | 76 |
| Bottom End | 75 |
| Short End | 80 |



Graph-5- Temperature vs. Muffler guard Respective points for case-2

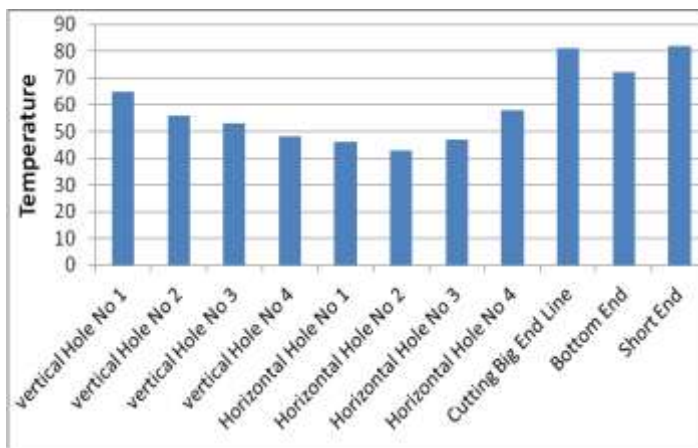
Table-6- Next After running position for 20 min

| Muffler Guard Respective Points | Temperature (°C) |
|---------------------------------|--------------------|
| Vertical Holes | |
| Hole edge at no. 1 | 65 |
| Hole edge at no. 2 | 56 |
| Hole edge at no. 3 | 53 |
| Hole edge at no. 4 | 48 |
| Horizontal Holes | |
| Hole edge at no. 1 | 46 |
| Hole edge at no. 2 | 43 |
| Hole edge at no. 3 | 47 |
| Hole edge at no. 4 | 58 |
| Cutting Big End Line | 81 |
| Bottom End | 72 |
| Short End | 82 |

Graph-4- Temperature vs. Muffler Guard Respective points for case-2

Table-5- After running position for 20 min

| Muffler Guard Respective Points | Temperature (°C) |
|---------------------------------|--------------------|
| Vertical Holes | |
| Hole edge at no. 1 | 62 |
| Hole edge at no. 2 | 58 |
| Hole edge at no. 3 | 52 |
| Hole edge at no. 4 | 50 |
| Horizontal Holes | |



Graph-6- Temperature vs. Muffler Guard Respective points for case-2

7. CONCLUSION

It is observed that from experimental results of muffler guard in the Case-1 for Graph No. 3 temperature with muffler guard end shows the value of temperature is maximum at big end and minimum at short end of muffler guard. In the Case-2 for Graph No. 6 temperature with muffler guard respective points shows value of temperature is maximum at short end and minimum at horizontal holes of muffler guard. We tried to validate the experimental results and it is found that the value of temperature for muffler guard is decreases when the changes in design of muffler guard.

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