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RESEARCH ARTICLE

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SIMULATION OF SOUND TRANSMISSION LOSS FOR RECTANGULAR CROSS SECTION MUFFLER WITH DIFFERENT ASPECT RATIO IN SAME SPACE

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ABSTRACT
The paper shows the measurement of the acoustical transmission loss of rectangular cross section expansion chamber muffler with various aspect ratio of cross section. A muffler (silencer) is an important noise control element for reduction of machinery exhaust noises other noise sources 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. The wave 1-D used as a simulation tool.

Keywords: Rectangular Cross Section Muffler, FEA Acoustic Module- wave 1-D, Sound Transmission loss,

1. INTRODUCTION

The UK based term muffler (silencer in English, or back box in Irish English) is a device for reducing the amount of noise emitted by the exhaust of an internal combustion engine [1].Mufflers are mostly used to reduce noise related with internal combustion engine exhausts, high pressure gas or steam vents, compressors and fans. These examples lead to the conclusion that a Muffler allows the passage of fluid while at the same time restricting the free passage of sound. The greatest source of noise which disturbs people and creates impact on their environment comes from transport vehicles [2]. The huge increase in mobility achieved by technological development in the last century accompanied by high background noise levels, particularly due to road traffic, has become a feature of our society.[7]

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. 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].

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]

2. OBJECTIVES AND MODELLING

For evaluation of transmission loss of muffler the volume of Expansion chamber is keeping constant then changing the aspect ratio of rectangular cross section muffler. Than the FEA result simulate by using acoustical simulation tool wave 1-D which is already proven software.

Following design conditions are applied to analyzing the transmission loss of the simple expansion chamber:

1. Volume of the Expansion chamber is kept constant for throughout the modeling and analysis.
2. Modeling of circular expansion chamber by keeping the length of expansion chamber as constant i.e., 500 mm.
3. Modeling of rectangular expansion chamber by keeping the constant cross section 31329 mm^2.

3. ACOUSTIC MODULE WAVE 1-D MODELLING

Table 1. Modeling of rectangular expansion chamber with different aspect ratio

S No.	Length of the cross section in mm	Width of the cross section in mm	Constant Volume of the Muffler 15664500 mm^3 having length 500 mm	Aspect Ratio (Length/Width)
1	177	177	177X177X500	1
2	200	156.6	200X156.6X500	1.28
3	250	125.3	250X125.3X500	2
4	306.17	102.39	306.17X102.39X500	3

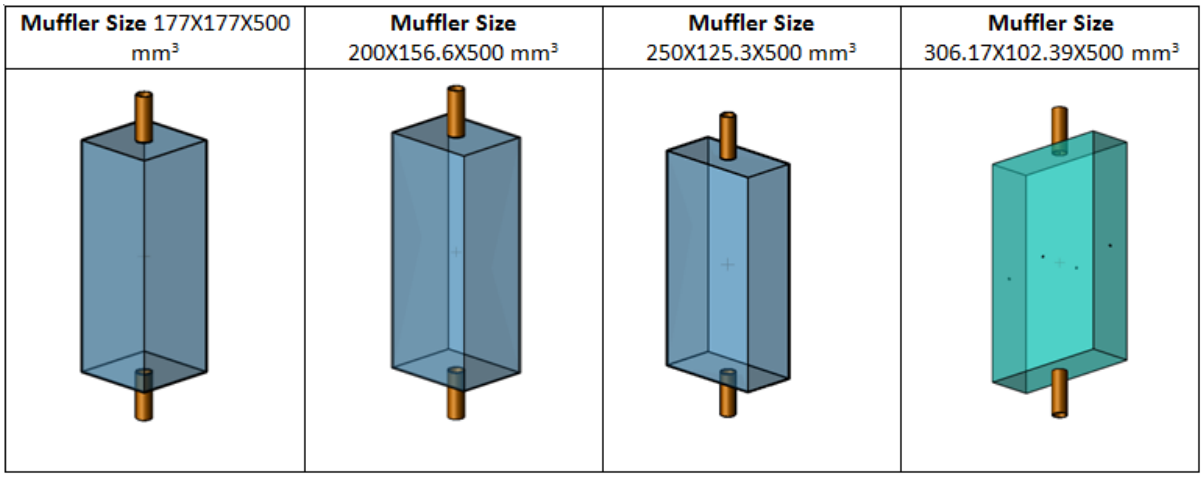

Figure 1: Different Configurations of Rectangular cross section muffler

4. POST PROCESSING BY USING WAVE 1-D

WAVE 1-D is based on Computational fluid dynamics code which is collaborated with ANSYS used to calculate the calculate orifice noise and insertion loss as well as radiated shell noise using these codes, tailpipe noise of exhaust system, information about the engine as an acoustic source is needed [4].

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 [4]:

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.

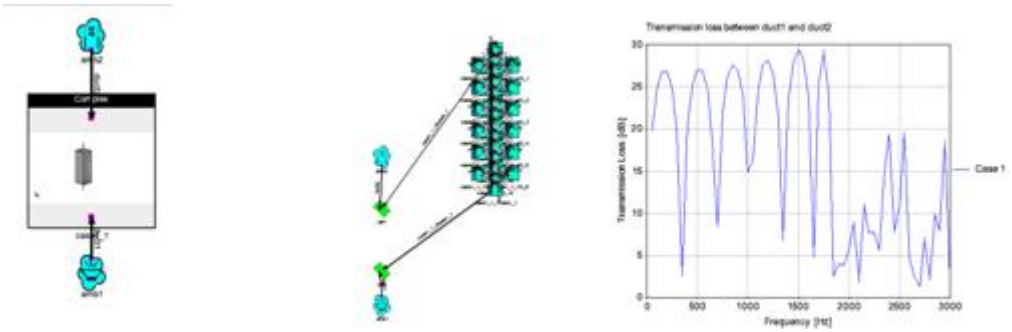

Figure 2: Transmission Loss evaluation by using WAVE 1-D

5. RESULTS AND DISCUSSION

Now table 2 shows the result of transmission loss for rectangular expansion chamber with different ratio

Table 2. Results of rectangular expansion chamber for transmission loss

S No.	Constant Volume of the Muffler 15664500 mm^3 having length 500 mm	Aspect Ratio (Length/Width)	Average Transmission Loss (dB)
1	177X177X500	1	16.3
2	200X156.6X500	1.28	17.21
3	250X125.3X500	2	14.97
4	306.17X102.39X500	3	16.18

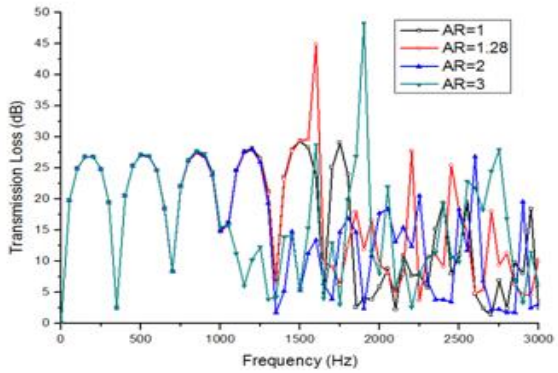

Figure 3: Transmission Loss vs Frequency curve by using WAVE 1-D

WaveBuild 3D is used to as gas volume with any arbitrary shape box, canister, straight or curved shape tube with and without perforation, Baffle with and without perforation. Suitable mesh parameter can be created for the required meshing. The effect of transmission loss by changing the aspect ratio of rectangular expansion shows that higher aspect ratio attenuate the noise level in mid to high frequency zone. For the aspect ratio 1.28 shows maximum average transmission loss among them.

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