Noise Attenuation Of Diesel Engine With Different Types Mufflers

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ABSTRACT:

Noise is a nuisance for present day urban society. The automobile is a major culprit in increasing unwanted sound level. An engine noise is mainly due to exhaust noise. The suppression of an engine exhaust noise has been a subject of interest for many years. Mufflers are commonly used to minimize sound transmission caused by exhaust gases. Therefore muffler design becomes more and more important in noise reduction. The present work aims at development of an exhaust muffler for noise attenuation of single cylinder diesel engine.

INTRODUCTION :

Exhaust noise is one of the major contributors to noise from vehicles powered by internal combustion engine. For the same power rating, diesel engines are noisier than gasoline engines, since the combustion characteristics of diesel engines produce more harmonics than slower combustion of gasoline. An unmuffled gasoline engine radiates exhaust noise in the range from 90 to 100 dBA while an unmuffled diesel engine under identical conditions radiates exhaust noise in the range from 100 to 125 dBA. The suppression of engine exhaust noise has been a subject of interest for many years. Fortunately, however, this noise can be reduced sufficiently by means of a well-designed muffler. The muffler is an important component of the modern vehicle exhaust system. In order to comply with the law of environmental protection, the exhaust of vehicle including the noise and the burned gas should be strictly controlled. Thus muffler design becomes more and more important in noise reduction. In general two types of mufflers are in use. [1] dissipative muffler and reactive muffler.

According to the available literature [6], for muffler system to be of high performance, it should be a combination of reactive and dissipative muffler to reduce high frequency sound and active attenuation to reduce low frequency sound.

Exhaust noise is by far the most significant component of engine noise. Fortunately it can be reduced to level of the total noise from all other components and analysis of exhaust noise pattern of a diesel engine showed large peaks just above and below its firing frequency. There may be some harmonics of firing frequency present. [4]

In the present work three models as shown in Fig.2 are fitted on the exhaust pipe of a single cylinder diesel engine and their performance measured at constant speed through the entire load range of the engine. The three models investigated in the present work are given in Table 1.

EXPERIMENTAL SETUP :

Fig.1 shows block diagram of experimental setup. All noise data were taken on a relative basis in the closed space of the laboratory and in the presence of other engines and instruments in the close vicinity of the muffler exit. The background noise was recorded before experimentation. In order to keep background noise to a minimum, all other engines and machines in the laboratory was shut down during recording of the background noise.

A single cylinder, vertical, four stroke water cooled, constant speed diesel engine was used for testing the performance of three mufflers. The engine is loaded using a rope brake dynamometer. Fuel consumption is measured by using burette and stopwatch. Exhaust gas temperature is measured by using thermocouple. Back pressure measurement at mufflers is carried out by using U-tube manometer for all the models except without muffler (MW). Speed of an engine is measured with the help of tachometer. B&K Sound Analyzer type 2260 is used to measure the sound pressure level.[5]

Three different models of muffler of circular cross section and having expansion ratio of 16 are fabricated using 20 gauge mild steel plate. Each was 600 mm long and made to fit on 38.1 mm exhaust pipe of engine. These mufflers are fitted onto the exhaust pipe of the engine and for each setup the SPL is measured at a distance of 1 meter from the muffler outlet end and at an angle 45^0 to the horizontal axis of the muffler. SPL is also recorded at a distance 1 meter from the exhaust pipe outlet and at angle 45^0 to the horizontal axis of the exhaust pipe after disconnecting the muffler. The difference between the two readings is taken as the noise attenuation produced by the particular model.

According to Beranek [2], instead of arranging inlet and outlet at the center axis of the chamber, there will be increase in transmission loss if they are arranged eccentric by a few millimeters. Hence both the pipes are arranged eccentrically. The perforated section is given about 5% porosity by drilling holes on the surface.

RESULTS AND DISCUSSIONS :

Fig. 3 – 7 represents the graphs of sound pressure level, sound attenuation, fuel consumption, brake specific fuel consumption, back pressure versus brake power at constant speed.

Fig. 3 shows the graph of SPL versus brake power. The graph represents variation of SPL with different loads with and without mufflers. As load increases, torque of an engine increases. So SPL of an engine increases. The magnitude of the noise is controlled by the engine torque.

Fig. 4 shows the graph of sound attenuation versus brake power. The graph shows that the SPL decreases at all engine test conditions. This is due to the muffler configuration having reactive , concentric-tube resonator and combined reactive and dissipative structure.

A sound attenuation of 19.7, 18.2 and 20.8 dBA for M1, M2 and M3 respectively. According to sound attenuation sequence of muffler model is M3, M1, M2.

Fig. 5 shows the graph of fc versus brake power. There is increase in fuel consumption with mufflers. This is due to the back pressure exerted on an engine.Fig.6 represents graph of bsfc versus brake power. There is nominally increase in bsfc for all the three models through the entire load range compare to the MW.

Back pressure is exerted on an engine due to obstruction made in the passage of exhaust gases. This back pressure is due to the loss in the stagnation pressure in various tubular elements and across various junctions.

CONCLUSIONS :

Noise attenuation of diesel engine is carried out using different types of mufflers. These mufflers were fitted on exhaust pipe of diesel engine. Engine as well as acoustic performance are measured for entire load range. From this work following conclusions are drawn.

1. Sound attenuation of 19.7, 18.2 and 20.8 dBA is achieved with M1, M2 and M3 mufflers.
2. There is increase in fuel consumption with mufflers. This is due to the back pressure exerted on an engine.
3. There is nominal increase in bsfc for all the three models through the entire load range compared to the MW.
4. There is no significant increment in the back pressure.
5. Muffler M3 is better than M1 and M2 mufflers from sound attenuation point of view.

6. According to engine performance muffler M1 is better than M2 and M3 mufflers.
7. Muffler M1 has optimum design considering both engine performance and sound attenuation together.

REFERENCES :

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3. Ghosh B. B., Chaudhary J., Development of a Muffler for Control of Noise Pollution in a Diesel Engine, Journal of Automabile Engg., Vol. 213 part D, 83-90 , 1999.
4. Harris C. M.,Handbook of Noise Control, McGraw-Hill, New York , 1957.
5. Instruction Manual of B & K Precision Sound Analyzer type 2260.
6. Munjal M. L., Acoustics of Ducts and Mufflers, John Wiely and Sons, New York 1987.

Table No. 1 :Details of the three muffler models investigated under study.

Model	Type	Descriptions
MW	Without Muffler	---
M1	Multi-chamber Reactive Muffler	Double expansion chamber of unequal length. Inlet and outlet tube extended in chambers and arranged with eccentricity of 25 mm.
M2	Concentric-tube Resonator Muffler	Muffler is simply constructed through the use of an axially located perforated tube passing through the chambers and forming the inlet and outlet.
M3	Combined Reactive and Dissipative Muffler	Structures loosely packed with sound absorbing material is incorporated into the reactive design protected by a perforated metal sheet. Exhaust and tail pipes are arranged with eccentricity of 25 mm and extended in first expansion chamber.

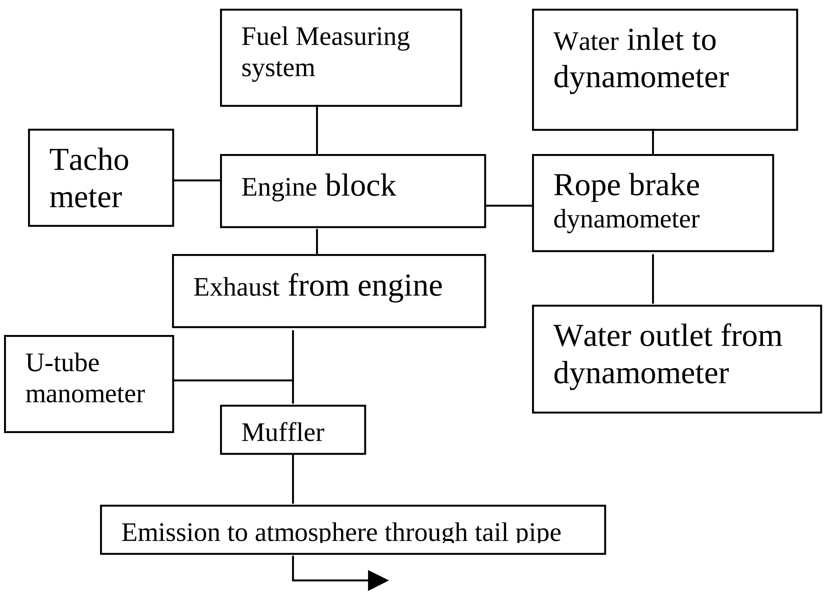


Fig.1 Block diagram of experimental setup

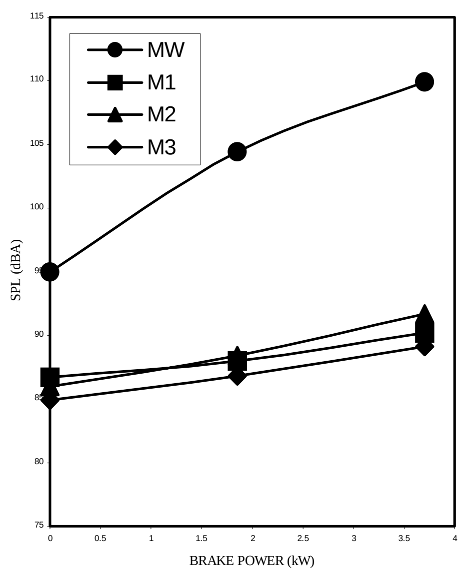
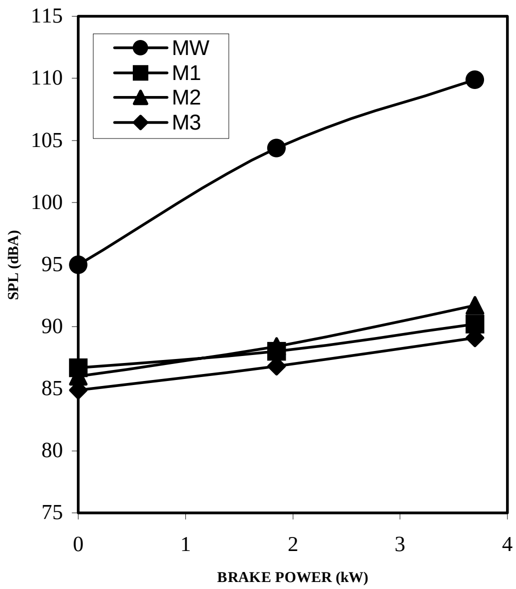


Fig. 3 Brake Power vs Sound Pressure Level



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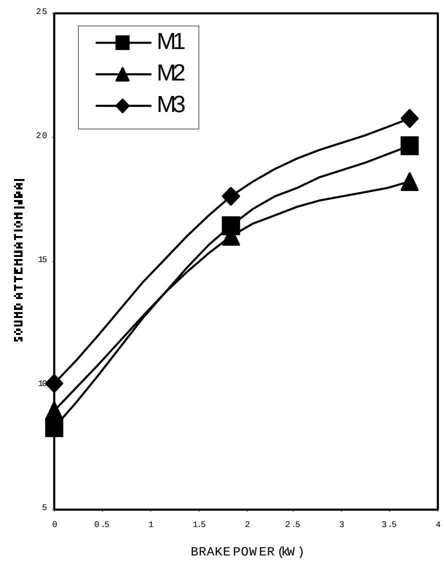

Fig. 4 Brake Power vs Sound Attenuation

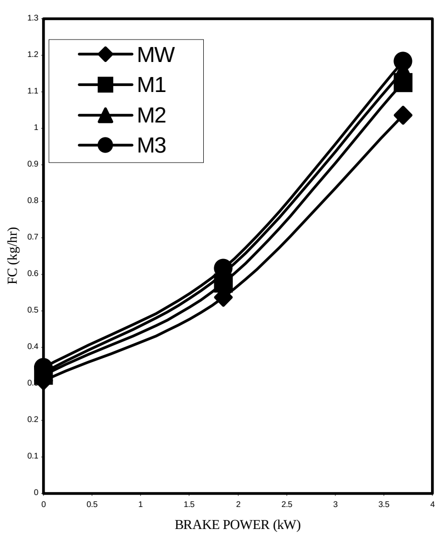

Fig. 5 Brake Power vs Fuel Consumption

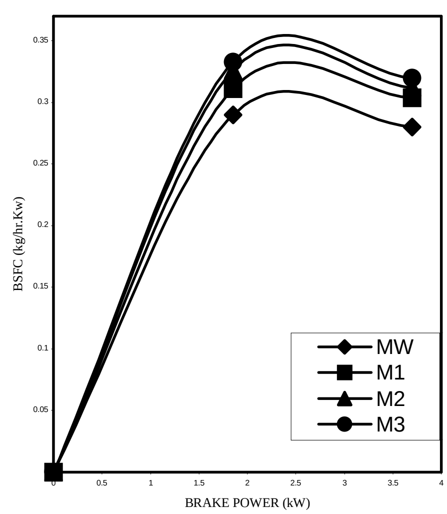

Fig. 6 Brake Power vs Brake Specific Fuel Consumption