



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**STUDY ON THE EFFECT OF HOLE SHAPE AND GEOMETRY
OF ABSORPTIVE SILENCER ON THE SOUND
TRANSMISSION LOSS PERFORMANCE**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours.

by

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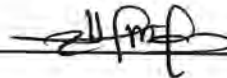
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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance) with Honours. The member of the supervisory is as follow:



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ABSTRACT

Noise pollution produced by industry and car makes an area exposed to noise will cause danger ahead and can get hearing problem. The important thing that the noise is usually comes from the exhaust system. This paper investigated the effect of hole shape and geometry of absorptive silencer in a muffler. Muffler is such a device used for reducing the amount of unwanted noise. The design inside muffler have silencer, the silencer have a perforated tube to reduce the sound transmission loss of the muffler. Noise attenuation muffler depends on quality of the absorption materials and its internal geometry. This paper discuss the effect when use different hole size for silencer on sound transmission loss and insertion loss with use the size of hole is 2 mm, 4 mm, 6 mm, 8mm and 10 mm with using the glass wool for material absorption silencer tube. The experiment to investigate the effect hole shape and geometry of absorptive silencer in the muffler tested using ASTM E2611 to determine the sound transmission loss and insertion loss for each sample hole size. In conclusion the result shows that when the hole size was changed from smallest up to the larger size from 2 mm, 4 mm, 6 mm, 8 mm and 10 mm the absorption sound transmission loss is increase when the holes size is increased, hole size 10 mm has a good absorptive sound transmission loss because can absorb higher frequency.

ABSTRAK

Pencemaran bunyi yang dihasilkan oleh industri dan kereta membuatkan kawasan yang terdedah boleh menyebabkan masalah kesihatan kepada kita seperti akan menghadapi masalah pendengaran. Perkara yang perlu tahu bunyi biasanya datang daripada sistem ekzos. Kertas kerja ini menyiasat kesan bentuk lubang dan geometri penyenyap penyerapan. Muffler ialah peranti yang digunakan untuk mengurangkan jumlah bunyi yang tidak dikehendaki. Reka bentuk didalam muffler mempunyai penyenyap bunyi, mempunyai tiub berlubang untuk mengurangkan kehilangan penghantaran bunyi penyenyap. Pengurangan bunyi yang tidak dikehendaki muffler bergantung kepada kualiti bahan penyerap dan geometri di dalamannya. Kertas kerja ini membincangkan kesan apabila menggunakan saiz lubang yang berbeza untuk penyenyap kehilangan bunyi penghantaran dan kehilangan sisipan dengan penggunaan saiz lubang 2 mm, 4 mm, 6 mm, 8 mm dan 10 mm dengan bulu kaca untuk bahan penyenyap penyerapan. Kajian ini adalah untuk menyiasat kesan bentuk lubang dan geometri penyenyap penyerapan di dalam muffler dan diuji menggunakan ASTM E2611 untuk menentukan kehilangan penghantaran bunyi dan kehilangan sisipan bagi setiap sampel saiz lubang. Kesimpulannya, menunjukkan apabila saiz lubang ditukar dari saiz kecil sehingga saiz yang lebih besar daripada 2 mm, 4 mm, 6 mm, 8 mm dan 10 mm penyerapan kehilangan penghantaran bunyi meningkat apabila saiz lubang bertambah, saiz lubang 10 mm mempunyai penyerapan bunyi kehilangan penghantaran yang baik kerana boleh menyerap frekuensi yang lebih tinggi.

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DEDICATION

To my beloved parents

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

°C	-	Temperature
D	-	Diameter
dB	-	Decibel
Hz	-	Frequency
IL	-	Insertion Loss
ISO	-	International Organization for Standardization
L	-	Length
Mic	-	Microphone
Mm	-	Millimetre
OSHA	-	Occupational Safety and Health Administration
<i>P_i</i>	-	Incident Noise
<i>P_r</i>	-	Reflected Noise
<i>P_t</i>	-	Transmitted Noise
PVC	-	Polyvinyl chloride
STL	-	Sound Transmission Loss

CHAPTER 1

INTRODUCTION

1.1 Noise

Noise has a variety of criteria which must be known because there are a variety of sounds we can be hear until you cannot stand the noise to be heard. For specific noise is called unwanted sound. Have many noise can be heard in an environment, for the examples in everyday can be heard is the sound of the car, the sound of people laughing, people who were playing musical instruments and more. When work at industrial normally be exposed to the sound of machine tools for the industry because there are a lot of machines that produce a variety of sounds ranging from slow sound to the unwanted sound. Noise is very important to the human to react to the sound to be heard. More example industry noise, industry have component such as compressor pump, fan blade, machine cutting and others machines that produce noise. Unpleasant noise can disturb people when heard for the physical and physiological and noise can also damage the environment. (Atmaca et al., 2005). Aero plane when taking off can produce very loud sound with the average sound level 140 dB. The airport has a variety of sounds that can make the public think of anything negative, when have the information provided will reduce their negative reaction to aircraft noise in the area because of the attitude of a public likes to take out the sounds they hear. (Kroesen et al., 2011).

The common method to control noise have the three element, first element is source to control the vibration, second transmission path for the sound absorption and sound transmission lost, for the last is receiver for the output of noise. Figure 1.1 shows about the element of general communication system.

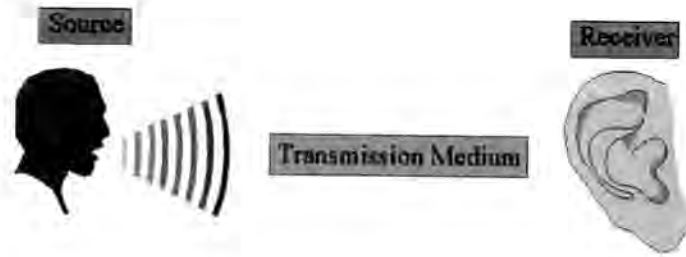


Figure 1.1 : A general communication system for source, transmission and receiver.
(Comlab, 2005).

For explanation Figure 1.1, the source may be coming from machineries for example noise cutting tool, transportation coming from movement of car on the road and noise from turbulent flow. The transmission medium is air, oil and water and the receiver is human ear to detect communication.

1.1.1 Effect of noise

Many effects noise that we know, some noise is good to hear and some noise not healthy for heard because can effects the environment and health. In general, noise is one of the unpleasant sounds because it will cause or result in a disruption of the physical and human physiology that will lead to environmental damage caused by noise pollution and environmental damage to property. (Atmaca et al., 2005). Hearing the noise continuously will cause a problem will happen to our body that is hearing loss due to exposure to noise above the level that can be heard. If want to do job that led the occurrence of high noise, must wear safety equipment such as ear protection to protect ears from loud noise and we can avoid hearing damage. Hearing the noise level continued only 85 dB audible only if more than that can cause hearing loss continuously (Atmaca et al., 2005). The Figure 1.2 below shows measured the sound level and provides type of noise is harmful to hearing.

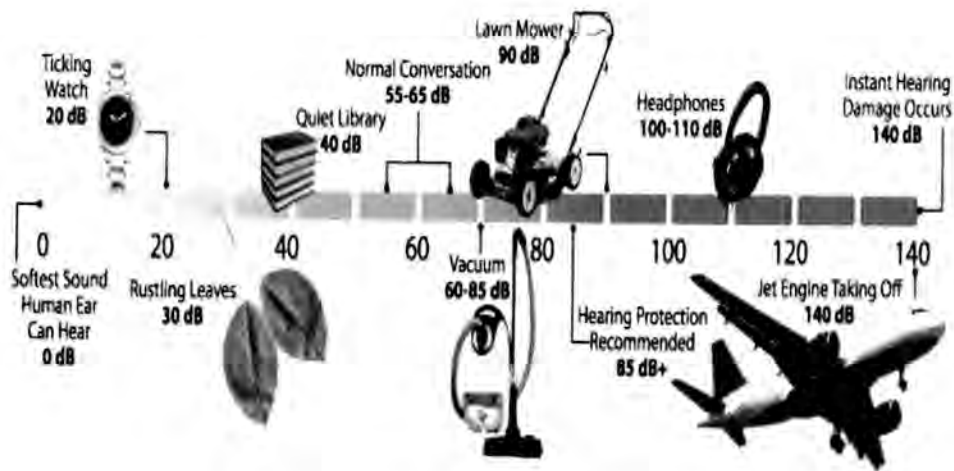


Figure 1.2 : Estimates from the World Health Organization suggest that hearing loss afflicts 28 million Americans. (Hearing, Speech & Deaf Center, 2016).

According to Figure 1.2 the lowest noise is a ticking watch because level noise 20 dB, for the medium noise is vacuum cleaner because noise level between 60 dB to 85 dB and the example high noise level is jet engine taking off 140 dB more than that hearing can be damage. The safety most important to do for example employee work eight hour sound pressure level must be low than 85dB. (OSHA, 2002).

1.1.2 Noise Reduction Method

To reduce noise have a two method must be know because want to decrease noise with the method, first method want to apply is sound transmission loss (STL) and for the second method apply is absorption. These are two method very important to use when you want to reduce the noise because can absorb the noise becomes less noisy there are sound transmission loss and absorption.

Definition of the sound transmission loss (STL) is the difference between the power of sound entering in incident wave and transmitted wave exiting the muffler when the muffler is anechoic. The sound can be reduces because no

reflecting wave have in the muffler. Reduction sound will be gives in dB when the component through sound wave passes. The measures sound transmission loss is very important for industry because want to reduce the sound and protect the hearing when work. Acoustic devices in muffler is very important because can decrease in intensity of a waveform energy.

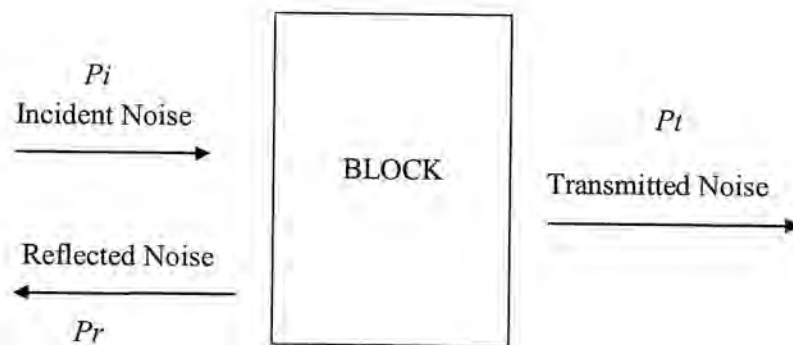


Figure 1.3 : Conceptual illustration of noise transmission through a structure.

Figure 1.3 shows conceptual illustration of noise being transmitted through a structure. Incident noise vibrates the structure; some of the noise is reflected with the rest being transmitted through.

Definition of the absorption is absorbed sound by various material or component which can absorb sound of noisy. Using good material for absorbing, the sound pressure allow enter to their surface and using air friction to release energy. Absorption always in place that produce a lot of noise as the hall, cinema, construction areas and other places that produce noise to make some noise transmitted and partly absorbed into the walls. Absorbing material is the main component to reduce energy sound interesting because a lot of noise, so important to control the sound level of the noise. (Arenas and Crocker, 2010).

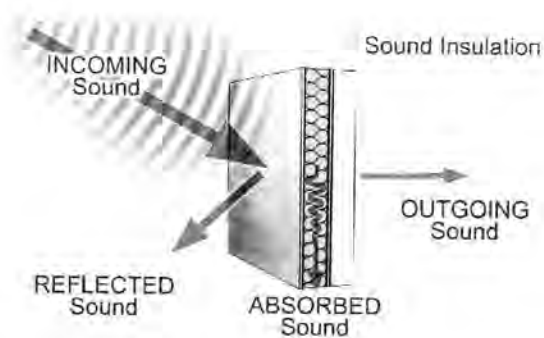


Figure 1.4 : When sound is transmitted through an element the acoustic incoming energy takes three forms. (Isover, 2010).

1.1.3 Silencer

Silencer is defined as material to absorb the loud sound becomes loud noise caused silencer built. Silencer widely used in industry, vehicles, guns, and others to reduce the noise produced by each item. In the industry normally use mufflers and silencers, has a very complex internal component because it has a different design, different tube diameter hole and a different geometry. It is important to use a silencer to avoid people hear something very loud sound can cause hearing problems due to the occurrence of an article is not mounted silencer. For example the water at the barrel of a gun silencer reduces the firearm to a lot of noise and visible muzzle flash generated by firing.

Silencer for car: Car has a muffler installed within exhaust system and the silencer design in inner tube of muffler. The device to reduce the unwanted sound, muffler is a tool for proofing acoustic pressure to reduce loud noise emanating from the engine through the acoustic quieting. Hole diameter and geometry in the internal tube of the muffler is very important to reduce the noise of muffler or increase the noise.

Silencer for industry: Industry has a lot of machine and lot of employee must be work, the important silencer must be used in the industry because many machine or environment in industry exposed to very loud sound

1.2 Problem Statement

Excessive noise will make the person has a hearing problem for listening to the noise that exceeds the ability of the human person to hear the noise. The level higher than 85 dB can be to hearing loss caused by excessive noise exposure, according to the advantage of someone's got to hear the frequency and duration of the noise that is heard. (Atmaca et al., 2005). For general knowledge silencer as a component to absorb noise and reduce the noise that occurs. Many silencers installed in the car and industry to reduce noise machine in the factory and exhaust system for the car. Also known silencer element to the sound transmitted along the duct to reduce the sound to allow gas flow freely through. (Praful and Swastik, 2015). However, on the research performance of silencer is taking in terms of holes performance and want to study the advantages of using different size hole in silencer. Sound transmission loss perforated plates is reduce when use the large diameter. (Putra and Ismail, 2014).

1.3 Objective

This study embarks with the following objectives:-

1. To design and fabricate a novel design of an absorptive silencer with difference hole size.
2. To test the silencer using sound transmission loss method.
3. To investigate the effect of hole size on the sound transmission loss performance.

1.4 Scope

Scopes of study for this study are:-

1. Design and fabricate a novel design of an absorptive silencer with different hole size.
2. Testing the silencer using ASTM E2611 standard.
3. Investigate the effect of hole size on the sound transmission loss performance.

CHAPTER 2

LITERATURE REVIEW

2.1 Silencer

Silencer is a control emission and noise for the main factor to reduce noise, silencer must be installed in automobile, gun and machinery because produce loud noise can be defect the hearing when always hear. Silencer usually located on the inside for example silencer on the exhaust muffler automobile parked in the tube for the processing of exhaust noise is because it acts as reducing the noise that will be released, if no silencer on the exhaust muffler that it will produce a lot of noise. Exhaust system will be the one that called the muffler, this component as a tool that can reduce the noise produced by the internal combustion engine. (Balamurugan et al., 2015). However, silencer have three element must be known first is absorption, second reactive and lastly combination. Each element interdependent to make a silencer that can reduce noise. The silencer is a complex component because have many hole must be drilled and have many design can to be make it. Hole is actually a very important role as it can reduce noise according to diameter holes that is bored. To reduce structural noise radiation holes can be one of the reasons used to reduce the velocity of the surface of that vibrating structure. (Putra and Ismail, 2014).

2.1.1 Absorptive

Absorptive silencer is one type designed classic dissipative design, noise control can be performed by using materials that can absorb the sound and reduce noise. Conventional sound absorptive silencer is known as the absorbing

material. (Harris, 1991). For each material is used difference absorption amount and each material has advantages and disadvantages. Absorptive silencer is something the best thing because it can withstand the frequency until 500Hz to 8,000Hz. (Universal Acoustic & Emission Technologies. 2011). There are a variety of fibrous materials that can be found in the absorptive silencer system for an ingredient that is often used for the purpose of reducing noise. By using absorptive goods categories will also get the different sounds because the material used is not the same.

However, there are all kinds of variations in excess of a substance in the environment that exists on the sound system. Material commonly used in the sound absorbing material such as rock wool, glass wool and sponge or polymer. The exhaust system will be installed absorption material for exhaust force flow through the absorption material to establish a large pressure drop to reduce noise pollution produced by exhaust. Absorption material will typically be located on around the main exhaust pipe because the exhaust flows through that area. Figure 2.1 shows the absorption silencer in the muffler.

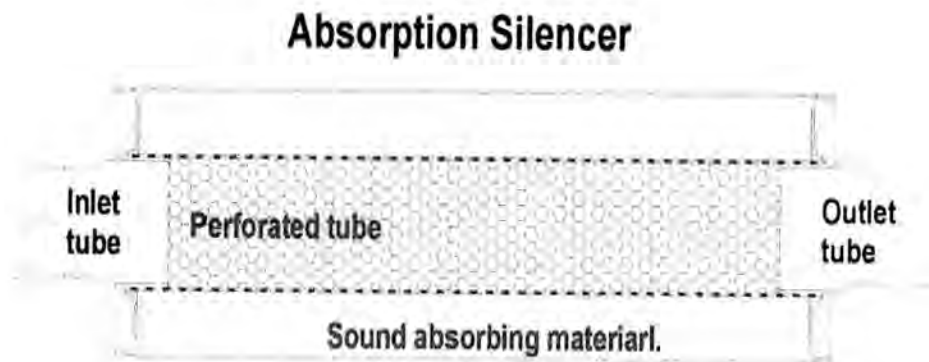


Figure 2.1 : Typical absorption silencers system use heat resistant sound absorption materials which are held in position by perforated tube. (Franklin silencer limited, 2016).