International Journal of Applied Environmental Sciences
ISSN 0973-6077 Volume 13, Number 7 (2018), pp. 669-676

http://www.ripublication.com

An Experiment on Noise and Emission Control in a Modified Exhaust System

N.Boominathan[1], R.Kathiravan[2*], G.K.Vijayaraghavan[3]

[1]Research scholar, Periyar Maniammai University, Vallam, Thanjavur-613403, Tamilnadu.India.

[2]Professor, Aerospace Engineering Department, Periyar Maniammai University, Vallam, Thanjavur - 613403, Tamilnadu, India.*

[3]Principal, Dhaanish Ahmed College of Engineering, Padappai, Chennai - 601301, Tamilnadu, India.

Abstract

Emissions from automobiles play an important and serious role in environmental pollutions like noise and air pollutions. Due to the population growth and societal requirements the usage of vehicles is unavoidable one. Silencer usage considerably reduces the effects of such pollutions. Silencers with various pollution control materials available today. Here, asbestos fibers are used as a noise absorbing and pollution control material. Its effects on noise and emissions reduction level are analyzed. The model is tested with 100cc Suzuki, four stroke, petrol engine. Better results observed than a conventional one. Modification is done in silencer structure without much change. From the exhaust gas analyzing results, it is observed that 11.3% reduction in exhaust frequency and 20% in noise level, compared with the conventional silencer which confirms the commercial usage of this modified silencer.

Keywords: Noise pollution, Exhaust gas analysis, modified silencer, Asbestos fiber

1. INTRODUCTION

An automobile exhaust system has several functions. Originally, it is used for attenuating the noise caused by high pressure exhaust gases leaving the engine and for transporting these hot and toxic gases away from the driver's compartment.

Nowadays, it is also an important and integral part of combustion and emission control. For this to work properly there must be no leakage upstream of the catalytic converter. The durability of that part of the system is therefore crucial. Customer demands for comfort and long product life guarantee also for the exhaust system as a whole are additional reasons for the increasing importance for design engineers to be able to predict, describe and assess the dynamics of various system design proposals during product development. The above considerations converge into the critical objective of obtaining low vibration levels in the exhaust system. Modifications are going on to attain optimization both in performance and efficiency. Automotive emission-control technologies comprise all technologies that are used to reduce pollutants produced and released into the atmosphere by automobiles.

This modified exhaust system generally consists of a outer shell, inner shell with perforation and asbestos fibers as a filling and noise absorbing material. There is a trend to use more computer simulations in the design of products. This is mainly due to demands on shortened time to market, higher product performance and greater product complexity. To be useful in the design process it is important that the simulation models are kept as simple as possible while still being accurate enough for the characteristics they are supposed to describe. To reveal weaknesses in the simulation models experimental investigation is often necessary. The simulation models can then be updated to better correlate with experimental results. The catalyst includes a honeycomb ceramic material and the outside shell structure is rather complicated. Thus, detailed modeling would be computationally expensive. perforated pipes pass through the mufflers. The mufflers are filled with sound silencing material. Their outside shell structure is also rather complicated. Besides the connection to the manifold the exhaust system is attached to the chassis of the car by rubber hangers. Two hanger attachments are placed at the intermediate muffler and a third is placed just downstream the rear muffler.

The frequency interval of interest for the model analysis is obtained by considering that a four-stroke engine with four cylinders gives its main excitation at a frequency of twice the rotational frequency. Usually the 36 rotational speed is below 6000 rpm. Excitation at low frequencies may arise due to road irregularities, . Thus, the interval is set to 0-200 Hz. Free boundary conditions are generally desired to facilitate a comparison between the field evaluation results and the experimental results. This also makes it possible to easily exclude the influence of the non-linear joint in the present analysis. It is assured that the flexible joint does not have any internal deformations. Thus it will move as a rigid body in the present analysis.

2. CONSTRUCTION

The silencer shell is constructed of 22to 18 gauge galvanized steel for superior strength and maximum sound transmission reduction through the side walls.

Figure1 Internal view of silencer

No flimsy 26 or 24 gauge material is used that vibrates in the airstream. A perforated pipe is placed in the middle of the shell and closed with end gaps. Asbestos fiber material is filled between the outer and inner shells. Figure 1 and Figure 2 show the inner and outer details of the modified silencer. All internal are electric resistance welded under quality controlled factory conditions for an outstandingly long life. No screws or clips are used which could come loose in shipment or vibrate loose in the air steam. The length of the silencer is limited as per the reduction level since it has a direct effect on the noise reduction rate.

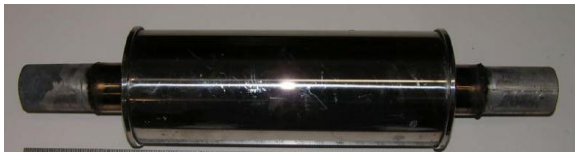

Figure 2 External view of silencer

This is a typical resonator muffler designed for automotive applications and was expected to have a low frequency attenuation characteristic that targets the noise generated at the engine firing frequency. Due to its complexity of design it is not possible to estimate the performance of this muffler from its dimensions alone unless a numerical finite element analysis is carried out and accurate estimates can be made of the flow resistance in the perforations connecting the cavity. Figure 3 illustrates the fitting arrangement of the modified silencer in a two wheeler

Figure3 Fitting details

3. TESTING PROCEDURE

The Society of Indian Automobile Manufacturers (SIAM) has proposed a computerized emission checking system to replace the existing PUC system in India. The main aim of the system is to bring accountability and reduce false passes in the process. The proposed system intends to reduce the human touch involved in the current PUC system and thus reduce malpractices which otherwise exist in the current system

The testing procedure still remains based on idle tests only. The general layout of the computerized testing system is given in Figure. In this system the gas analyzer is connected to a computer, which has a printer and a web camera attached to it. The emission values from the gas analyzer are directly sent to the computer and simultaneously photograph of the number plate as identification of the vehicle is captured by the web camera. This emission data are to be stored in the computer and sent to the required departments on-line. Figure 4 shows the schematic diagram about the sequence of exhaust gas analyzing process.

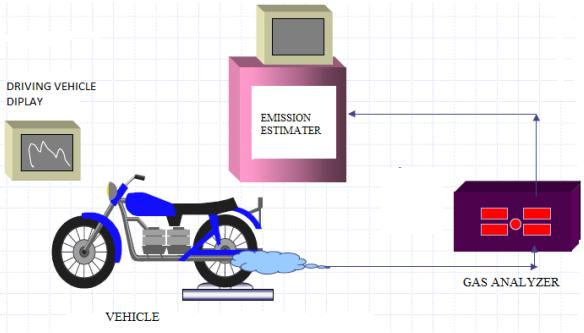

Figure 4 Exhaust gas analyzing process

While the engine idles, the sampling probe shall be inserted into the exhaust pipe to a depth not less than 300 mm. After the engine speed stabilizes, the reading shall be taken. The value of CO and HC concentration reading shall be recorded. In cases where gadgets or devices are incorporated in the exhaust system, for dilution of the exhaust, both CO and CO2 shall be measured using an instrument having facility to measure both CO and CO2. If the total of the measured values of CO and CO2 (T. CO and T. CO2) concentration exceed15% for four stroke engines and 10% for two stroke engines, the measured value of CO shall be taken as carbon monoxide emissions from the vehicle.

If it does not, the corrected value (T corrected) shall be taken, as given below

For 4-stroke engines

T corrected = T CO x 15/ (T CO + T CO2)

For 2-stroke engines

T corrected = T CO x 10/ (T CO + T CO2)

Multiple exhaust outlets shall be connected to a manifold arrangement terminating in a single outlet. If a suitable adopter is not available, the arithmetic average of the concentrations from the multiple pipes may be used. If the measurement is to be repeated, the entire procedure of para 3.0 shall be repeated. For the purpose of PUC (Pollution under Control) certification, if the idling CO and/or HC are not within limits as per 4.0 below, the testing shall be discontinued and the vehicle owner shall be advised to resubmit the vehicle after repair / service.

This computerized emission checking system is expected to achieve the following objectives

- Eliminate/minimize malpractices currently in vogue with respect to issue of PUC certificates and minimize human intervention by computerizing the process.
- Improve credibility and acceptance of emission certification process, thereby establishing discipline on periodic maintenance and certification of in-use vehicles. This would help in keeping emissions from in-use vehicles under control.

4. RESULT AND ANALYSIS

International and national standards for permissible limits of CO, HC and noise emissions are available. It may vary with the environment and road conditions of the particular area. Authorized emission test centers are located for test certificates. Table 1 displays the values of the emission certificate of emissions from the conventional and modified silencer.

Table 1. Values of emissions

SlNo	Pollutant	Conv	Modified	reduction	%
1	CO (% by Vol)	1.360	0.255	1.105	81
2	HC in PPM	1228	320	900	73
3	CO_2 % by Vol	12.01	12.48	0.47	3.9
4	O_2 % by Vol	01.07	01.14	0.07	6.5

From the above the values obtained from the usage of modified silencer shows a considerable reduced percentage of emissions.

Figure 5 also illustrate the below

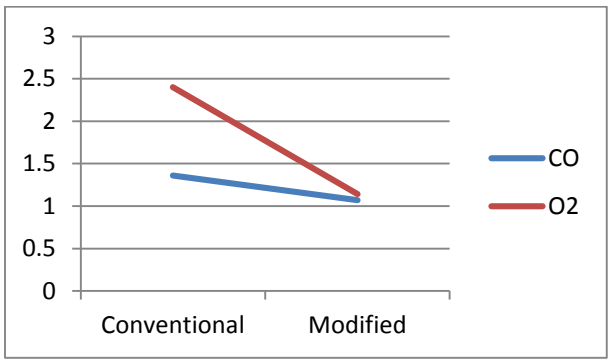

Figure 5. Comparison of CO, O_2 emissions

A comparison between the certification vs estimated mass emission is showed in Figure 6

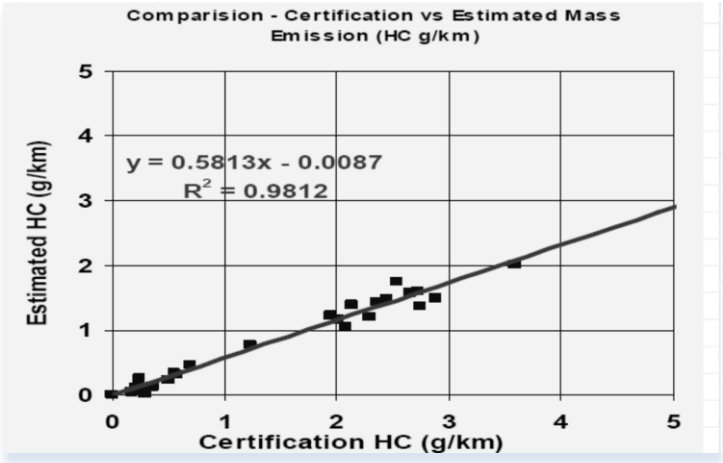

Figure 6. Certification vs estimated mass emission

The trade-offs between CO-HC, NOx-HC, CO2-HC are explored in Figure .These are shown to better clarify in BAT. The mass capacity of CO, HC, CO_2, NO_X are taken from three different places of road areas.

Considerable frequency and noise reduction is revealed from figure 7 and figure 8. It is easy to observe that the usage of modified silencer gave better results than the conventional one, without major change in construction.

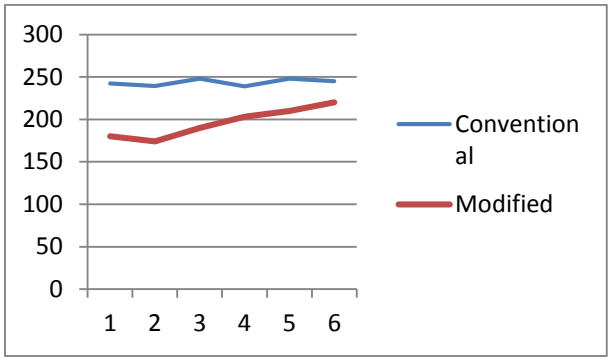

Figure 7. Comparison of frequencie

To adequately define the noise problem and set a good basis for the control strategy, the following factors should be considered

- ✓ type of noise
- ✓ noise levels and temporal pattern
- ✓ frequency distribution
- ✓ noise sources (location, power, directivity)
- ✓ noise propagation pathways, through air or through structure
- ✓ Space acoustics (reverberation).

Muffling devices are commonly used to reduce noise associated with internal combustion engine exhausts, high pressure gas or steam vents, compressors and fans. Here continuous and intermittent noise emission is observed.

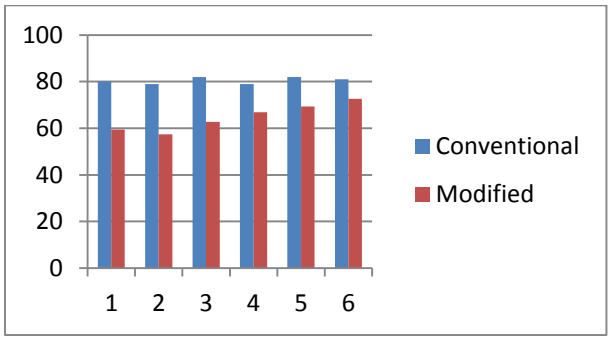

Figure 8. Comparison of noise emission

The data presented by points represent the pair of emissions of specific measurements while the bar lines represent the emission factor chosen as representative of the best available technology for the respective axis (20% percentile per pollutant). The charts are presented for each of the cycles – driving modes separately

5. CONCLUSION

This research investigated the flow characteristics and emission rates by the change of noise absorbing material in a two wheeler silencer and relatively reduced values are

obtained on testing the modified silencer in 100cc four stroke petrol engine. Frequency rate reduced from 240 cycles per second to 220 cycles per second. It shows 11.3% of reduction. The noise emission rate gives 20% reduction i.e from 80 dB to 64 dB which harmless to human beings. Hydrocarbon emission shows considerable reduction by this the modified silencer helps to reduce green gas effects on environment. Almost no changes in the design and the construction, research proves that the modified silencer is commercially possible one.

REFERENCE

[1] Francisco Payri, Jesus Benajes, and Jose Galindo (1999), 'One-dimensional Fluid –Dynamic Model for catalytic converter in automotive engines', SAE-1999-01-0144.

[2] Daniel Chatterjee, Olaf Deutschmann and JurgenWarnatz(2001),'Detailed surface reaction mechanism in a three way catalytic converter', Interdisciplinary Centre of Scientific Computing (IWR), Heidelberg University.

[3] Ming Chen, Joe Alexio, and Thierry Leprince (2004), 'CFD Modelling of 3-way catalytic converter with detailed catalytic surface reaction mechanism', SAE 2004-01-0148.

[4] 'Recent Development Trends in Catalyst Technologies for Reducing Nitrogen Oxides Emission', Science &Technology Trends. (2005)

[5] Shoji, A**.** (2007) 'Diesel Engine-Efficiency and Emissions Research (DEER) Conference', Detroit, MC, USA.

[6] Jerry G.Lilly ,P.E Jel (2009) 'Engine Exhaust Noise Control by acoustics'. SAE 2009-01-0148.

[7] 'Engine Silencer Catalog', by Idaho Clean Snowmobile Challenge Team.

[8] 'Implementation of noise control measures', by Dr Chew ChyeHeng

[9] 'Study on possible new measures concerning motorcycle emissions', by Thessaloniki.

[10] PSG Design Data Book

[11] www.youtube.com