International Journal on Emerging Technologies **7**(1): 37-41(2016)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Performance of Extended Inlet and Extended Outlet Tube on Single Expansion Chamber for Noise Reduction

Amit Kumar Gupta
Mechanical Engineering Department,
IET-Devi Ahilya University, Indore, (Madhya Pradesh), INDIA

(Corresponding author: Amit Kumar Gupta)
(Received 04 February, 2016 Accepted 02 April, 2016)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: This research paper shows that the measurement of the acoustical transmission loss of extended inlet and extended outlet tube on single expansion chamber for noise reduction with same gas volume. A muffler (silencer) is an important noise control device for reduction of machinery exhaust noises other noise source which involves the flow of gases. Mufflers are typically arranged along the exhaust pipe as the part of the exhaust system of an internal combustion engine to reduce its noise. Here basic term is used for noise attenuation namely transmission loss (TL). An experimental method for muffler's transmission loss (TL) measurement for central inlet and central outlet muffler shows the validation of result. Finite element analysis tools wave -1D used to validate the results. The wave 1-D used as a simulation tool. This paper is investigating to achieve maximum transmission loss by using extended inlet and extended outlet tube on single expansion chamber.

Keywords: Extended Inlet and Outlet Tube, Acoustic Module- Wave 1-D, Transmission loss.

I. INTRODUCTION

Sound waves propagating along a pipe can be attenuated using either a dissipative or a reactive muffler. A dissipative muffler uses sound absorbing material to take energy out of the acoustic motion in the wave, as it propagates through the muffler. The UK based term muffler (silencer in US) is a device for reducing the amount of noise emitted by the exhaust of an internal combustion engine [1]. In recent scenario growths of automobile vehicle are in increasing day by day. Basically a muffler for an automobile is characterized by numerous parameters like Insertion Loss (IL), Transmission Loss (TL). The best used parameter to evaluate the sound radiation characteristics of muffler is Transmission loss (TL). Transmission Loss is defined as difference between power incident on muffler proper and that transmitted downstream into an anechoic termination. It is independent of source and presumes an anechoic termination at tail pipe. It describes performance of a muffler [5]. Noise levels of more than 80 dB are injurious for human beings [3]. Hence to reduce noise from internal combustion engines they are equipped with an important noise control element known as silencer or exhaust muffler which suppresses the acoustic pulse generated by the combustion processes [4]. This is only the one of the most frequently used physical parameters of the muffler. Numerical methods are very useful for optimization of model of having complicated shapes and also where the cost is involved. So that it is essential to optimize the model by Finite Element Analysis and validate it by experimental methods. Validation of experimental setup it is necessary to test the results of model of which analytical, numerical results are known [2]. It describe that the transmission losses can be determined reliably with the test rig setup. Many tools are available to simulate the transmission loss characteristics of a muffler. Experimentally Two-load method is commonly used to predict the transmission loss of an Acoustic muffler [6]. Finite Element Method is also used to show the comparative study of Transmission Loss of Muffler. Muffler Designing is a complex function that affects the noise characteristics and fuel efficiency of the vehicle. In this paper, muffler is simulated by Finite Element Analysis tool Comsol is used to predict muffler's transmission loss performances. As well Muffler's Transmission loss also predicted by Two Load Method [12]. Firstly evaluation of Transmission loss for cylindrical muffler is compared with 1-D Wave simulation, Comsol and Two Load method. Than after transmission loss is evaluated for square and rectangular cross section muffler.

II. OBJECTIVES AND MODELLING

For evaluation of transmission loss of muffler the volume of Expansion chamber is keeping constant like cylindrical muffler. Than the FEA result simulate by using acoustical simulation tool wave 1-D, comsol which is already proven software [10-11].
Following design conditions are applied to analyzing the transmission loss of the simple expansion chamber:
(i) Volume of the Expansion chamber is kept constant for all the modeling and designing work.
(ii) Modeling of circular expansion chamber by keeping the length of expansion chamber as constant i.e., 500 mm.
(iii) Modeling of circular expansion chamber by keeping the diameter of expansion chamber as constant i.e., 130 mm.
(iv) Modeling of circular expansion chamber by keeping the diameter of central inlet and central outlet tail pipe as constant i.e., 35 mm.
(v) Modeling of circular expansion chamber by keeping the length of Inlet tail pipe and Outlet tail pipe as 100 mm.

III. ACOUSTIC MODULE WAVE 1-D MODELLING

A Sound Analyzer is a testing and measurement instrument which is used to quantify the audio performance of electronic and electro-acoustical devices. Audio quality measurements covers a wide variety of parameters like level gain, noise and inter modulation distortion, frequency response, and relative phase of signals. The circuit comprises of mike for taking audio input, mike interfacing assembly for sensitivity selection, low-noise mike preamplifier circuit with variable gain adjustment, bandwidth adjustment from more than one octave down to a tenth of an octave, frequency range selection from 20 Hz to 20 KHz in three bands selection. An NE5534 op-amp is used for the mike preamplifier stage because of its low input noise [7, 12]. Noise level of 40 dB of gain is sufficient for most microphones, since the white noise will be played through the speakers at a moderately high level.

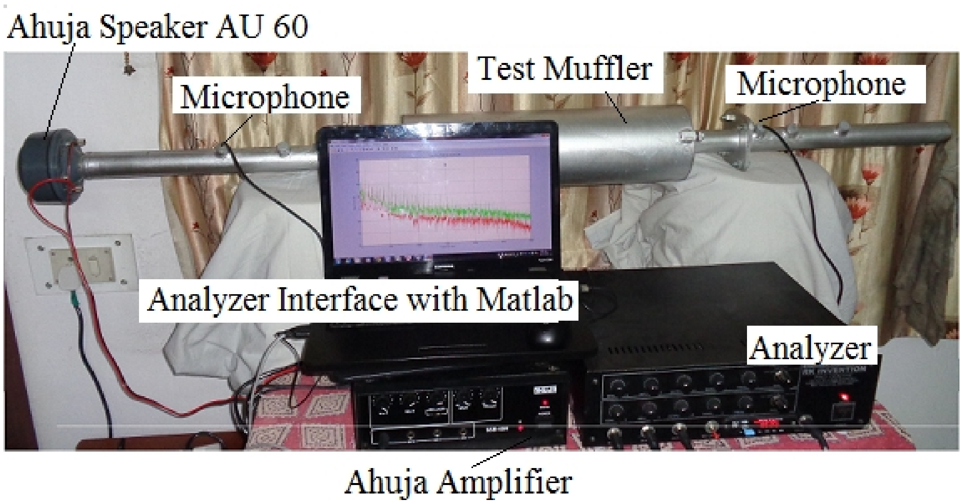


Fig. 1. Layout of Actual Experimental Test Rig Setup.

IV. POST PROCESSING BY USING WAVE 1-D AND COMSOL

WAVE is a 1-dimensional gas dynamics code which is based on finite volume method for simulating engine cycle performance. Tools using this one dimensional approach accurately predict all engine breathing characteristics. This enables engineers to Consider air system and combustion effects during analysis. A. F. Seybert model is used to compare the wave result. The working fluid was perfect air having following boundary conditions [8-9]:

1. Gas Volume approximately: 6636500 mm^3.
2. Exhaust gas Temperature: 300 K.
3. Exhaust Gas pressure: 1.0 bar.
4. Initial fluid composition: Fresh Air.
5. Upper frequency Limit: 3000 Hz.
6. Lower Frequency Limit: 25 Hz.

Model is prepared on wave build 3D with inlet & outlet boundary condition shown in figure 2. The same dimension is simulated in Comsol tool the result shown in figure 3.

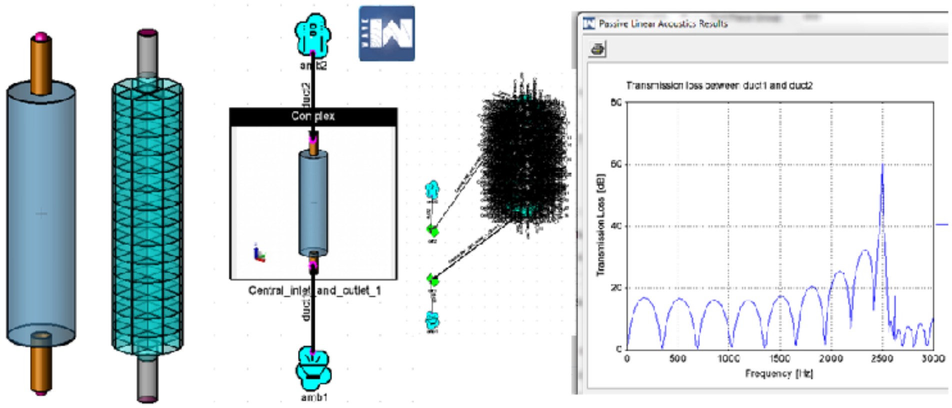


Fig. 2. GUI for Post Processing of Wave 1-D.

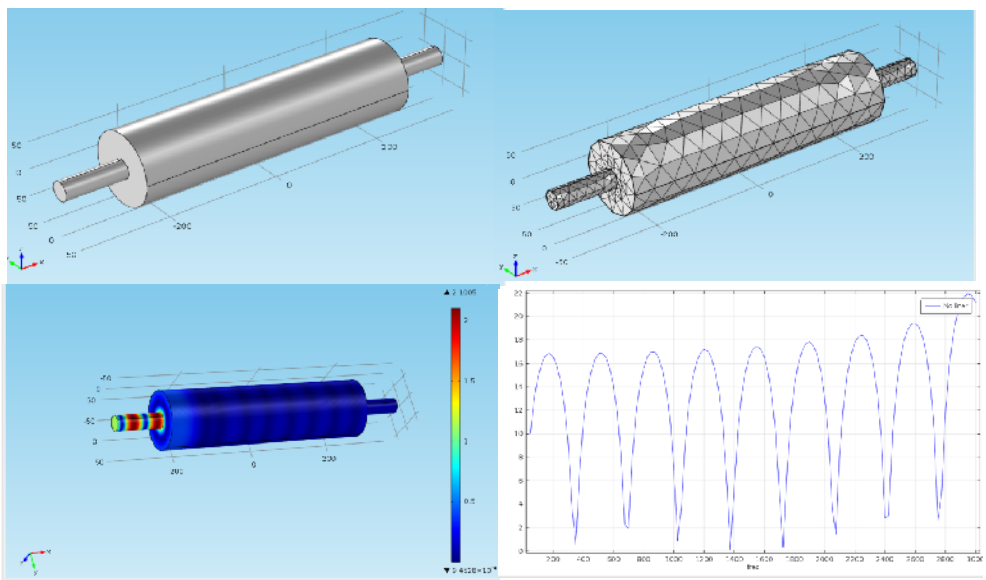


Fig. 3. GUI for Post Processing of Comsol.

V. COMPARISON OF EXPERIMENTAL AND ACOUSTIC TOOL RESULTS

Attenuation curves represent among two observations clearly shows that by the comparison with two results experimental (two load method) and FEA tools like Ricardo wave 1-D and comsol the transmission loss are equally are comparable. Small deviation is appeared with FEA tool is due to meshing parameter.

Now any shape of muffler can be modeled to predict the TL measurement. In recent scenario so many complicated geometry where the practical analysis proves too expensive and complicated. Therefore the FEA Tool can be the best approach to achieve the expected outcomes regarding the transmission loss of Muffler shown in Figure 4.

VI. SIMULATION FOR MUFFLER HAVING EXTENDED INLET AND EXTENDED OUTLET PIPE

Acoustical transmission loss of extended inlet and extended outlet tube on single expansion chamber for noise reduction with same gas volume is observing. The length of extended inlet and expended outlet tube is quarter the length of expansion chamber. The dimensions of chambers are taken in such a way to observe complete wave propagation phenomenon. Fig. 5 to Fig. 12 shows the post processing of the result in all four case namely Single Expansion chamber, Chamber with Extended Inlet, Chamber with Extended Outlet, Chamber with Extended Inlet and Outlet.

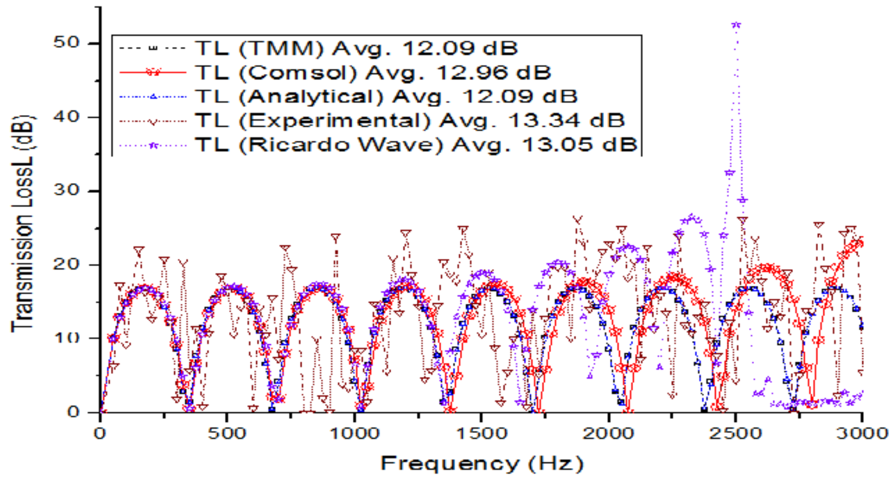


Fig. 4. Result comparison of TL for all methods.

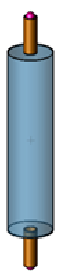
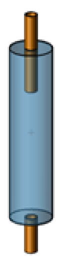
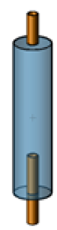
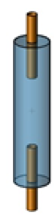
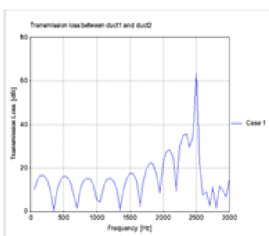
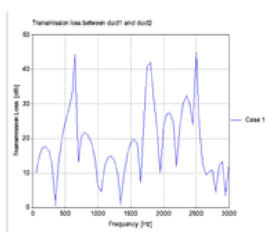
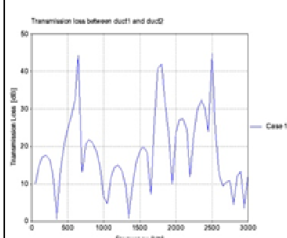
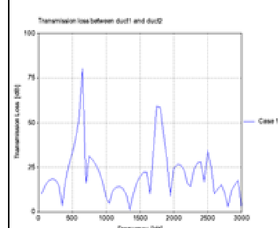
<table>
<tr>
<td>
Case 1
Fig. 5. Single Expansion chamber.</td>
<td>
Case 2
Fig. 6. Chamber with Extended Inlet.</td>
<td>
Case 3
Fig. 7. Chamber with Extended Outlet.</td>
<td>
Case 4
Fig. 8. Chamber with Extended Inlet and Outlet.</td>
</tr>
<tr>
<td>
Fig. 9. TL for Single Expansion chamber.</td>
<td>
Fig. 10. TL for Chamber with Extended Inlet.</td>
<td>
Fig. 11. TL for Chamber with Extended Outlet.</td>
<td>
Fig. 12. TL for Chamber with Extended Inlet and Outlet.</td>
</tr>
</table>

Table 1: TL comparison for all Four Cases.

Case	Types of Duct	Average Transmission Loss (dB)
1.	Single Expansion chamber	15.26 dB
2.	Chamber with Extended Inlet	18.30 dB
3.	Chamber with Extended Outlet	18.30 dB
4.	Chamber with Extended Inlet and Outlet	21.39 dB

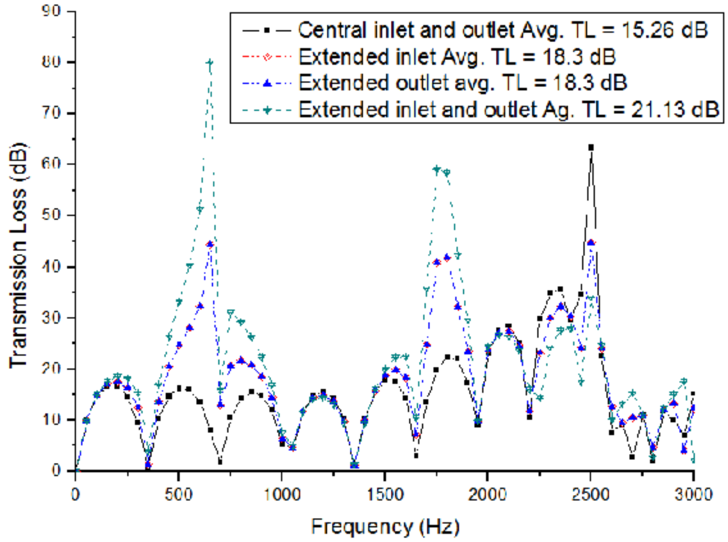


Fig. 13. TL Comparison for all four cases.

VII. RESULTS AND DISCUSSION

The experimental results show good agreement with the numerical results. This research paper shows the results of Transmission loss of Single Expansion Muffler which are verified by experimental method. From this result it can be concluded that the developed experimental setup can measure the performance of Muffler's Transmission loss. The small deviation in the result of experiment from the numerical results may be due to sound leakage, low surface finish of impedance tube, and problems in generating white noise from the FFT sometimes it is not accurate. The transmission loss is evaluated in the four cases of Single Expansion chamber, Chamber with Extended Inlet, Chamber with Extended Outlet, Chamber with Extended Inlet and Outlet. The result shows that the maximum Transmission Loss achieved in case of Chamber with Extended Inlet and Outlet (21.39 dB) as compared to other cases shown in Fig. 13. Also attenuation curve represent that the transmission loss is same in case of Chamber with Extended Inlet and Chamber with Extended Outlet.

REFERENCES

[1]. Gupta A. and Tiwari A., (2015). "Improvement and validation of acoustic performance on reactive muffler with central inlet and side outlet position", *National Journal of Technology, PSG, (Coimbatore)*, ISSN 0973-1334 Vol. **11**, No.3 pp 85-92, September, 2015.

[2]. Nakra B. C., Said W. K. and Nassir A., (1981). "Investigations on mufflers for internal Combustion engines." *Applied Acoustics*, Vol. **14** pp 135-145, (1981).

[3]. Gupta A.K. and Tiwari A., (2014). "Comparison of Finite element analysis with an Experimental Validation on Transmission Loss Measurement for Acoustic Muffler", *Journal of Automobile Engineering and Applications*, Volume **1**, Issue 2, pp 21-26, 2014.

[4]. Amit Kumar Gupta, Dr. Ashesh Tiwari (2013). "Acoustic Characterization of Reactive Mufflers by Different Cross Sections Using One-Dimensional Analysis" *Paripex - Indian Journal Of Research,* Vol. **2** , Issue 3 , March 2013.

[5]. Yasuda T., Wu C., Nakagawa N., Nagamura K., (2013). "Studies on an automobile muffler with the acoustic characteristic of low-pass filter and Helmholtz resonator", *Applied Acoustics*, pp 49-57, (2013).

[6]. Gupta A.K. and Tiwari A., (2015). "Measurement of Sound Transmission Loss on Straight and Zigzag Perforated Concentric Tube Muffler with Constant Porosity", *International Journal on Emerging Technologies*, ISSN 2250–2459, Volume **6**, Issue 1, pp 35-40, 2015.

[7]. M.L. Munjal, (1987). "Acoustics of Ducts and Mufflers", John Wiley & Sons, (1987).

[8]. Amit Kumar Gupta, Dr. Ashesh Tiwari (2015). "Modeling For Transmission Loss Prediction of Different Shapes of Acoustic Muffler With An Experimental Analysis" *Journal of Experimental & Applied Mechanics*, Vol. **6**, No. 1 (2015).

[9]. Gupta A.K. and Tiwari A., (2015). "Performance of Transmission Loss on hybrid muffler by using rock wool and glass wool as a absorbing materials" *International Journal of Advances in Materials Science and Engineering (Australia)*, ISSN: 2201-2311, Vol.**4**, No.4, pp -49-57, 2015.

[10]. Lima K., Arcanjo Lenzi, Renato Barbieri, "The study of reactive silencers by shape and parametric optimization techniques", Applied Acoustics, pp 142-150, (2011).

[11]. Gupta A.K. and Tiwari A. (2015). "Enhancement on Sound Transmission Loss for Various Positioning of Inlet and Outlet Duct of the Muffler", *International Journal of Engineering and Manufacturing (Hong Kong)*, ISSN: 2305-5982, IJEM-V5- N4, 2015.

[12]. International Standard (10534-2), Acoustics - Determination of sound absorption coefficient and impedance in impedance tubes.