

Investigation of Muffler for Noise Reduction

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Abstract- Internal ignition motor is a noteworthy wellspring of commotion contamination. Fumes commotion lessening from motors is a vital issue. Suppressors are utilized to diminish this fumes commotion. Configuration of the suppressor ought to give the best commotion diminishment and offer ideal backpressure for the motor. In this paper the Experimental and reproduction results for altered suppressor are exhibited. The standard suppressor with various change are displayed in Autodesk Inventor programming and tried for acoustical execution in COMSOL a reproducing programming. Clamor estimation for various suppressor alterations are completed tentatively utilizing Fast Fourier Transform. Relatively changed intelligent suppressor with astounds demonstrates decrease in clamor level and least fuel utilization.

Keywords—*Noise, Muffler, FFT Analyser, COMSOL*

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I. Introduction

The noise created by internal combustion engine has been a constant source of problem to the atmosphere. So the problems of reducing engine noise consist of mainly the attenuating exhaust noise. Exhaust systems are developed to attenuate noise levels to meet prescribed levels and sound quality, and emissions based on environment norms. Mufflers are an important part of engine system and are commonly used in exhaust system to minimize sound transmissions caused by exhaust gases. A resistance against the flow of exhaust gases stems the flow is called as back pressure and it causes an extra pressure inside the engine. Because of the back pressure, volumetric efficiency decreases and specific fuel consumption increases. Therefore, there must be specific limitations for the back pressure. Noise pollution created by engines becomes a vital concern when used in residential areas or areas where noise creates hazard. Generally, noise level of more than 80 dB is not comfortable for human being. Design of mufflers is a complex function that affects emission and fuel efficiency of engine. Therefore, muffler design has become important for noise reduction, making this an important area of research and development.

Particularly focusing on the engine under study, this paper tackles the problem of the inconvenience caused due to the noise produced by the engine by determining a suitable muffler design for it by actual modification and by doing acoustical analysis of 3D model of muffler in COMSOL software. Comparative study of the muffler modifications helps to determine the best design type for noise reduction, taking into consideration the effect of the design on fuel economy.

II. Methodology

Microphone (Bruel & Kjaer make) & FFT SN-28995 is used for measurement of Sound pressure level. The experiment has been carried out in an open environment. The Figure 2.1 shows experimental setup for noise measurement.

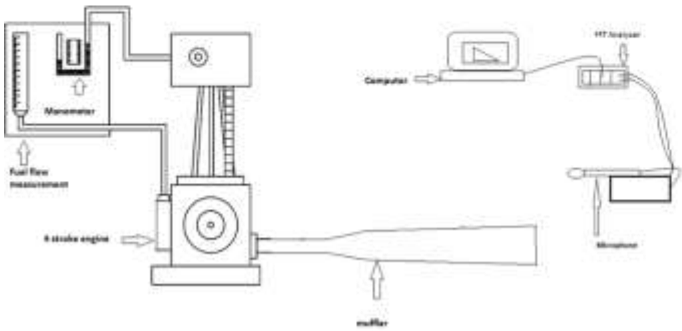

Fig.2.1 Experimental setup

Hardware components in the system are noise source, sensor and FFT system. The engine generates the noise level which is to be measured and the sensor and the FFT system are used to measure the noise level and to convert it into a computer understandable format.

The single cylinder 4-stroke petrol engine used for the experiment has the following specifications:

- Make Bajaj Auto Ltd.
- Engine Capacity 5 HP at 1500 rpm
- Capacity 100cc
- Rated speed 1500 rpm
- Rated BHP 6 K.W.

Measurements are carried out when no other major noise sources are in action. The background noise was neglected and is assumed to be in a constant range for all readings.

Noise level of the engine is first measured without attaching a muffler, then with a standard muffler and afterwards with different modifications. The standard muffler used for experiment is of the same make of Bajaj 4S Champion. Measurements are taken at 3 speeds of 2500 rpm, 3500 rpm and 4500 rpm. The time taken for consumption of 10 cm level of fuel is recorded for all modification.

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III. Modifications in muffler design

The standard muffler used for experimental analysis is shown in Fig.3.1 which is purely reflective type with no absorptive material. Three different modifications are done as below.

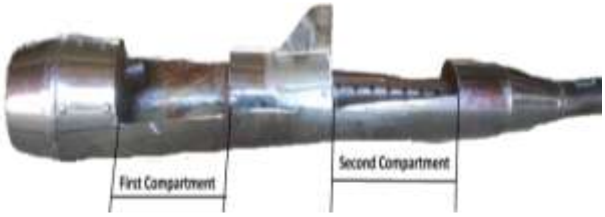

Fig.3.1 Standard muffler

A. Absorptive type muffler

Glass wool packing is used due to its good noise damping properties and low cost. Absorptive mufflers are those mufflers that attenuate sound by using absorbing materials. They dissipate the acoustic energy into heat energy with the use of porous materials like mineral fiber, fiber glass etc. The absorptive muffler is shown in Fig. 3.2

Fig.3.2 Glass wool packing

B. Reflective type muffler (with baffles)

In the first chamber, two baffle plates were placed. The baffle plates used were 80 mm in diameter and 1 mm thick and 4 holes of diameter 12 mm. Placement of baffles is determined by considering the fundamental frequency of emitted noise, so as to cancel the sound waves by reflections. The plates are placed so as to make the three partitions in the chamber of equal length and then different modifications were done by keeping distance between two plates constant and by changing the distance between the first compartment fixed wall and first baffle plate (X). Reflective type modification of muffler with baffle plates is shown in Fig. 3.3.

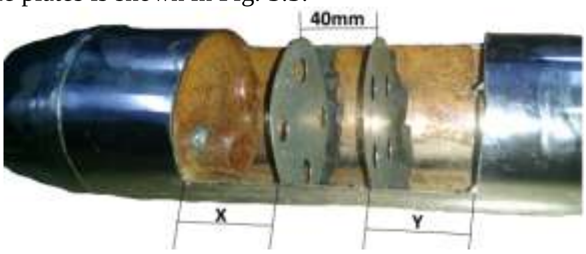

Fig.3.3 Reflective muffler with baffles

C. Hybrid muffler (with baffles)

A combination of the above two modifications, with the absorptive part in the second chamber and the reflective part in the first chamber made up the hybrid muffler.

IV. Experimental and simulation Results

Acoustic simulation of all muffler modifications was done in COMSOL software. The experiments were conducted for all modifications and without and with standard muffler, reading were noted at three different speed for the SPL and the time taken for 10cm level of fuel consumption. Fig. 4.1 shows the comparative time taken for 10cm level of fuel consumption for different modifications and it is listed in Table 1.

Table 1 Time (sec) taken for 10cm level of fuel consumption

Different Conditions	Time (sec) taken for 10cm level of fuel consumption		
	2500 rpm	3500 rpm	4500 rpm
Without Engine Noise	-	-	-
Without muffler	73	70	65
With standard muffler	71	67	63
Absorptive modification	62	58	55
Reflective modification	67	60	62
Hybrid modification	64	62	59

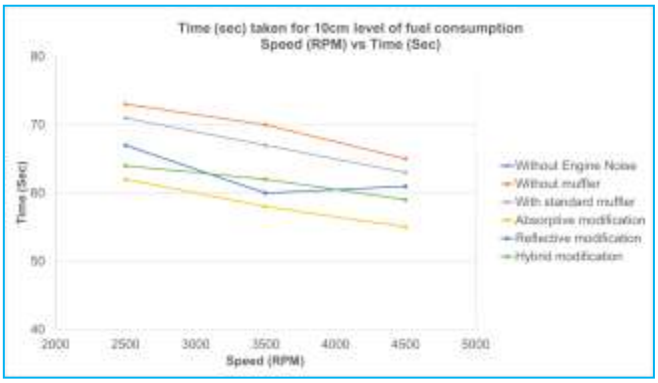

Fig. 4.1 Time (sec) taken for 10cm level of fuel consumption

Fig.4.2 shows comparative sound pressure level for different modifications and Table 2 shows maximum SPL in dB obtained at 600Hz frequency from experimental and simulation results.

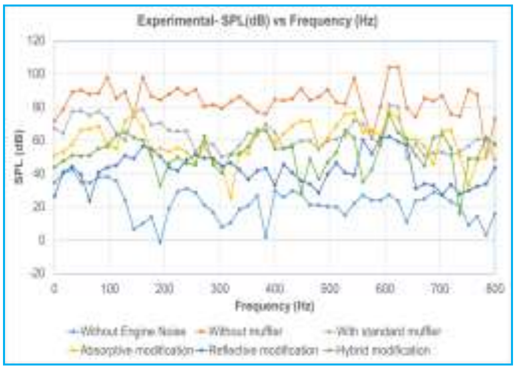

Fig. 4.2 Experimental-SPL(dB) vs Frequency (Hz)

Table 2 SPL (dB) at 600 Hz frequency

Different Conditions	SPL(dB)	
	Experimental	Simulation
Without Engine Noise	27.09	-
Without muffler	103.76	-
With standard muffler	81.37	78.14
Absorptive modification	77.99	72.70
Reflective modification	62.28	62.39
Hybrid modification	75.32	69.36

Fig. 4.3 and Table 3 shows SPL readings for different modifications of reflective muffler with baffles. It is observed that as the distance X increases the SPL reduces.

Table 3 SPL (dB) for Distance X of reflective modification.

Baffle distance X (mm)	SPL (dB) Experimental	SPL (dB) Simulation
35	73.24	75.62
50	68.77	72.24
65	62.28	62.39

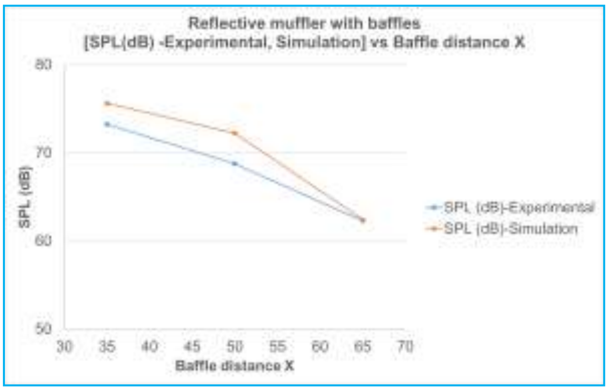

Fig. 4.4 shows acoustic simulation results for standard muffler

Fig. 4.3 SPL (dB) vs Distance X for Reflective modification

and Fig. 4.5 shows acoustic simulation results for reflective muffler.

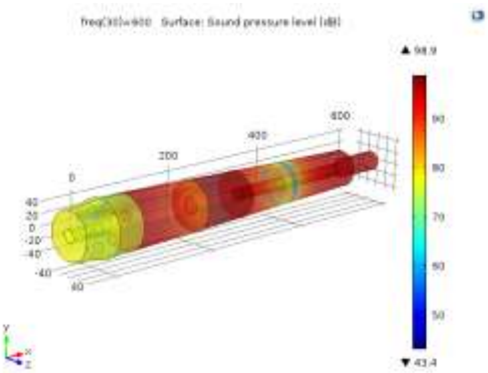

Fig. 4.4 SPL (dB) for standard muffler at 600Hz Frequency in COMSOL (dB) for standard muffler at 600Hz Frequency in COMSOL L

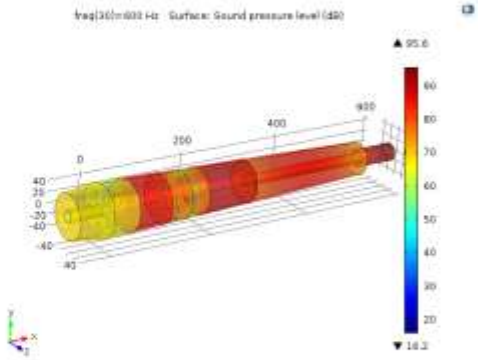

Fig. 4.5 SPL (dB) for reflective muffler at 600Hz Frequency in COMSOL

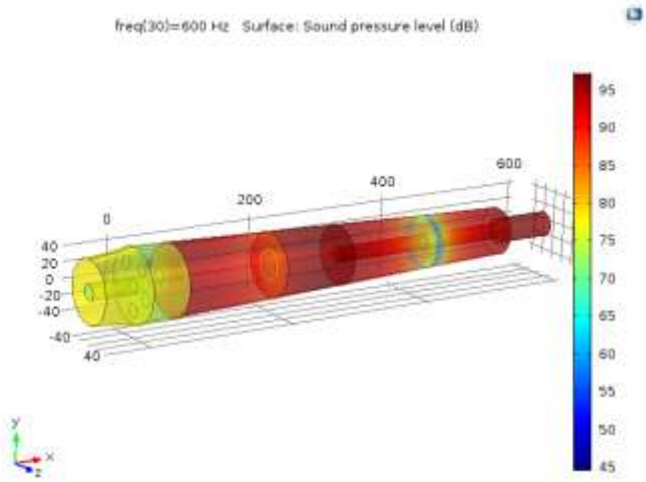

Fig. 4.6 SPL (dB) for absorptive muffler at 600Hz Frequency in COMSOL

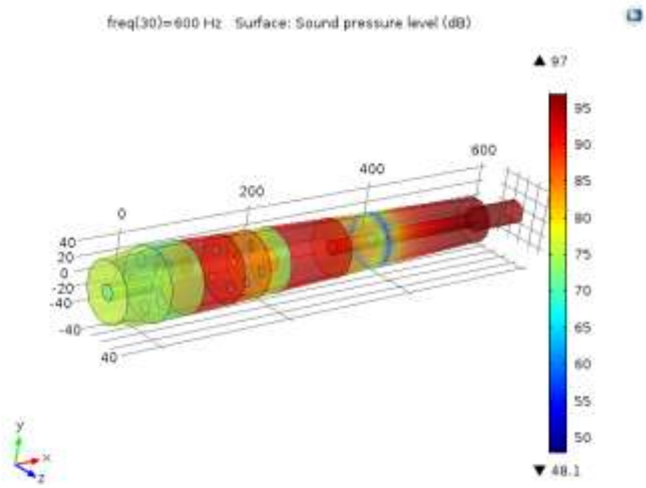

Fig. 4.7 SPL (dB) for hybrid muffler at 600Hz Frequency in COMSOL

V. Conclusion

After experimental investigation and simulation for the Bajaj 4S champion muffler with different modifications like reflective, absorptive and hybrid type for noise reduction it is concluded that the values of noise level and fuel consumption for hybrid type modification lies between reflective and absorptive type muffler. By placing the baffles at optimum distance from fixed wall for the reflective type muffler the minimum noise level can be achieved. The reflective muffler with baffles is the better design amongst the four designs studied as it achieves a balance between sound pressure level and fuel consumption.

VI. References

[1] Sidharam Ambadas Basargi, "Design and Development of Automobile Silencer for Effective Vibration Control", ME Mechanical Engg., pursuing DKTEs Textile and Engineering Institute, Ichalkaranji, Maharashtra, INDIA.

[2] Prof. B.S. Patel, Sunil Khokhar, "Design of Muffler Toward Reduce Sound in Exhaust System of IC Engine", Mechanical Dept., BVM Eng. College.

[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" Department of Mechanical Engineering, Bangladesh University of Engineering and Technology. December 2005, ICME05-TH-47

[4] Twinkle Panchal, Dhruv Panchal, Bharat Dogra, Krupal Shah, "Effect of Exhaust Back Pressure on Exhaust Emissions by Altering Exhaust Manifold Position", Automobile Department, Indus University. International Journal of Emerging Research in Management &Technology. November 2014.

[5] Salunkhe Karan Vishwas, Shingade Akshay Haribhau, Thorat Tejas Arjun, Waghmare Prashant Uttam, "Modification of exhaust system of two wheelers for emission control", Smt. Kashibai Navale College of Engineering, Pune, (IJERT) June – 2014.

[6] Potente, Daniel, "General Design Principles for an Automotive Muffler", Proceeding of ACOUSTICS, Busselton, Western Australia, November 2005, pp. 153-158.

[7] Dragos Tutunea, Madalina Calbureanu, Lungu Mihai, "Computational fluid dynamics analysis of a resistance muffler" University of Craiova.

[8] M.Rajasekhar Reddy, Dr K.Madhava Reddy "Design and Optimization of Exhaust Muffler in Automobiles",Department of Mechanical Engineering, G Pulla Reddy Engineering College, Kurnool, A.P., India, (IJERA) October 2012, pp.395-398.

[9] Paritosh Bhattacharya, Bankim Bihari Ghosh, Probir Kumar Bos, "Transmission Loss and Performance Test of a Two Cylinder Four Stroke Diesel Engine", Journal of Engineering Science and Technology Vol. 5, No. 3 (2010) 284 – 292 © School of Engineering, Taylor's University.

[10] How stuff works – web link http://auto.howstuffworks.com/muffler4.htm

[11] Sonal Zakmi, "Study of noise generated by Two Stroke Engine", Thapar University Patiyala, July 2009.

[12] M. Swamy, "Optimisation of Acoustic Silencer for the Screw Compressor System", 2014 COMSOL Conference in Cambridge.

[13] Web link-https://www.comsol.co.in/acoustics-module

[14] Web link-http://www.theflyingbanana.com/mufflers.html

[15] Eiji Sato, Toshio Tanoue, "Present and future trends of materials for automotive exhaust system", Nippon steel technical report no.64, January 1995.

[16] Zaid Shaikh, Sushant Ugale, Anuja Vekhande,Sanjay Rukhande "Muffler Modification for Noise Reduction", in "International Conference on Civil, Mechanical, Biological& Medical Engineering" at Nagpur Organized by IRD India on 20th April, 2014, ICMBME/ Volume II/pp.78-82