ACOUSTIC ANALYSIS OF EXTENDED INLET & OUTLET TUBE PARAMETERS IN SINGLE EXPANSION CHAMBER REACTIVE MUFFLER FOR INCREMENT IN TRANSMISSION LOSS

Tushar Sonkule[1], Suyash Dhadve[1], Akshay Shahane[1], Yash Malpani[1], Mahesh Kulkarni[2]

[1]U.G Student, School of Mechanical Engineering, MIT World Peace University, Pune, India
[2]Assistant Professor, School of Mechanical Engineering, MIT World Peace University, Pune, India

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Abstract : *The internal combustion engine is the major source responsible for noise pollution. A muffler is a device used to reduce noise within the exhaust system. It is arranged along the exhaust pipe for the purpose of noise attenuation. Exhaust noise from engines is one of component noise pollution to the environment. Exhaust systems are developed to attenuate noise meeting required dB levels and sound quality; emissions based on environment norms. Set up for experimental analysis is developed to predict the acoustic performance of reactive muffler using the two-load method. The decrease in the exhaust noise level is controlled by muffler construction and operating techniques. Therefore, the muffler configuration plays an important role. In this research work, an effort has been made to study the different methodologies for evaluation of transmission loss for extended inlet & outlet tube parameters of single expansion chamber reactive muffler. The detail study of acoustic performance of the muffler is carried out by: (1) Theoretical analysis (2) The finite element method by using COMSOL Multi-Physics, (3) Experimental validation by method of two loads.*

Keywords **- Transmission Loss (TL), Single Expansion Chamber reactive muffler, Numerical Method, Experimental Method, Inlet & Outlet tubes.**

1. Introduction

In automotive exhaust system design, accurate prediction of sound radiation characteristics of reactive muffler carries significant importance. Noise pollution produced by engines becomes a major concern when used in residential areas or areas where noise creates hazard. Noise level greater than 80dB is injurious for human being. As well as the diesel generator sets are observed as common norm in public and corporate places as electric source or backup. Hence it is necessary to reduce the noise produced by diesel engines of generator. Noise of diesel engine can be reduced by using muffler. Sound waves propagating along a duct can be attenuated using either an absorptive or a reactive muffler. There are several parameters that describe the acoustic performance of a muffler and/or its associated piping. These include the noise reduction (NR), the insertion loss (IL), and the transmission loss (TL). Exhaust noise from engines is one of the components of noise pollution to the environment. Numerical methods are often useful for optimization of model with complicated shapes and where the cost is involved. So, it is essential to optimize the model by numerical analysis and validate it by experimental method. The internal changes in the geometry of the muffler are made to develop the impedance mismatch for maximizing the transmission loss. Moreover, for a given internal configuration mufflers must work for a broad range of engine speed. The TL measured with experimental setup is compared with numerical method to demonstrate that the TL can be predicted reliably with the setup which is prepared.

2. Theoretical Analysis

The empirical relation for theoretical analysis of single expansion chamber reactive muffler is given by the transmission Loss (TL) of muffler and is calculated by the following empirical formula.

$$TL=10\log10\ [1-1/4(m-1/m)^2 Sin^2 kl]$$

Where,
m: Expansion ratio; cross-sectional area of expansion chamber to cross-sectional area of inlet & outlet pipe.
k: Wave number; 2πf/c
c: Velocity of sound, m/s
l: Length of expansion chamber; m
TL: Transmission Loss; Db

The muffler transmission loss for the single expansion chamber reactive muffler is evaluated using theoretical analysis. The design conditions used for evaluating transmission loss of single expansion chamber reactive muffler are listed as follows

a. The length of expansion chamber is kept constant i.e., L=740mm.
b. The diameter of expansion chamber is kept constant i.e., D=160mm.

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