

# EXTERIOR AUCOSTIC AND MODAL ANALYSIS OF MUFFLER OF AN AUTOMOBILE BY EXPERIMENTAL AND NUMERICAL APPROCH: A REVIEW

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**Abstract:** A pollutant of concern to the mankind is the exhaust sound which should be about 105dB in the internal combustion engine. However this sound can be reduced sufficiently by means of a well-designed silencer. The suitable design and development will help to reduce the sound level, but at the same time the performance of the engine should not be hampered. Muffler design is an important research area for automotive industries because of new regulations and standards for noise emission. To examine the performance of any muffler, certain parameters are used. These parameters are Experimental modal analysis and Exterior Acoustic analysis. Hence in this paper review both Modal and Exterior acoustic analysis is carried out experimentally using FFT analyser and by numerical approach that is by finite element method. [1]

**Keywords:** Exterior Acoustic analysis, Experimental modal analysis, exhaust muffler, FEM, FFT.

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## 1. INTRODUCTION

Sound that is unwanted or disrupts one's quality of life is termed as noise. When there is lots of noise in environment, it is termed as Noise pollution. Maximum pollution is through by an automotive, as there are more moving parts in the engine. Noise production is more due variation of oscillating sound waves coming out from engine of an automobile and friction between the moving parts causes a noise pollution. In order to control over the noise of an automotive a device called Muffler or Silencer is used.

Silencer, main function of this unit is to attenuate the high intensity sound waves to low intensity as much as possible. This device is designed in such a manner that it must attenuate sound as well as maintain engine efficiency well.

Once combustion takes place, the engine ejects exhaust gases in the form of high pressure pulses. This high pressure pulses create very powerful sound to low level. Depending on the style, a muffler uses some combination of baffles, chamber, perforated tubes, and/or sound deadening material to achieve the goal. Ideally, well designed muffler will provide a good performance exhaust tone without creating too much backpressure. A sound wave coming out from the engine is about 120dB. This wave enters silencer and come out at the range of 90-95dB.

Eigen values and Eigen vectors are determined by using Software or numerical analysis that is FEM of exhaust muffler. Amongst power train parts silencer is the major noise reducing structure. From literature survey and FEM technique, the TATA INDICA Vista exhaust silencer is tested to understand the dynamic, structure and Exterior acoustic behavior and is compared with numerical values.

## 2. LITERATURE SURVEY

### 2.1. Potente, Daniel: [2]

Potente and Daniel discuss the general principle of muffler design and explains the main advantages of various styles of mufflers. When designing muffler for any application there are several functional requirements that should be taken in to account, which include both acoustic and non-acoustical design issues.

### 2.2. M.Rahman, T.Sharmin, A.F.M.E.Hassan, and M. Al Nur: [3]

This paper explains design and construction of the muffler in order to reduce the noise. They mainly focused on the exhaust noise reduction that is reducing the noise pollution. They manufactured and design muffler for stationary petrol engine. The characteristic performance, that is noise reduction capability of muffler, has been tested and compared with that of the conventional muffler. They found result has been found satisfactory.

### 2.3. Rahul D. Nazirkar, S.R.Meshram, Amol D. Namdas, Suraj U. Navagire, Sumit S. devarshi: [4]

This paper focused on transmission loss (TL) and natural frequency (NF) of muffler. In this they designed the muffler of single expansion chamber and double expansion chamber. They modeled the solid model of exhaust muffler by using CATIAV-5 and the modal analysis is carried out by ANSYS to study the vibration and natural frequency of muffler. So as to differentiate between the working frequency from natural frequency and avoid resonating. And they found that double expansion chamber gives better results as compared to single expansion chamber.

### 2.4. Mr. Jigar H. Chaudhri, Prof. Bharat S. Patel, Prof. Satis A. Shah: [5]

This paper explains different types of mufflers and design of exhaust system belonging engine has been studied. The object of this study is deciding muffler design which one reduces a large amount of noise level and back pressure of engine. In designing, there is different parameter which has to take in to the consideration. These parameters affect the muffler efficiency. And they finally found that combination type of muffler is more efficient than reactive and absorptive mufflers.

### 2.5. Wang jie and Dong-peng Vue: [6]

This paper gives present study on the model analysis of an automobile exhaust muffler based on PRO/E and ANSYS in order to improve design efficiency. The solid model is created by PRO/E and model analysis is created out by ANSYS to study the vibration of the muffler, so as to distinguish working frequency from natural frequency and avoid resonating. Data exchange between PRO/E and ANSYS using IGES (Elementary graphics exchange specification) format for data exchange specification. Muffler natural frequencies modal shapes have been calculated by the FEM analysis software named ANSYS. So the muffler vibration can be intuitive analyzed. The natural frequencies and mode shape are considered during the design of the muffler, so avoid the resonance occurred in exhaust system.

### 2.6. A.K.M. Mohumuddin, Mohd Rashidin Ideres and Shukari Mohad Hashim: [7]

This paper presents experimental study of noise and back pressure for silencer design characteristics. The main objective of this study was to find the relationship between the back pressure and the noise level. He concludes that the relationship between the noise and the back pressure is inversely proportional.

### 2.7. Takashi Yasud, Chaoqun Wu, Noritoshi Nakagawa, Kazuteru Nagamura: [8]

This paper presents Studies on an automobile muffler with the acoustic characteristic of low-pass filter and Helmholtz resonator. Based on the typical structure, a muffler with an interconnecting hole on the tail pipe was proposed to improve its acoustic performance. Acoustic performances of the proposed muffler were studied experimentally and theoretically in frequency and time domain. Results showed that the specimen muffler had attenuation performances of low-pass filter and Helmholtz resonator when an interconnecting hole was designed on the tailpipe.

### 2.8. M RAJASEKHAR REDDY and K .MADHAVA REDDY: [9]

This paper explains design and optimization of exhaust muffler in automobiles by study of Muffler dimensions are measured through the Benchmarking, to create CAD models. The CAD models are created in CATIA V5 R19, later these

CAD models of muffler are exported to HYPER MESH for pre-processing work. Free analysis is carried out on this muffler by FEA Method using NASTRAN Software. In order to determine the resonance frequencies, were then compiled to determine which peaks were the most significant for the system. From the data, side baffles were selected as weak parts of the muffler. In order to minimize the effects of these resonance frequencies, the suggested design improvement is to add thickness and also add damping to the system.

### 2.9. Jun Chan and Xiong Shi: [10]

This paper investigates CFD Numerical Simulation of Exhaust Muffler based on the physical numerical modeling of the flow field of the muffler in this paper, the author simulated the field by numerical method with Fluent and analyzed the effect which the internal flow field has on the performance of the muffler. The author simulated the field by numerical method with Fluent and analyzed the effect which the internal flow field has on the performance of the muffler.

### 2.10. Sunil, Dr. Suresh P M: [11]

This paper gives experimental and numerical validation of modal analysis of a muffler of an automobile which is helpful in designing and construction of muffler.

## 3. CONCLUSION

The case study mainly focus on the experimental modal analysis of silencer and Exterior acoustic analysis of exhaust silencer (TATA INDICA CAR) which finds the performance parameters like Acoustic performance (dB) based on different Frequencies and different loading conditions, which form the basis for the design of silencer. This methodology helps the manufacturer and OEM (Original Equipment Manufacturers) to reduce the design cycle time for silencer.

## REFERENCES

- [1] Bell, L.H., 1982, Industrial Noise Control, Marcel Dekker, Inc, New York. Lilly, J.J., "Engine Exhaust Noise Control", ASHRAE Technical Board 2.6.
- [2] Potente, Daniel: General design principles of automotive muffler. 9-11 November 2005, Buss Elton, western Australia.
- [3] M. Rahman, T. Sharmin, A F M E. Hassan, and M. Al Nur: Design and Construction of a muffler for engine exhaust noise reduction. International Conference on Mechanical Engineering 2005 (ICME2005) 28- 30 December 2005, Dhaka, Bangladesh.
- [4] RAHUL D. NAZIRKAR, S.R.MESHRAM, AMOL D. namdas, suraj u. navagire, sumit s. devarshi: Design & optimization of exhaust muffler & design validation. Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala-410401, India.
- [5] Mr. Jigar H. Chaudhri, Prof. Bharat S. Patel, Prof. Satis A. Shah: Muffler Design for Automotive Exhaust Noise Attenuation - A Review
- [6] Wang jie and Dong-peng Vue: The Modal Analysis of Automotive Exhaust Muffler Based on PROE and ANSYS.
- [7] A.K.M. Mohumuddin, Mohd Rashidin Ideres and Shukari Mohad Hashim: Experimental study of noise and back pressure for silencer design characteristics.
- [8] Takashi Yasud, Chaoqun Wu, Noritoshi Nakagawa, Kazuteru Nagamura. Studies on an automobile muffler with the acoustic characteristic of low-pass filter and Helmholtz resonator.
- [9] M. Rajasekhar reddy and K..Madhava reddy: Design and optimization of exhaust muffler in automobiles
- [10] Jun Chan and Xiong Shi: CFD Numerical Simulation of Exhaust Muffler.
- [11] Sunil, Dr. Suresh P M: Experimental Modal Analysis of Automotive Exhaust Muffler Using Fem and FFT Analyzer.