

# A Review on Flow Controlled Noise Through Two Wheeler Silencer by Means of CFD Tool

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## Abstract:

Exhaust systems are developed to control emissions and to attenuate noise vibration and harshness to meet the regulatory requirements. The exhaust system components are manifold, close coupled and underbody catalytic converters, flexible bellow, muffler, resonator, connecting pipes, flanges, and tailpipe.” A well-designed exhaust system collects exhaust gases from engine cylinders and discharges them as quickly and silently as possible.

In this paper, the available literature on this topic is studied well and the possible methods of flow analysis are studied. Pressure and velocity variation inside the silencer will affect the noise from silencer. Hence the mufflers provided inside the silencers are studied well to understand the effect of velocity reduction on noise. Tools used for performing CFD analysis are also studied well and checked the possibility for using same tools for proposed CFD analysis of two wheeler silencer.

**Keywords — Silencer, Muffler, CFD Analysis**

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## I. LITERATURE REVIEWS

Ravindra S Girge, Nitesh Rane, “Analysis of Two Wheeler Exhaust Silencer With Thermodynamics Principle and Computer Aided Design” The hot gases from engine passes through the exhaust system of the automobile at very high temperature. Exhaust system of an automobile consist of three parts such as exhaust manifold, catalytic converter and silencer out of those silencer having very short life span as there is lot of restriction provided to the flow of hot gases due to complex geometry in order to reduce the noise level hence gases staying more time in this section as compare to other two part of exhaust system. Hence silencer needs to be focused for thermal analysis in order to increase its life span. For this improvement in life span the uniform

distribution of heat over the entire exhaust system which consequently enhanced life of the elements in the exhaust system is necessary. The problem recognized for this proposed study is to assess the heat flow during the passage of hot gases and design the passage in such a way that it will minimize the destructive effects of hot-spots and localized heating due to heat transfer barriers over the length of the silencer, especially at the front end mating with the exhaust manifold. [1]

Pradyumna Saripalli, K. Sankaranarayana, “CFD Analysis on Flow Through a Resistance Muffler of LCV Diesel Engine”. The exhaust pollution has become one of the important problems of environment pollution with applications in automobile industry, and the exhausted muffler has been paid attention to improve the performance of

engines. Computational Fluid Dynamics (CFD) method was used to explore the aerodynamic performance of the muffler. Resistance muffler research relates with the fields of acoustics, fluid dynamics, heat transfer and mechanism design. The project report simulates the field by numerical method with Cosmos Flow and analyses the effect which the internal flow field has on the performance of the muffler. With this method the pressure distribution in the muffler is simulated and the pressure loss is predicted for the structure modification. The experiment results verify that the assembly performance of the muffler modified is better than the original muffler. [2]

Prof. G. S Joshi, "Design and Development of Automobile Silencer for Effective Vibration Control". A Silencer is a part of the exhaust system of an automobile that plays a vital role. It needs to have modes that are located away from the frequencies that the engine operates at, whether the engine be idling or running at the maximum amount of revolutions per second. Their paper postulates the first stage in the design analysis of an exhaust system. With the specified properties of the material, the exhaust system is modeled by using a conventional FEM package. The results are compared with the reading taken on FFT analyzer, so as to distinguish working frequency from natural frequency and avoid resonating condition. [3]

Sweta Baruah, Sushowan Chatterjee, "CFD Analysis on an Elliptical Chamber Muffler of a I.C. Engine". Highest pressure and temperature are developed inside the combustion chamber of Compression Ignition (C.I.) engine. As the outlet of the exhaust system is the atmosphere, there might be adverse pressure gradient in the exhaust system which can be analysed for the purpose of attenuation of pressure wave in case of conventional silencer system. This hot exhaust gas coming out through the silencer pipes in the exhaust system of automobiles can be a scope of study for Computational Fluid Dynamic (CFD) simulation. In their work, an elliptical chamber muffler model of a MAHINDRA C.I. engine is studied based on CFD analysis of the exhaust gas flow through the muffler

chamber. Two designs for the aforementioned muffler are analyzed one of which consists of perforated inlet, outlet and central pipes which, if implemented in actual practice could bring about better and improved sound attenuation. Transmission loss is calculated for both the muffler models based on pressure distribution obtained from CFD analysis results. Comparative study of the two muffler models, one without the presence of any perforation and the other after incorporation of perforation, is carried out in ANSYS FLUENT 14.5 [4]

Vijay M Mundhe, Eknath R Deore, "Design and analysis of perforated muffler in Automobile Exhaust System". A muffler is an important part of an engine system used in exhaust system to reduce exhaust gas noise level. The literature review reveals that the exhaust gas noise level depends upon various factors. Muffler geometry, extension in inlet and outlet valves, number of whole perforations and its diameter are the factors which affects noise from engines. The objective of their study is to reduce exhaust gas noise level. The performance of the muffler is assessed by analyzing pressure variation, exhaust gas flow pattern, length of expansion chamber, transmission loss. The K-epsilon method is used to obtain desired outputs by inputting sinusoidal nature of pressure wave. The modeling of muffler is done by using modeling software CATIA V5 and performance parameters are estimated using Star CCM+ software. This study helps to improve reduce the noise level and environmental noise pollution. The results obtained from software are compared with analytical method and they are found close agreement with each other. [5]

Mohamed Filsuf M. A 1, Dr. S. Sankar 2, "Design and Development for Exhaust Back Pressure Reduction with Noise Control for Motorcycles". Motorcycle Back Pressure reduction is the process of reducing the resistance created by the motorcycle exhaust system that has been created for Noise Reduction so as to meet the standards of Noise Pollution within the atmosphere. The design is based on the concept of reducing the Back

Pressure created inside and to maintain the noise at the tail pipe of the exhaust system by the introduction of new concept of Wedge Theory which has been designed and Analyzes on ANSYS Software for its advantages, and also the introduction of Pressure Maintainer Valve helps in maintaining the reduced back pressure for, so as to maintain a correct ratio maintaining. [6]

Dattatray Dilip Giripunje, Prof. Dr. Vilas B. Shinde, “Thermal Analysis For Motor-Bike Exhaust Silencer for Ensuring Reduction in Hot Spots Through Design Enhancement”. The exhaust sub-system is exposed to high temperatures as they form the passage for the hot gases released upon combustion of fuel to be released to the atmosphere. While there are other prominent areas to be focused during design phase, the uniform distribution of heat over the entire exhaust system (including the silencer) is of importance for ensuing enhanced life of the elements in the sub-system. The problem identified for this proposed dissertation work is to assess the heat flow during the passage of hot gases and design the passage such as to minimize the harmful effects of hot-spots over the length of the silencer, especially at the front end mating with the exhaust manifold. [7]

Bharath M N1, Ganesha B B, “Design and Thermal Analysis of Motor Bike Exhaust Silencer” 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. Exhaust system of an automobile consist of three parts such as exhaust manifold, catalytic converter and silencer out of those silencer having very short life span as there is lot of restriction provided to the flow of hot gases due to complex geometry in order to reduce the noise level hence gases staying more time in this section as compare to other two part of exhaust system. Hence that area needs to be focused during design phase. The uniform heat distribution over the entire exhaust system is important for ensuing enhanced life of elements in the sub-system. This problem is important to identify and to assess

the uniform heat flow along the passage of hot gases and design the passage or passage surface to minimize the harmful effects of hot-spots over the length of the silencer, especially at the outer body of silencer. [8]

Tejas J. Kalange, “Design and Analysis of Muffler for Twowheeler”. Noise from automobiles is one of the components for noise pollution to environment. Exhaust noise is one of the main source of vehicle and exhaust systems are developed to attenuate noise meeting required levels and sound quality emissions based on environment norms. Muffler is important part of engine system and commonly used in exhaust system to minimize sound transmission caused by exhaust gases. So to deal with this problem, muffler should be modified. But again there is one problem that is selection of type of muffler either reactive or absorptive. Absorptive muffler has more weight than reactive type as it is consisted of wound material over perforated pipes. So in this study reactive type muffler is modified for 110 cm<sup>3</sup> four stroke engine of two wheelers. But maximum noise reduction affect backpressure of engine. Also pressure drop is one of the parameter which influences backpressure of engine as minimum pressure drop indicates minimum backpressure. Depending on space availability for muffler on vehicle body, external dimensions of new muffler are kept same as that of existing one. In their paper, a muffler is analyzed for varying porosity of pipes and it's effect on pressure drop by simulation. [9]

Prof. Ganesha B B, “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. Exhaust system of an automobile consist of three parts such as exhaust manifold, catalytic converter and silencer out of those silencer having very short life span as there is lot of restriction provided to the flow of hot gases due to complex geometry in order to reduce the noise level hence gases staying more

time in this section as compare to other two part of exhaust system. Hence that area needs to be focused during design phase. The uniform heat distribution over the entire exhaust system is important for ensuing enhanced life of elements in the subsystem. The problem identified for their 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. [10]

Jashanpreet Singh, “A Study on Effectiveness of Muffler on a Two-wheeler vehicle Noise”. The major cause of noise pollution is due to the traffic noise. Traffic noise from highways creates problems in surrounding areas, especially where there is high traffic volume and at high speed. Noise pollution has hazardous effect on human health. In traffic noise, the major cause of noise is two wheeler vehicle noise. In order to minimize two-wheeler noise, study of two-wheeler motorcycle with different types of mufflers has been analyzed. Acoustic power and sound pressure level at different engine speed with and without different types of mufflers have been studied and variations between them are investigated experimentally. [11]

Mr. Vishal M. Shrivastav<sup>1</sup>, Prof. S. B. Bawaskar, “Design and Analysis of Exhaust System for the Two Wheeler using FEA”. Their work focuses on the exhaust mufflers for two wheeler vehicles. Study will include CFD analysis and Fluid structural interaction analysis to be performed on the current design of the exhaust muffler with boundary conditions as per engines. Design of the muffler will be generated according to requirements. Exhaust gas temperatures, Velocities and back pressure will be evaluated and verified through Finite Element Analysis package ANSYS. Also the modal analysis is performed to study the effect of geometric change on natural frequency of system. Actual testing will be performed by manufacturing modified exhaust muffler and test it on the two wheeler engine test rig for back pressure and noise. [12]

Kabral, R.; Rämmal, H.; Auriemma, “A Novel Design for Cruiser Type Motorcycle Silencer Based on Micro-Perforated Elements”. In their paper a novel design for a cruiser type motorcycle silencer, based on micro-perforated elements, is presented. It has been demonstrated that the micro perforated elements can successfully be used to achieve high attenuation of IC-engine noise in strictly limited circumstances. A technical description of the design and manufacturing of the prototype silencer is given and technological issues are discussed. The acoustical and aerodynamical performance of the silencer is characterized by transmission loss and pressure drop data. The influence of the two-stage system valve operation has been analyzed by studying the acoustics data and engine output characteristics. In addition to the experimental investigations, numerical 1-D models were developed for the optimization of the silencer geometry and the results are compared in a number of operating conditions. [13]

1Sachin Chinchole,2Rajesh R. Borse, “Experimental and CFD Analysis of Muffler Guard of Two Wheeler for XTREME 200R Bike”. The muffler guard or heat shields are used to protect the components and human body touching over it. Generally muffler guard design based on ergonomic, aesthetic consideration and heat dissipation behavior. In this project to study and analysis of current design of muffler guard and modify design of muffler guard. Comparison of improved design with old design and effectiveness. In order to obtain the optimized thermal performance of muffler guard for XTREME 200R Bike carried out by experimental and using analysis tool likes CFD and FEA in ANSYS software. For their study performance parameters such as temperature, gap between muffler and muffler guard along that carried out the performance parameter at various plotting graphs. Generally, exhaust guards are designed based on both ergonomic and numerical design. Target of their study is to analyze the current design of the guard for Hero extreme using analysis tools like CFD and experimental trial to

study different parameters of the heat shield design. [14]

Prof. Ganesh B B, Mr. Bharath M N, “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. Exhaust system of an automobile consist of three parts such as exhaust manifold, catalytic converter and silencer out of those silencer having very short life span as there is lot of restriction provided to the flow of hot gases due to complex geometry in order to reduce the noise level hence gases staying more time in this section as compare to other two part of exhaust system. Hence that area needs to be focused during design phase. The uniform heat distribution over the entire exhaust system is important for ensuing enhanced life of elements in the subsystem. The problem identified for their study 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. [15]

1S.Prakash, 2M.Prabhakar, “CFD Analysis on Silencer Modified with Baffle Plates and Insulation of LCV Diesel Engine” In their study work, it is described as the silencer is device used for reducing the amount of noise emitted by the exhaust of an internal combustion engine. When exhaust gases are removed outside the combustion chamber at the end of the combustion process, the gases move into the exhaust manifold at high pressure and at a considerably high speed, with controlling their flow and speed, When an engine runs, high pressure exhaust gas is released with help of baffle plates and insulation in the rear most exhaust system inside the silencer to reduce pressure, The idea being to allow expanding exhaust gases ( hot and noisy) to be slowed to a more uniform rate before leaving exhaust system. The paper report simulates the field by numerical method with turbulence Flow and analyses the effect which the internal flow field

has on the performance of the silencer with 5 baffle plates and 15 baffle plates with compressed full insulation. With this method the pressure distribution in the silencer is simulated and the pressure loss is predicted for the structure modification. The experiment results verify that the assembly performance of the silencer modified. [16]

Praveen. R, S. Kalyana Kumar Mohamed, “Design and Analysis of Automobile Muffler”. The paper deals with the design of a commercial automotive muffler, which is being used in current automobile vehicles. Initially the muffler is designed in the basic 3D modelling can be done using commercial CAD software package and can be imported into Commercial FEM software using a neutral file format. The propensity to model these mufflers relies vastly on the thermal performance of the material, impedance and the perforations. In muffler the hot gases passes through, which may affect the properties of the muffler. So we have analyzed the thermal properties of the muffler. And defines the heat transfer occurring inside the muffler. The heat flow causes the variation in the properties of the muffler. [17]

## II. CONCLUSION

- 1) CFD Analysis with different velocities is to be examined for studying its effect on silencer.
- 2) Authors have focused on design and construction of muffler during their studies.
- 3) More concentration of studies is needed in virtual experimentation of muffler.
- 4) Effective Temperature distribution and flow management can reduce noise from engine.
- 5) There is large scope in CFD analysis for the improvement of design of silencer

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