MODELLING AND ANALYSIS OF TWO WHEELER MUFFLER

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ABSTRACT

Muffler is a crucial a part of the engine system and is usually employed in an system to reduce sound transmission caused by exhaust gases. the new gases generated from the combustion of fuel passes through the system of the car as they form the passage for the new gases and are released into the atmosphere, hence they're subjected to very warm temperature. The system of automobile consists of three parts as manifold, convertor and silencer, out of these silencer have very short generation as there's lot of restriction provided to the flow of hot gases thanks to complex geometry so as to scale back the background level. Hence gases staying longer during this section as compared to other two parts of exhaust. This area must be focused during design phase. The uniform heat distribution over the complete system is very important for ensuing enhanced lifetime of elements within the subsystem. Exhaust noise is one in every of the most source of car and exhaust systems are developed to attenuate noise meeting required levels and sound quality emissions supported environmental norms. to beat this problem muffler should be modified. By minimizing pressure drop surely reduces backpressure. This work focuses on the exhaust mufflers for two-wheeler vehicles. Study will include flow analysis and also thermal analysis to be performed on the present design of the exhaust muffler and the muffler are going to be designed within the solid works to satisfy the wants. Exhaust gas temperatures, Velocities and back pressure are evaluated and verified through Finite Element Analysis package ANSYS

Keywords: - *Muffler, Exhaust System, silencer, Back pressure, Solidworks, ANSYS*

1. INTRODUCTION

Mufflers are to blame for muffling the sound created by a vehicle's engine. Engines must generate a lot of power, and, as a result, they create numerous pulsating sounds that reverberate through the exhaust valves. Thousands of those pulses are created every single minute. Without a properly working muffler, your vehicle goes to be incredibly noisy. Excessive noise may be a great way to inform if you need a replacement muffler.[1]

A typical sound-absorbing material utilized in a muffler may be a thick layer of fine fibres; the fibres are caused to vibrate by the sound waves, thus converting the sound energy to heat. Mufflers that attenuate sound waves by interference are called reactive mufflers. These devices generally separate the waves into two components that follow different paths then close again out of phase (out of step), thus canceling one another out and reducing the sound

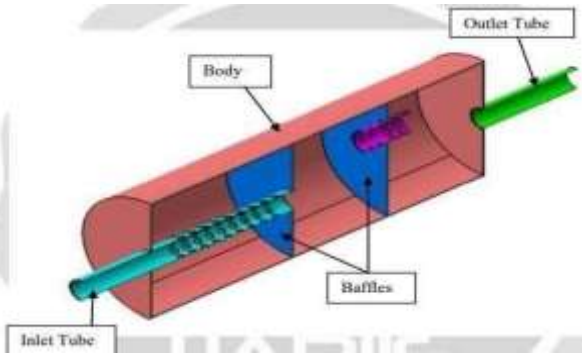

Figure 1 Cut Section of a muffler

1.1 History of muffler

The inventor of the catalytic muffler, Eugene Houdry, was a Frenchman inquisitive about reducing the pollution released into the air by automobile exhaust pipes. He started his line of inventions with a catalytic process that effectively doubled the number of useable oil that might be produced from fossil oil. He produced high-grade gasoline from low-grade fuel. His catalytic "cracking" process was employed by the French military during war II, in producing high-quality aviation fuel. presently, the remainder of the planet caught on and also the us was also using Houdry's process for manufacturing fuel for his or her planes. Also during war II, Houdry invented a singlestep butane dehydration process for manufacturing rubber. Rubber was in high demand for various vehicles within the war. So,

Houdry's process was quickly put into action and used on an outsized scale.[10]

1.2 How does the muffler works?

Mufflers are a part of your vehicle's system and are located at the rear, and bottom of your vehicle. They aid in dampening vehicle emissions and engine noise. they're product of steel and are coated with aluminum to safeguard from the warmth and chemicals released from the exhaust. Mufflers are used mainly to dissipate the loud sounds created by the engine's pistons and valves. whenever your valve opens, an outsized burst of the burnt gases used during your engine's combustion is released into the system. This release of gases creates very powerful sound waves. to know how a muffler dissipates the sound waves created by your engine, one must understand how sound is produced. Sound could be a pressure wave formed by vibrations. These vibrations are pulses of alternating high and low gas pressure. So, when your valve opens, a really high-pressured gas enters the exhaust. These highpressure gases will run into low-pressure molecules, create pressure waves (sound), and travel through the exhaust.

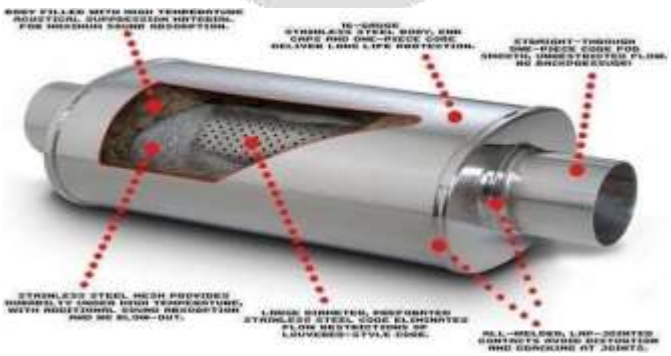

Figure 2 Sound reduction system

1.3 Types of mufflers

1.3.1 Baffle type muffler

It consists of several baffles spot welded inside the cylindrical body. the aim of those baffles is to shut the direct passage of the exhaust gases, thus the gases travel a extended path within the muffler. There are many designs of the baffles utilized in the muffler. The image shows two kinds of such mufflers which have low efficiency. thanks to the restricted flow of the exhaust gases, back pressure increases causing the loss of engine horsepower.

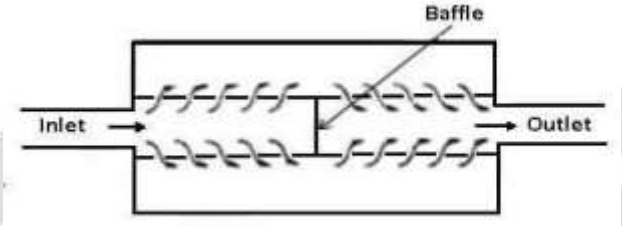

Figure 3 Baffle type muffler

1.3.2 Wave Cancellation Type Muffler

In this kind of muffler, the exhaust gases entering the muffler are divided into two parts to flow within the muffler. The lengths of those paths are so adjusted that after they are available out of the muffler, the crests of 1 wave coincide with the troughs of the second wave. Thus canceling one another and reducing noise to zero theoretically. this can be achieved if the lengths of the 2 paths differ by half the wavelengths. But this can be not achieved practically, because the noise produced by exhaust gases may be a combination of various frequencies at different engine speeds. However appreciable noise is reduced.

Figure 4 Wave cancellation muffler

1.3.3 Resonance type muffler

It consists of several Helmholtz resonators serial through which a pipe having an access port passes Helmholtz is that the name of an individual who originated the thought of this kind of muffler. The exhaust gases flow through this pipe. This resonator eliminates the basic and better harmonics of the engine noise.

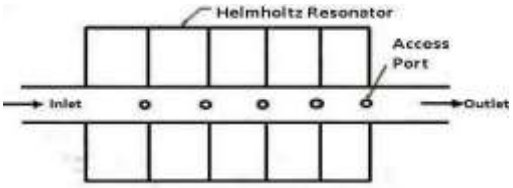

Figure 5 Resonance muffler

2.LITERATURE REVIEW

Tejas J. Kalange et al. The available space has a great influence on the size and type of muffler that may be used. Though noise reduction is the main purpose of the muffler it increases the backpressure of the engine too. This backpressure depends on pressure drop directly. So minimizing pressure drop surely reduces backpressure. And this can be achieved by varying some parameters like porosity, the shape of pipes, and the position of baffle plates. To study the effect of varying porosity of pipes on pressure drop value. They have designed a muffler with variation in porosity for minimum pressure drop, the maximum amount of pressure is distributed in the first chamber then in the next chamber such pressured gas is allowed to pass through the less porous pipe. But as it passes through more porregionsgion pressure is reduced so fast. So, it is better to vary the porosity of the pipe to get minimum pressure drop and uniform velocity distribution.[1]

Vishal M. Shrivastav et al. focuses on the exhaust mufflers for two-wheeler vehicles. The 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. The design of the muffler will be generated according to requirements. Exhaust gas temperatures, Velocities, and back pressure will be evaluated and verified through the Finite Element Analysis package ANSYS. Also, the modal analysis is performed to study the effect of geometric change on the natural frequency of the system. Actual testing will be performed by manufacturing a modified exhaust muffler and testing it on the two-wheeler engine test rig for back pressure and noise[.2]

Bharath et al. system of an automobile consists of three parts as manifold, converter, and silencer out of these silencer having a really short lifetime as there's plenty of restriction provided to the flow of hot gases because of complex geometry to cut back the amplitude hence gases staying longer during this section as compared to other two a part of the system. They concluded that hot spots on the silencer surface because of non-uniform distribution of warmth over the surface will be significantly reduced by changing the profile of the silencer tube by providing dimples on the surface. Hotspots on the silencer body create high-temperature oxidation that would result in corrosion and mechanical breakage of the silencer. By providing dimple patterns on the outer surface of the silencer the temperature distribution is uniform and that we found there's a decrease within the temperature on the outer surface of the silencer. it's also proved that providing dimples won't have such influence on building backpressure that might affect silencer performance.[3]

C.Y.R Cheng et al. has performed accurate performance predictions for highly complicated muffler designs that might greatly reduce the hassle in fabricating and testing multiple design iterations for engineers. and that they have explained the employment of a component-based technique tool for the look and analysis of exhaust mufflers. A comprehensive trojan horse supported the Direct Mixed-Body Boundary Element Method was developed to predict the transmission loss characteristics of muffler systems. The transmission loss is calculated by an improved fourpole method that doesn't require solving the boundary element matrix twice at each frequency, and hence, it's a significantly faster approach compared to the standard four-pole method. The numerical prediction of several muffler configurations shows excellent agreement with measured results including the results of temperature and mean flow.[4]

Tanmay C. Agrawal et al. have performed the project to reduce the harmful gas released from the exhaust. The gases from the combustion of the air-fuel mixture are reduced to non-harmful gases before releasing them into the atmosphere using a catalytic converter. Exhaust mufflers or silencers are used to reduce noise and vibrations levels due to the expansion of gases. They used a novel muffler designed for a 4-stroke, 125cc single-cylinder petrol engine, and structural analyses are carried out for optimization using ANSYS Static Structural solver. Fly ash as a catalyst in exhaust mufflers is effective in reducing the emission of CO and HC from both diesel and petrol engines. Fly ash can be activated to increase its content and obtain more emission reduction.[5]

Prof. G.S Josh has performed an analysis of an exhaust. With the required properties of the fabric, the exhaust is modeled by employing a conventional FEM package. The results are compared with the reading taken on the FFT analyzer, to tell apart working frequency from natural frequency and avoid resonating conditions. The silencer natural frequencies are calculated by using the ANSYS package and by the FFT analyzer. By both the strategy the

natural frequencies are nearly same which are useful while the planning of silencer to avoid the resonance. Though the dynamic performance may be increased by increasing the mass of silence.[6]

Rahul D. Nazirkar has designed a muffler so as to enhance the look efficiency of muffler, resonating of the exhaust muffler should be avoided by its natural frequency. Mufflers are most vital a part of the engine system and it's commonly employed in the exhaust to reduce the sound transmission level which is caused by exhaust gases. the look of muffler becomes more and more important for noise reduction. The solid modeling of exhaust muffler is formed by CATIA-V5 and modal analysis is administrated by ANSYS to review the vibration and natural frequency of the muffler. So on differentiate between the working frequency from natural frequency and avoid resonating. A double expansion chamber gives better results than compared to single expansion chamber. Transmission loss of double expansion chamber is 42.48 which is quite requirement and satisfactory. Also Natural frequency of double expansion chamber is within range of 583.62 to 1001.1 Hz leading to no resonance. By fixing the muffler initially and double expansion chamber we will increase the frequency and avoid the resonance. The transmission loss of the muffler will be increased by adding protrusion pipe at inlet and outlet.[7]

The exhaust is modeled by using CATIA and analyzed by using NASTRAN a traditional FEM package. Here we are visiting compare the natural frequency by FEM package with the practically by using FFT analyzer, so on compare working frequency with natural frequency for validation purpose.The natural frequency of silencer obtained through FFT test concurs with the results obtained by FEM method. Considering variation within the material properties and specifications within the test specimen, the results are acceptable and nearly the identical.[8]

Jayashri P. Chaudhari et al. used the various components to style the absorptive muffler with ammonia pulsator which is able to be reduce the unwanted noise and emission. during this project work, they performed test on maximum theoretical stress of the pipes (casing pipe and charcoal pipes) used and test on engine without ammonia pulsator. The outcomes of the comparison with von-mises stress, maximum stress by theoretical methods and von-mises are well below the allowable limits, it implies that design of the casing pipe and charcoal pipes are the safe design. The casing and charcoal pipe which demonstrates negligible deformation under the action of system of forces. The new optimized absorptive muffler with ammonia pulsator is meant for stationary engines and it will be utilized as an element in automotive exhaust with minor modifications. Different design parameters with ammonia pulsator are considered to enhance the efficiency & emission control of the absorptive muffler. Aim of this work is to style, develop, and analysis of mathematical modeling and derivation of dimensional parameters of the absorptive muffler with ammonia pulsator using UG NX-8.0 and ANSYS workbench. The formulated muffler traditional design problem are solved by new design and optimization.[9]

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