SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature
Name of Supervisor: Mr. MOHD HAFIZI BIN ZOHARI
Position: SUPERVISOR
Date:

STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature : ....
Name : MUHAMMAD SAUFI BIN ABDUL
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Date : 6 DECEMBER 2010

Dedicated to my beloved mother

Mrs Halimah Bt A. Bakar

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I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream, sacrifice, patience and understanding that were inevitable throughout my life to make this possible. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. Special thanks should be given to my committee members. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

ABSTRACT

This report is the result of a research on undergraduate project of Experimental Study on the Noise Reduction of Hydraulic Bench. The hydraulic bench is used to study the performance of fluids and the hydraulic theory. This report presents the noise source identification and noise reduction at hydraulic bench. The identification of the main source of noise must be done first before the noise reduction is done at hydraulic bench because the noise reduction will do based on the part that produce the main source of noise at hydraulic bench. Many method can be use for noise reduction process but in this research, the egg tray and fibre is used as material to reduce noise from hydraulic bench. The egg tray is use only for shaped the fibre to get more surface absorption. In this project, the result is achieved by using PULSE LABSHOP (Intensity Mapping). In intensity mapping, the colour contour represents the sound power. Comparison of result before and after noise reduction was conducted. The result from the experiment show that the main source of noise is at hydraulic pump and the noise from the hydraulic bench can be reduce up to 15 dB.

ABSTRAK

Laporan ini merupakan hasil kajian dalam projek sarjana muda tentang Kajian Eksperimen Pengurangan Hingar pada Bangku Hidrolik. Bangku hidrolik digunakan untuk mempelajari prestasi cecair dan teori hidrolik. Laporan ini menunujukkan tentang pengenalan sumber hingar dan pengurangan hingar di bangku hidrolik. Pengenalan sumber utama hingar harus dilakukan terlebih dahulu sebelum pengurangan hingar dilakukan pada bangku hidrolik kerana pengurangan hingar akan dilakukan berdasarkan pada bahagian yang menghasilkan sumber utama hingar di bangku hidrolik. Banyak kaedah boleh digunakan untuk proses pengurangan hingar tetapi dalam kajian ini, dulang telur dan serat digunakan sebagai bahan untuk mengurangkan hingar dari bangku hidrolik. Dulang telur digunakan hanya untuk membentuk serat untuk mendapatkan penyerapan permukaan yang lebih banyak. Dalam projek ini, hasil yang dicapai dengan menggunakan PULSE LABSHOP (Pemetaan Intensiti). Dalam pemetaan intensiti, kontur warna merupakan kekuatan bunyi. Perbandingan hasil sebelum dan selepas hingar dikurangkan telah dilakukan. Hasil dari kajian ini menunjukkan bahawa sumber utama hingar adalah di bahagian hidrolik pam dan hingar dari bangku hidrolik boleh dikurangkan sehingga 15 dB.

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LIST OF SYMBOLS

L_W	Sound power level
W	Sound power of the source
W_{re}	Reference sound power
I	Sound intensity
A	Surface area
λ	Wavelength
c	Speed of sound
f	Frequency
Hz	Hertz
L_P	Level
P	Sound pressure
P_o	Reference sound pressure
f_1	Lower band-edge frequency
f_2	Upper band –edge frequency
N	Speed of impeller
Z	Number of blades
η	Loss factor
D	Energy dissipation per cycle of vibration
W_o	Average total energy of the vibrating system
Δ	Decay rate
ξ	Damping ratio
C	Viscous damping coefficient
C_c	Critical damping coefficient

F(e)	Equivalent noise exposure factor
T	Period of noise exposure
L	Duration of the permissible noise exposure at the constant level

LIST OF ABBREVIATIONS

SPL	Sound power level
dB	Decibel scale
ISO	International standard

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The World Health Organization has recognized noise as the most significant health hazard to the working population in terms of the number of people affected. In many industries, there is much method to avoid harmful noise. The most insidious aspect of noise induced hearing loss is that in most cases damage accumulates over time and is only recognized as a problem when it is too late to do anything about it (Hansen, C. 2005).

Noise also can affect our daily living away from the work place. This type of problem is called environmental noise pollution. Environmental noise pollution can affect our physical health. In this context, noise can be defined as sound that is unwanted by one or more individual even though it may be wanted by someone else.

When considering noise control, it is well known that the most cost effective solution to a problem is often to control the noise generating mechanism right at its source. This often has the benefit of making the process more efficient in addition to being less noisy. Commonly, the method that used to reduce noise is considered about barriers, enclosure, mufflers, absorbing and vibration isolation. It is referred to as add-on noise control technology (Hansen, C. 2005).

In order to reduce noise at hydraulic bench, firstly must to identify the main source of noise and the amount of sound power. The sound power of the hydraulic bench can be identified by measuring sound intensity. The sound intensity is measured in a specified direction. It is the average rate at which sound energy is transmitted thought a unit area perpendicular to the specific direction. The sound pressure in a medium is naturally related to the power of the medium. The sound pressure in a medium is naturally related to the power of the source of sound. The sound power of a source is the rate at which acoustic energy is transferred from a vibrating source to a medium. If the source of noise can be identified, the noise of hydraulic bench may be able to be reduced.

1.2 PROBLEM STATEMENTS

The hydraulic bench will produce noise while it operating. The noise produced will cause disruption to the environment. A way should be taken to overcome the noise problem in the hydraulic bench to find the main source of noise and the appropriate way to solve the noise problem in hydraulic bench.

1.3 OBJECTIVES OF THE PROJECT

(i) To identify the main source of noise at hydraulic bench
(ii) To reduce the noise at hydraulic bench

1.4 PROJECT SCOPE

To identify the main source of noise at hydraulic bench. The test will run at anechoic chamber. After the main source of noise is identified, the noise reduction method will use to reduce the noise according to the main source of noise at hydraulic bench.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will briefly explain about the basic characteristic of sound, basic characteristic of noise, source of noise, noise measurement, noise reduction method, and level of noise. All this information is needed to complete this research.

2.2 HYDRAULIC BENCH

In fluid mechanic lab, the hydraulic bench is used to study the performance of fluids and the hydraulic theory. The upper part of the bench consists of an open channel and two tanks that we known the volume for a volume measurement of flow rate. An external view tube with scale enables to read the water level inside these tanks. A dump valve is installed in the bottom of the volumetric tank, this valve allows the water flows into the supply tank available at the base of the hydraulic bench. The water is drawn to the top of the bench by a centrifugal pump, whereas the flow rate is adjusted through a control valve. A variable area flow meter enables to compare the flow rate read on the instrument to the flow rate measured through the measuring tanks (Veneta, S.P.A. 1999). Hydraulic bench is show in Figure 2.1.

Figure 2.1: Hydraulic bench

2.3 SOUND

Sound is defined as the fluctuations in pressure above and below the ambient pressure of a medium that has elasticity and viscosity (E. H. Berger, 2003). Sound is also defined as a pressure disturbance that moves through a material at a speed which is dependent on the material. The basic parameter of sound that must be to know is:

(i) Sound power
(ii) Sound intensity
(iii) Sound pressure

2.3.1 Sound Power

The Sound Power is the total radiated acoustical energy in Watt. The Sound Power Level (L_W) is the Sound Power relative to a reference Sound Power level of 1 Pico Watt (Bruel & Kjaer, 2000). The sound output of a source is expressed in terms of its sound power level (L_W).

$$L_W = 10\log\left(\frac{W}{Wre}\right) \tag{2.1}$$

W represents the sound power of the source in watts. W_{re} represent the reference sound power defines as 10^{-12} watt (Bell, L.H. 1994; Bell, D.H. 1994). The sound power standard is:

(i) No requirement for the measurement room
(ii) No requirement for the size of the source
(iii) No requirement for the shaped and size of the measurement surface
(iv) No requirement for background noise level
(v) Quality of the measurement is controlled by a number of field indicators

Sound power levels are useful for:

(i) Calculation of sound pressure levels around a machinein a specific environments
(ii) Comparing the noise radiated by machines of the same type and size or different types and sizes
(iii) Planning noise reduction treatments to reduce noise levels in the adjacent environment produced by a machine.
(iv) Engineering design or development work to reduce noise radiated by a particular machine.

2.3.2 Sound Intensity

Sound intensity, I is the acoustical power passing through a unit area. Unit for sound intensity is W/m^2. It can be representing as:

$$I = \frac{W}{A} \tag{2.2}$$

Where W represent the acoustical sound power of the source in watt. A represent the surface area in meter square(m^2). When sound is radiated from a point source into free space, the acoustic power is evenly distributed over a sphere (Ostergaard, P.B. 2003). Sound intensity is generally depends on distance from the source (Bell, L.H. 1994; Bell, D.H. 1994). The advantages of the Sound Intensity are:

(i) Can measure in any room
(ii) Can identified noise source location
(iii) Can use for near and far field measurements
(iv) Eliminates stationary background noise source
(v) Partial sound power measurements
(vi) Physically correct method for determination of sound power

The useful of sound intensity is:

(i) Sound power determination
(ii) Noise source location
(iii) Building acoustics
(iv) Sound reduction work

2.4 CHARACTERISTICS OF SOUND

Sound is the quickly varying pressure wave traveling through a medium. When sound travels through air, the atmospheric pressure varies periodically. There are two important characteristics of sound. It is frequency and wavelength.

2.4.1 Wavelength and Frequency

The number of pressure variations per second is called the frequency of sound, and is measured in Hertz (Hz) which is defined as cycles per second. The higher the frequency, the more high-pitched a sound is perceived. The wavelength of sound wave is use for determine the behaviour of sound wave. The wavelength is the distance between peak to peak of the wave (Barron, R.F. 2003). The wavelength can be described in term:

$$\lambda = \frac{c}{f} \tag{2.3}$$

Where λ represent the wavelength in meter, c represents the speed of sound in meter per second and f represent the frequency in hertz (Barron, R.F. 2003). The value of frequency can be calculated from:

$$f = \frac{1}{t} \tag{2.4}$$

Where t represent the period to complete one cycle in second.

2.4.2 Longitudinal Wave

Longitudinal waves are waves that oscillate in the same path that the sound wave is moving. This is different than the up and down or transverse motion of a water wave. The longitudinal wave is shown in Figure 2.2 (Kurtus, R. 2009).

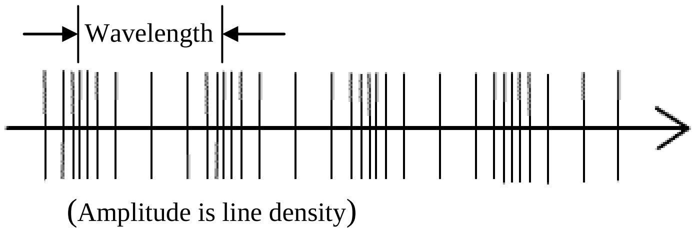


Figure 2.2: Longitudinal or compression wave for sound

Source: Kurtus, R. 2009

A sound wave has the same characteristics as any other type of waveform. It has wavelength, frequency and amplitude.

2.4.3 Beat Frequency

For the first case, the superposition of two sound waves which are same amplitude but slightly different in frequency. It will shown in Figure 2.3.

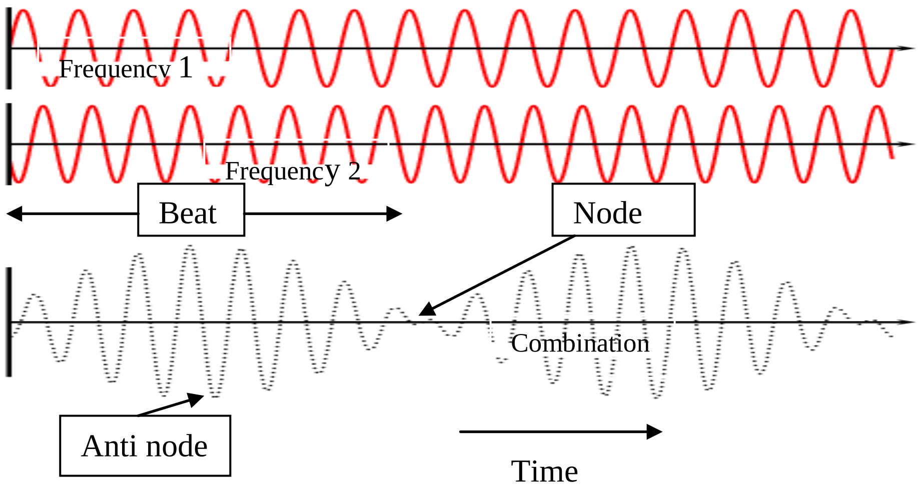


Figure 2.3: Superposition of two waves of slightly different in frequency but same amplitude.

Source: http://www.igs.net

For the general case, the amplitude of superimpose waves are not equal. A common example for this phenomenon is when pumps in industry operated at slightly different rotational speed (Bell, L.H. 1994; Bell, D.H. 1994). It will shown in Figure 2.4.

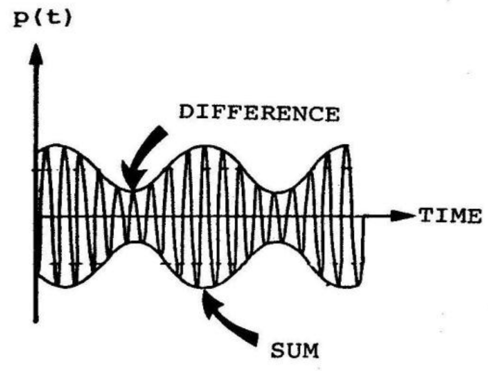


Figure 2.4: Superposition of two waves of different amplitude.

Source: Bell, L.H. 1994; Bell, D.H. 1994

In Figure 2.4, the different means the different of the amplitude of the waves and the sum is summation of the amplitude of the waves.

2.5 SUPERPOSITION WAVE

At hydraulic bench, it difficult to say there is a single source of noise present. When two or more sound waves are superimposed, it called superposition wave. Superposition wave is shows in Figure 2.5. With the amplitude and frequency of each wave component, the major noise source present can be identified. There are two special case of superposition that occurs frequently that must be mention. The first case is beat frequency and the second case is standing frequency. When two of special case is recognize, we can avoid error in measurement or analysis of noise (Bell, L.H. 1994; Bell, D.H. 1994).

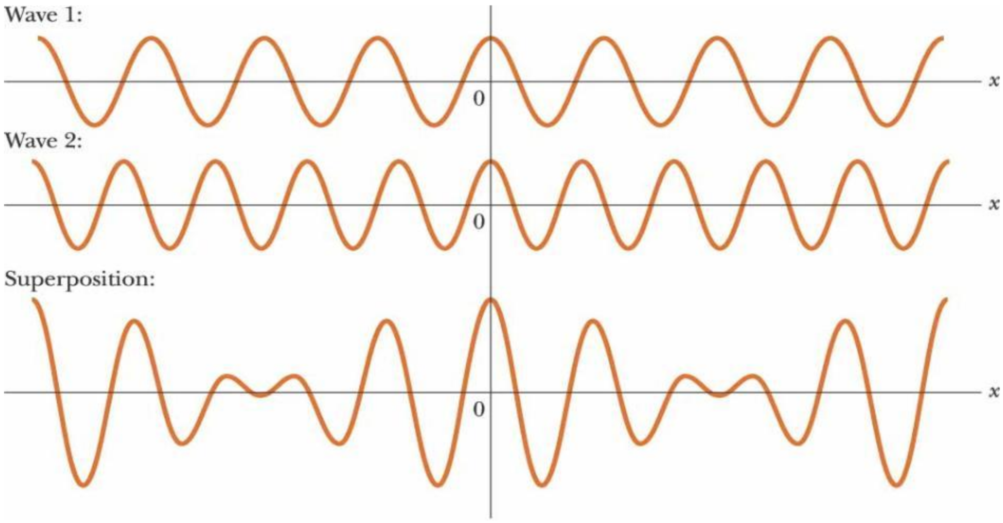


Figure 2.5: Superposition wave

Source: http://www.hesston.edu

A superposition is when a group of waves that are combined together so that they combine their amplitudes. When one wave's amplitude is affected by another, it's called interference. If one wave's amplitude gets larger because of another wave, that is constructive interference. If a wave's amplitude gets smaller because of another wave, which is called destructive interference.

2.6 INFRASONIC AND ULTRASONIC SOUND

Infrasonic waves are sound waves with frequencies below 30 Hz. Infrasound like all sound is ever-present in modern life. It is generated by motor vehicles, aircraft, watercraft, trains, hydroelectric power stations, compressors, and industrial equipment Intense infrasound exposure is generally accompany by exposure to intense sounds above 20 Hz (Berger, E.H. 1996). In fact, infrasonic acoustic energy does not usually occur in the absence of sounds within the normal audible range due to the processes in which such sounds are generated.

Ultrasonic waves consist of frequencies greater than 20 kHz and exist in excess of 25 MHz. Ultrasonic waves are used in many applications including plastic welding, medicine, jewellery cleaning, pipe inspection, and non-destructive test. Within non-destructive test, ultrasonic waves give us the ability to see through solid material and detect surface or internal flaws without affecting the material in an adverse manner. It is suitable to test the hydraulic bench pump to check the internal damage of pump that makes the pump noise (Ali, S.E. 2000).

2.7 THE DECIBEL SCALE

From the American heritage science dictionary 2005, decibel is a unit used to measure the power of a signal, such as an electrical signal or sound that relative to some reference level. The decibel is a logarithmic unit used to describe a ratio (Wolfe, J. 1998**)**. The ratio may be power, sound pressure, voltage or intensity. The dimensionless quantity base on the logarithm of the ratio of two powers is defined as;

$$L_P = 20LOG\left(\frac{P}{P_O}\right) \tag{2.5}$$

Where L_P represents the level, P represent the sound pressure in Pascal, and P_o represent the reference sound pressure. The value for reference sound pressure is 20 X 10^{-6} in Pascal. In acoustic, all levels are defined as the logarithm of the ratio of two quantities with the denominator as the reference quantity. Decibel is negative value when measured value less than reference quantity. Decibel is positive value when measured value equal to reference quantity (Berger, E. H. 2003).

2.8 BANDWIDTH

Source of the acoustic energy of sound and vibration normally is widely distributed over the frequency spectrum. The frequency range in acoustic is too broad to handle as a single unit for noise control. So when it is necessary to analyze, the frequency range must be broke into smaller units. Commonly for the noise measurements, bandwidth or range of frequencies used is octave band.

$$f_2 = 2 f_1 \quad (2.6)$$

Where f_1 represent the lower band-edge frequency in hertz and f_2 represent the Upper band –edge frequency in hertz. When it's upper band-edge frequency is twice the lower band-edge frequency, a frequency band be an octave wide. Usually, for noise control work, Octave band measurements will use. Octave band measurements are used because it will give useful and often essential amount of information with reasonable number of measurements (Berger, E. H. 2003). Figure 2.6 is shown the bandwidth.

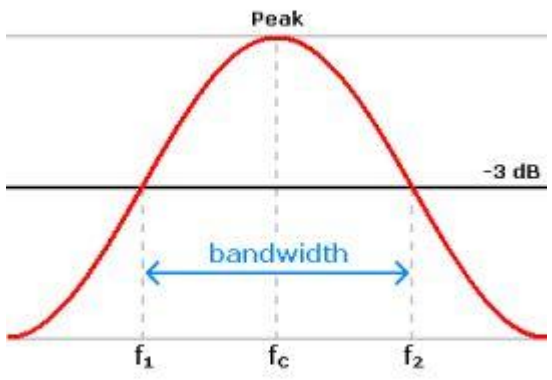


Figure 2.6: -3dB bandwidth.

Source: Christopher, C.G. 2006

2.9 CHARACTER OF NOISE

The meaning of noise is the vibrations transmitted through an elastic solid or a liquid or gas, with frequencies in the approximate range of 20 to 20,000 hertz, capable of being detected by human organs of hearing. Sounds that are unpleasant are called noise. The character of noise that must to identify is loudness, source of noise, material used for noise reduction, and level of noise.

2.10 SOURCE OF NOISE

In noise control, first, we need to know the main source of noise. It is important to identify the source of noise to know the method that is suitable to use for noise reduction. Commonly, the source of noise at pump is misalignment, unbalance rotor, pressure pulsation, and vibration at mounting of pump (Yedidiah, S. 2000).

2.10.1 Misalignment

One source of noise is misalignment of the pump and driver. Commonly, the pump is isolated from the piping. Static force from piping may misalign the pump from its driver. For the excessive loading, the pump case may distort and seal or bearing may damage. Power that was transmitted by a coupling with pins or teeth also a cause of misalignment (Yedidiah, S. 2000).

2.10.2 Unbalance Rotor

Vibration can be induced by a loose or by unbalance rotating parts. Unbalance of rotating shaft can cause large transverse vibration at certain speed known as critical speed that coincide with that natural or literal frequency of shaft. Vibration also occurs at a frequency for a bent shaft (Yedidiah, S. 2000).

2.10.3 Pressure Pulsation and Hydraulic Effects

Hydraulic effects and pulsation can result almost any frequency of vibration of the pump or piping from one per revolution to vane pass frequency. In a single stage volute pump, the blades of an impeller move past the volute tongue with a frequency equal to the number of impeller vanes multiplied by the rotating speed of the pump (Yedidiah, S. 2000). This causes pressure pulsations in the liquid, whose frequency F is equal to:

$$F = Nz \qquad (2.7)$$

Where Z represent the number of blades and N represent speed of impeller in revolutions per second.

2.11 NOISE MEASUREMENT

To measure sound, first we need to know the instruments that will be use. Many methods that can be use to identify the noise. The noise identification that will discuss is using sound intensity probe. The apparatus that will use in this method is laptop with noise source identification software, sound intensity probe, sound intensity calibration, microphone, and analyzer.

Sound intensity probe consist two closely microphone which measure both sound pressure and pressure gradient between the microphones. The signal processing necessary will convert these signals to sound intensity values are carried out in the sound intensity analyzer. The microphone selection has to fulfil two rather different conditions. The first criterion is the microphone must be operating satisfactorily over a range of environmental condition such as humidity, temperature, and wind. The second criterion is the microphone must also meet constraints such as frequency response, dynamic range, directivity and stability.

The ability of the sound intensity technique to reject background noise from other machinery operating in proximity to the machine of interest is specially advantages for this analysis. The noise identification must be done in anechoic room to avoid the reflection of sound.

2.12 SOUND POWER MEASUREMENT IN AN ANECHOIC CHAMBER

In an anechoic room, the wall and floor surfaces are treated with acoustic material. The surface absorption is 100% absorb the sound that radiate in this room (Barron, R.F. 2003). In this room, the sound can measure directly and no need to consider the reflection of sound. An anechoic room is available at University Malaysia Pahang (UMP) campus Pekan. The dimension of anechoic room at UMP is 10950mm x 10950mm x 5500mm where the length of room is 10950mm, the width of room is

10950mm and the high of the room is 5500mm. The measurements of sound can be run in this room to avoid the background noise and reflection noise. The room acoustics at UMP Pekan will shown in Figure 2.7 and Figure 2.8.

Figure 2.7: Room acoustics at UMP campus Pekan

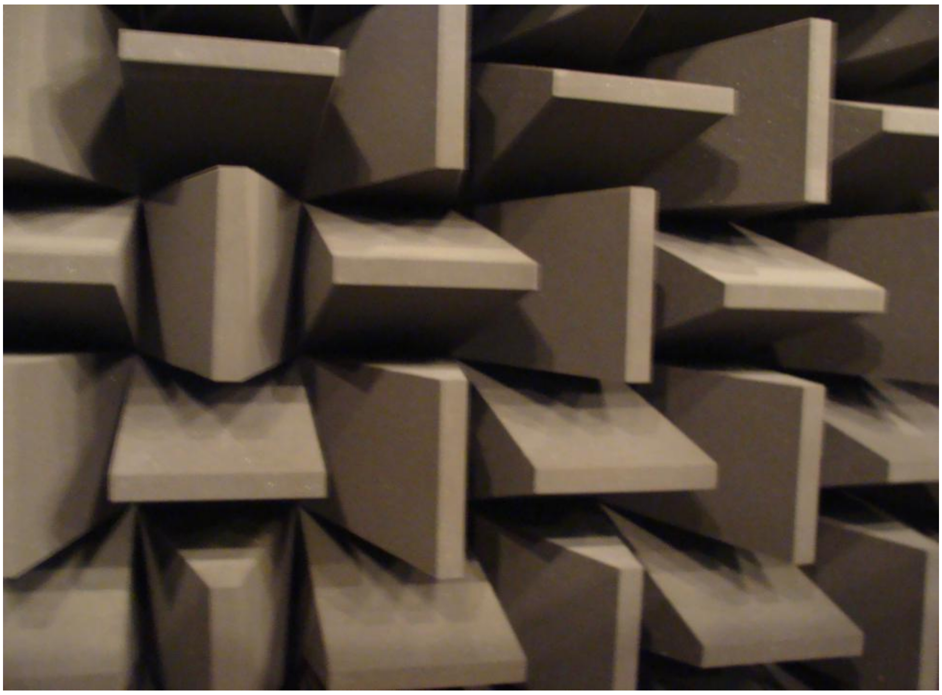


Figure 2.8: Room acoustics wall at UMP campus Pekan

2.13 NOISE REDUCTION METHOD

When considering noise control, it is well known that the most cost effective solution to a problem is often to control the noise generating mechanism right at it source. This often has the added benefit of making the process more efficient in addition to being less noisy. Commonly, the noise reduction methods that are use are vibration isolation and damping material (Hansen, C. 2005). This method is referring as add-on noise reduction method technology. Add-on noise reduction technology is preferred because it is low cost than change the main part of system to reduce the noise.

2.14 VIBRATION ISOLATION

Vibration isolation refers to the use of comparatively resilient elements for the purpose of reducing the vibratory forces or motions that are transmitted from one structure or mechanical component to another (Ver, I.L. 2006; Beranek, L.L. 2006). There are three major types of isolators. The isolator is metal springs, elastomeric mounts, and rubber pads. It should also be emphasized that the basic design approach will be to select isolator devices such that the natural frequency of the system is well below the lowest applied forcing frequency (Bell, L.H. 1994; Bell, D.H. 1994).

2.14.1 Spring mounts

Metal spring have perhaps the widest use of all isolation types. They are particularly applicable where large heavy equipment is to be isolated. The metal springs allow for large deflections. the most important feature of spring mounts is their ability to withstand relatively large deflection and as such provide good low frequency isolation (Bell, L.H. 1994; Bell, D.H. 1994). The spring mounts is shown in Figure 2.9.

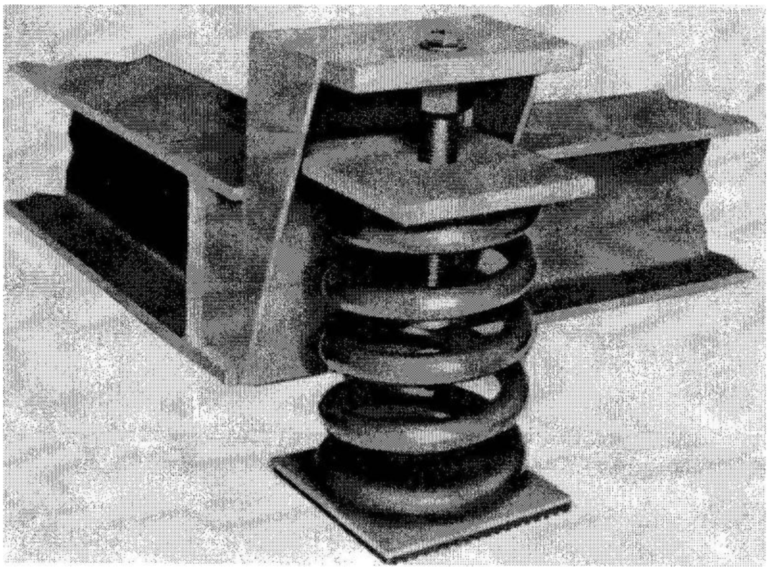


Figure 2.9: Examples of commercial available springs mounts

Source: Bell, L.H. 1994; Bell, D.H. 1994

2.14.2 Elastomeric isolators

Over a limited range of stress, elastomeric isolators can also be used effectively for a wide variety of vibration isolation problem. This type of mount is suitable to use at small machines. The most common materials selected for elastomeric mediums are natural rubber, neoprene, butyl, silicone, and combination of each (Bell, L.H. 1994; Bell, D.H. 1994). The elastomeric isolation is shown in Figure 2.10.

Figure 2.11: Examples of commercially available elastomeric isolator

Source: Bell, L.H. 1994; Bell, D.H. 1994

The stiffness for this mounts is varied by controlling the hardness or durometer of the rubber. With these deflections versus load curves, one can apply essentially the same method for mount selection as with springs. It must to remember that static deflection must keep under 0.5 in.

2.14.3 Rubber Pads

The design selection for rubber pads follow basically the method established in the preceding section on rubber mounts. Load versus deflection curves are always available from the manufacturer for a variety of rubber stiffness (durometers) or the layer thickness. For a single sheet, the upper load should not exceed 70 psi (Bell, L.H. 1994; Bell, D.H. 1994). The load characteristics is show in Figure 2.11.

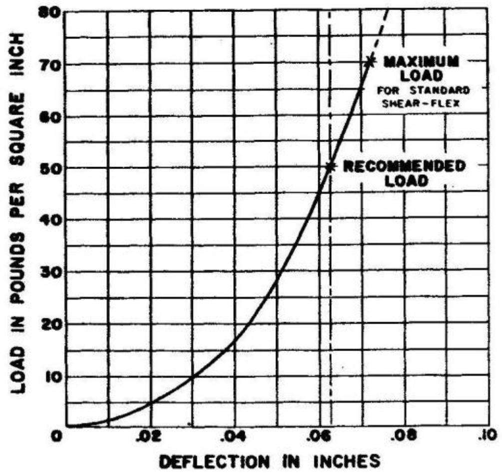


Figure 2.11: Examples of commercially available rubber isolator

Source: Bell, L.H. 1994; Bell, D.H. 1994

2.15 DAMPING

Damping is used to describe the dissipation of mechanical energy associate with vibration. A damping material is any material that is applied to a structural member to increase its damping (Bell, L.H. 1994; Bell, D.H. 1994). The parameter that must consider describing the characteristic of damping material is:

$$\eta = \frac{D}{2_{\pi} W_o} \tag{2.8}$$

η represent the loss factor. D represents energy dissipation per cycle of vibration and W_o represents the average total energy of the vibrating system. Total energy for W_o is kinetic energy plus potential energy. The loss factor is also can define as the energy dissipated or the damping to stiffness ratio.

Second parameter that must consider is decay rate. Decay rate is related to the loss factor. Decay rate can be described as:

$$\Delta = 27.3 f \eta \tag{2.9}$$

Δ represent decay rate in dB per second. f represent the decay frequency in hertz and η represent the loss factor. The loss factor is unit less.

Third parameter that also consider is damping ratio. Damping ratio can describe as:

$$\xi = \frac{C}{C_c} \tag{2.10}$$

ξ represent damping ratio. C represent the viscous damping coefficient of material in (Ns/m). C_c represents the critical damping coefficient in (Ns/m). This equation is valid when $C_c < C$ (L.H. Bell, D.H. Bell, 1994).

2.16 LEVEL OF NOISE

Noise can cause permanent hearing loss at chronic exposures equal to an average SPL of 85 dB (A) or higher for an eight-hour period. Based on the logarithmic scale, a 3-dB increase in SPL represents a doubling of the sound intensity. Therefore, four hours of noise exposure at 88 dB(A) is considered to provide the same noise "dose" as eight hours at 85 dB(A), and a single gunshot, which is approximately 140 to 170 dB(A), has the same sound energy as 40 hours of 90-dB(A) noise (Clark, W.W. 1999, Bohne B.A. 1999)**.** The permissible noise exposure is show in Table 2.1.

Table 2.1: Permissible noise exposure

Duration per day, hour	**Sound level dBA slow response**
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Source: Occupational Safety & Health Administration, 2000

Exposure to different levels for various periods of time shall be computed according to:

$$F(e) = \left(\frac{T_1}{L_1}\right) + \left(\frac{T_2}{L_2}\right) + \text{.........} + \left(\frac{T_n}{L_n}\right) \qquad (2.11)$$

where: F(e) represent the equivalent noise exposure factor, T represent the period of noise exposure at any essentially constant level and L represent the duration of the permissible noise exposure at the constant level. The exposure is in permissible level when the value equivalent noise exposure factor, F(e) is less than 1.

CHAPTER 3

METHODOLOGY

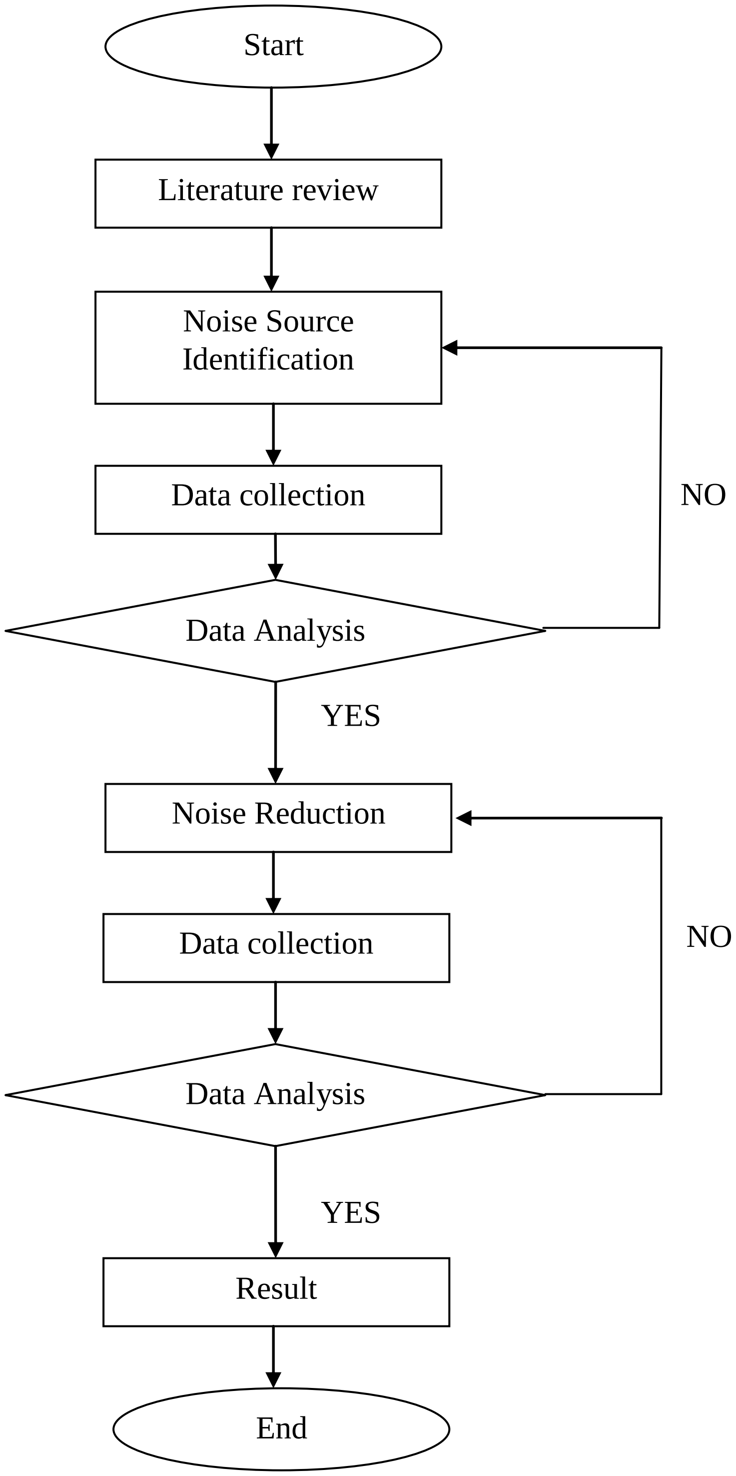
3.1 INTRODUCTION

In industry, there are many unwanted sound occurs from vibrating part of machine while the machine is running or operates. The unwanted sound called noise. There are many techniques to reduce noise. In this chapter will discuss about method to identify the noise and noise reduction method.

3.2 FLOW CHART METHODOLOGY

To achieve the objectives of the project, a methodology were construct base on the scope of products as guidance. The important of this project is to reduce the noise that produce from hydraulic bench pump. This is very important to make sure that the experiment in the right direction

3.2.1 Flow Chart



3.3 FABRICATION OF RIG

The rig is needed to fabricate because the rig is important part in this experiment. The rig is use for mapping the noise that comes from hydraulic bench. The measurement will involve in four sides which is right side, left side, rear side, and front side. Before start fabricate the rig, technical drawing must be done first. Technical drawing is show in Figure 3.1. Each section of the cross section for mapping is 10cm x 10cm according to international Standard ISO/DIS 9614-1. Figure 3.2 is show the rig stand for sound intensity mapping.

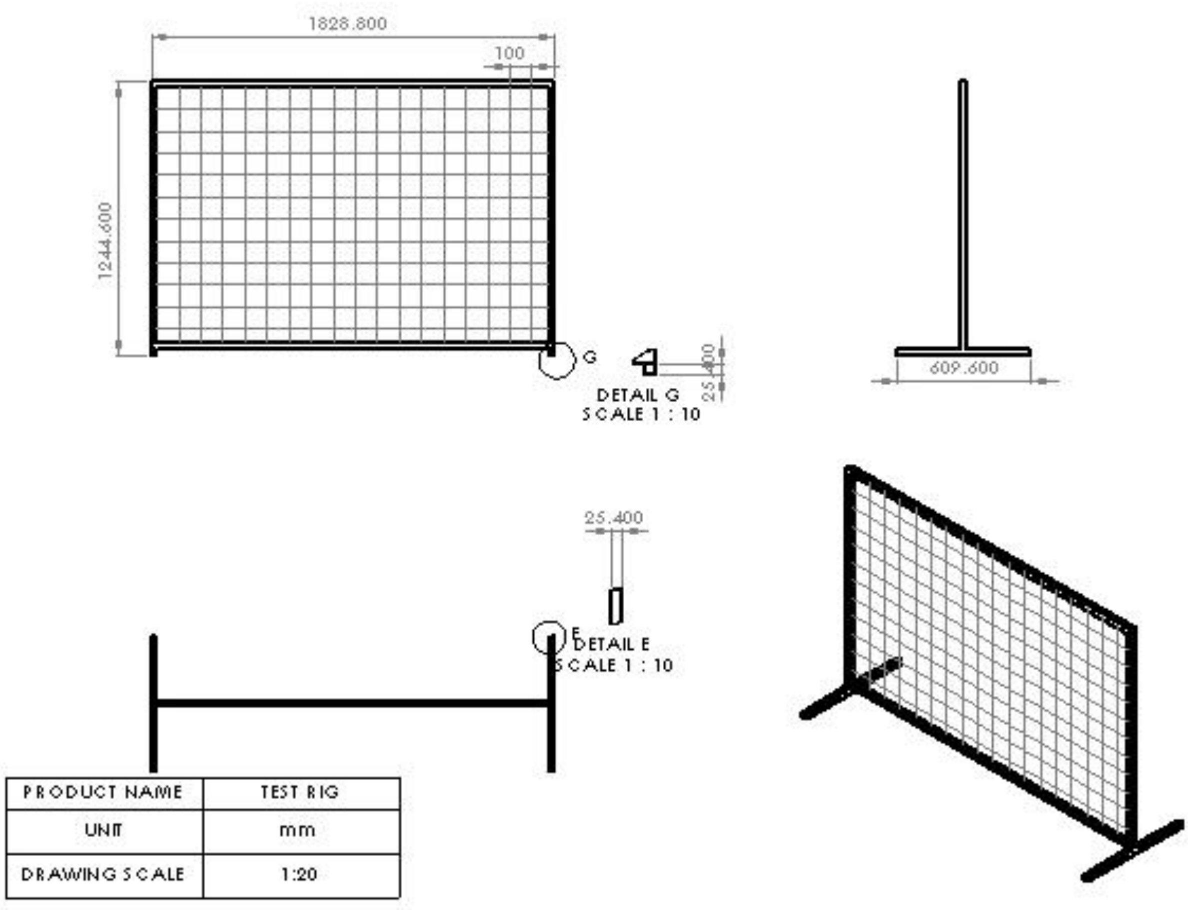


Figure 3.1: Drawing of rig stand for sound intensity mapping

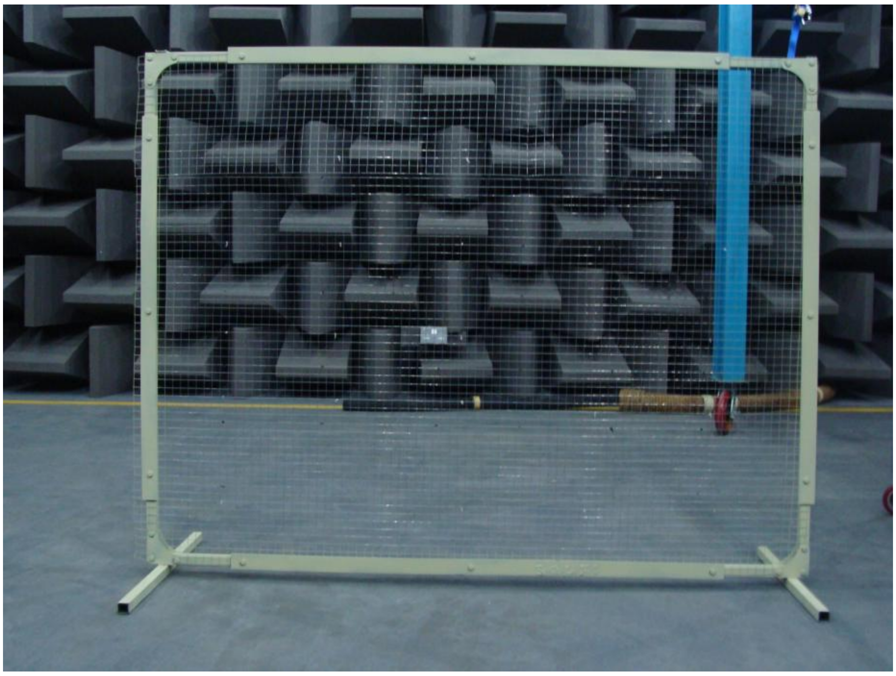


Figure 3.2: Rig stand for intensity mapping

3.4 TESTING PROCEDURE

Before run the experiment, the instruments setup must be done first. But the most important things before run the experiment is identified the instruments that want to use. The instrument that was identified is laptop with PULSE LABSHOP 11.1 software, Bruej and Kjaer intensity probe, sound intensity calibrator and analyzer. Figure 3.3 shows the instruments setup that been use in the experiment.

Figure 3.3: Instrument setup

3.5 EXPERIMENT PROCEDURE

Experiment procedure is an important part that must be to know first before run the experiment. The experiment procedure for setup the experiment is

(i) Sound intensity probe is connecting to the port at analyzer using cable that was provided.

(ii) Connect the transducer to the port at sound intensity probe.

(iii) Connect the laptop with PULSE LABSHOP 11.1 software to analyzer using LAN cable.

(iv) Place the microphone at rig. Run the experiment and take the data that will show in laptop.

(v) Repeat the experiment for different point at rig.

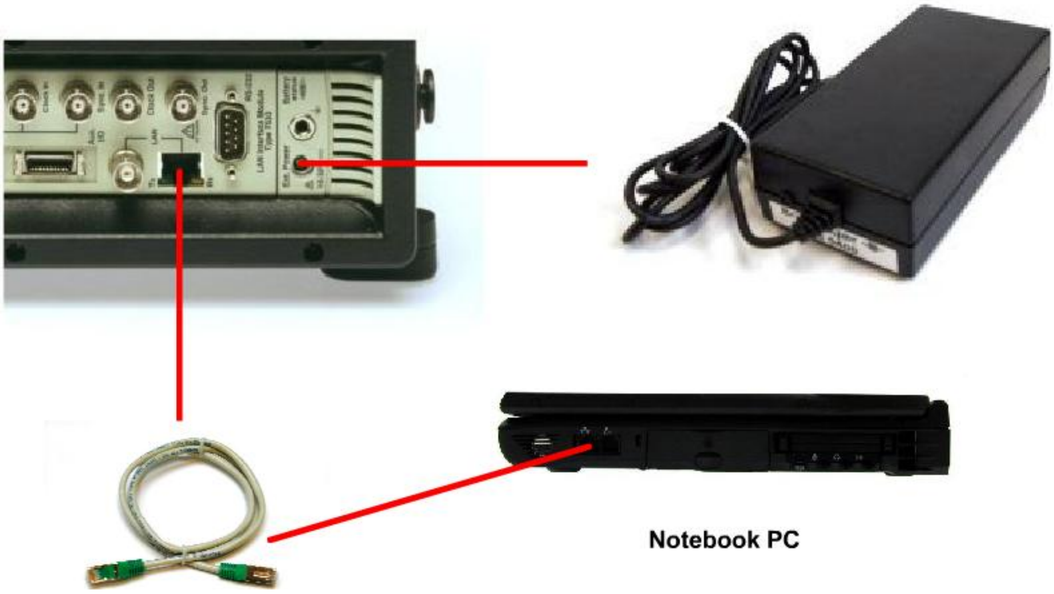


Figure 3.4: Connecting the front-end

Figure 3.5: Power on button

3.6 CALIBRATION OF SOUND INTENSITY PROBE

Before run the experiment, the calibration of sound intensity probe must be test first to get the best result. The calibration of sound intensity probe shows in Figure 3.6.

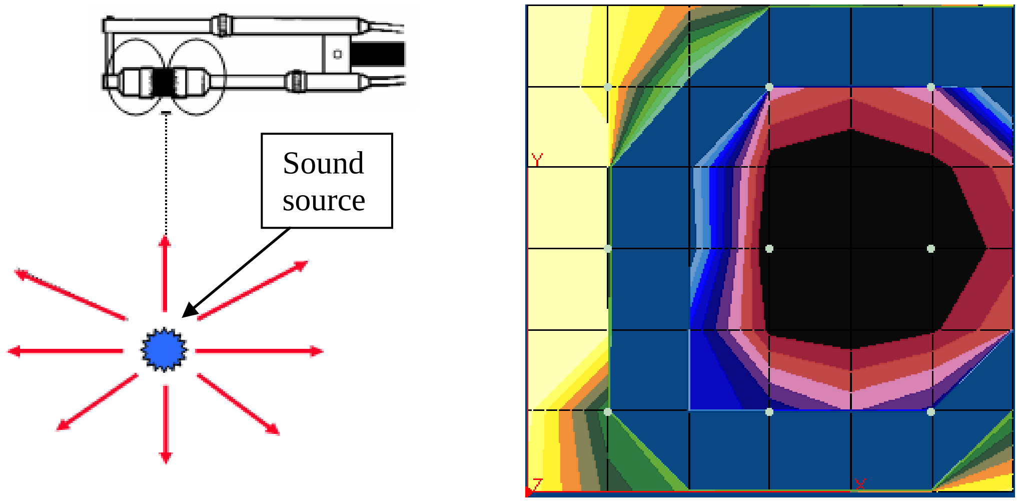
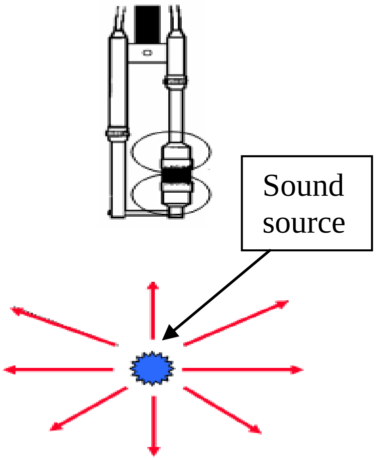


Figure 3.6: The calibration of perpendicular sound intensity probe

From the Figure 3.6, the direction of sound intensity probe will affect the result for sound intensity mapping. As indicated in Figure 3.6, the result for perpendicular calibration is not perfect. The source of noise is placing at the center of rig but from the color contour at Figure 3.6 is at the left side. So need to change the direction of sound intensity probe. The test for sound intensity probe is carried out using a hand phone as source of noise. The direction of sound intensity probe is change. The result for the parallel of sound intensity probe direction is:



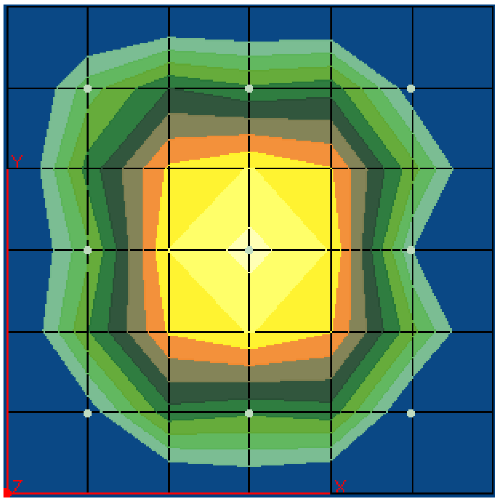


Figure 3.7: The calibration of parallel sound intensity probe

Base on the result for testing of the direction of sound intensity probe, the direction of the sound intensity probe that wants to use for this experiment same as in Figure 3.7.

3.7 DATA ANALYSIS

After the experiment was finish, the data can be interpreted by looking the color of the contour graph to know which part that produces the major source of noise. The graph amplitudes versus frequency must be plot to analyze where the major source of noise at hydraulic bench. The data is interpreted by looking the color of the graph base on frequency that produces higher level of decibel reading.

3.8 NOISE REDUCTION METHOD

There are many methods to reduce noise at hydraulic bench. But the main point that must to know first is the main source of noise that was produce from hydraulic bench. Logically, the main source of noise is generating by pump at hydraulic bench, but we can not think logically without any evidence. So we must provide many methods as a back up plan if the main source of noise is not come from hydraulic bench pump. The noise reduction method that will use is pump enclosure.

3.8.1 Pump Enclosure

This method will be use when the major of noise source is at pump. The material that will be use is fiber and egg tray. Firstly, shape the fiber according to egg tray shape. It shows in Figure 3.8. After that, the pump is coating with combination of fiber and egg tray that was shaped. After pump is already coat, the level of noise that produces from the hydraulic bench pump is checked. Combination fiber and egg tray is shown in Figure 3.8.

Figure 3.8: Combination fiber and egg tray

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

In this section, all the result is display and interpreted. Software that was use to get the result is PULSE LABSHOP 11.1. PULSE LABSHOP is software that can record all intensity information. To get better result, the experiment was repeated for many times and each data taken is compare for each experiment.

4.2 DATA ANALYSIS BEFORE NOISE REDUCTION

Analysis source of noise was carried out using sound intensity technique for front side, left side, right side, and rear side of hydraulic bench. The result from the experiment are show in Figure 4.1 to 4.8 and table 4.1 to 4.8.

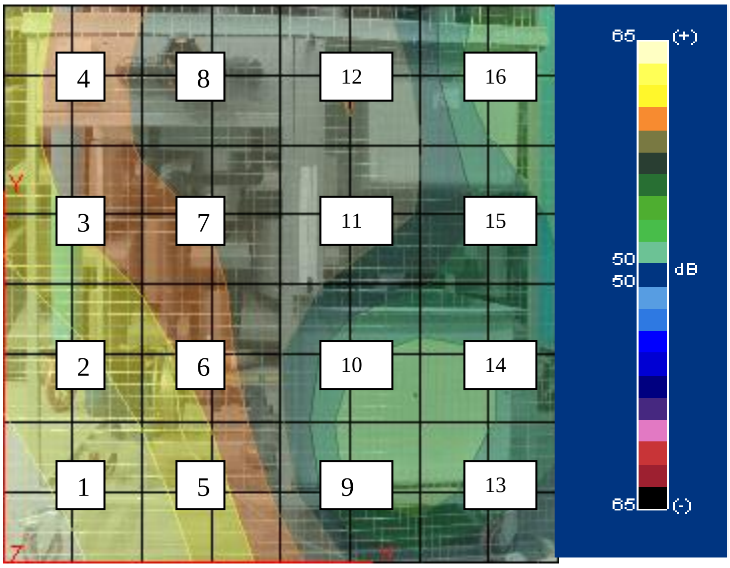


Figure 4.1: Sound intensity mapping for front side

The contour colour at Figure 4.1 represents the value of sound power. For the yellow contour colour at Figure 4.1 represent the highest part at hydraulic bench that produce sound power. As indicated in Table 4.1, the range value of sound power for front side is about 53.590dB to 64.319dB and the highest value sound power that produces from hydraulic bench for front side is 64.319dB where the location is at point 1. The value of sound power produced is determined by placing the cursor at each point after the mapping was done.

Table 4.1: Value for each point sound power produced for front side.

Point	Sound power(dB)
1	64.319
2	63.348
3	61.326
4	60.995
5	62.196
6	60.688
7	59.875
8	58.904
9	55.033
10	55.781
11	59.537
12	60.090
13	56.305

Table 4.1: Continued

Point	Sound power(dB)
14	55.446
15	56.665
16	53.590

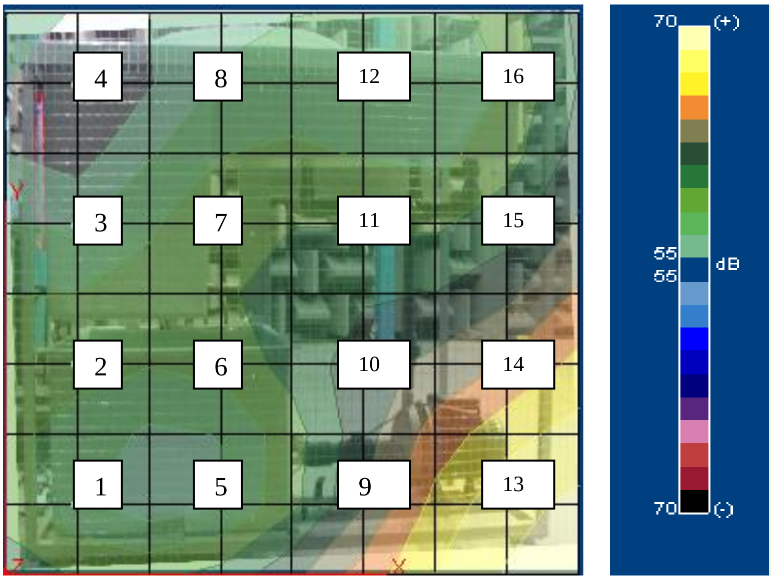


Figure 4.2: Sound intensity mapping for rear side

For the rear side of hydraulic bench, yellow contour colour at Figure 4.2 represent the highest part at hydraulic bench that produce sound power. As indicated in Table 4.2, the range value of the sound power for rear side is 52.455dB to 68.031dB and the highest value sound power that produces from hydraulic bench for front side is 68.031dB where the location is at point 13. The value of sound power produced is determined by placing the cursor at each point after the mapping was done.

Table 4.2: Value for each point sound power produced for rear side.

Point	Sound power(dB)
1	56.716
2	58.601
3	56.287
4	52.455
5	56.283
6	58.514

Table 4.2: Continued

Point	Sound power(dB)
7	59.117
8	56.715
9	62.417
10	61.868
11	59.415
12	56.773
13	68.031
14	64.108
15	60.304
16	58.128

From the analysis for front and rear side of hydraulic bench, the part that contributes with noise is at hydraulic bench pump. It is not enough with analysis at front and rear side of hydraulic bench to validate that the source of noise comes from hydraulic bench pump. To validate that the source of noise comes from hydraulic bench pump, the test for left and right side of hydraulic bench have been conducted. Same procedures were use for left and right side of hydraulic bench experiment. The result for left and right side are showed.

Figure 4.3: Sound intensity mapping for right side.

Base on contour colour show in the Figure 4.3, for the right side of hydraulic bench, the value of sound power produce is slightly same. As indicated in Table 4.3, the range value sound power for right side of hydraulic bench is about 52.239 dB to 55.138 dB and the highest value sound power that produces from hydraulic bench for right side is 55.138 dB where the location is at point 5. The value of sound power produced is determined by placing the cursor at each point after the mapping was done.

Table 4.3: Value for each point sound power produced for right side.

Point	Sound power(dB)
1	54.316
2	55.019
3	55.033
4	52.371
5	55.138
6	54.891
7	54.714
8	53.209
9	54.996
10	54.434
11	53.511
12	52.239

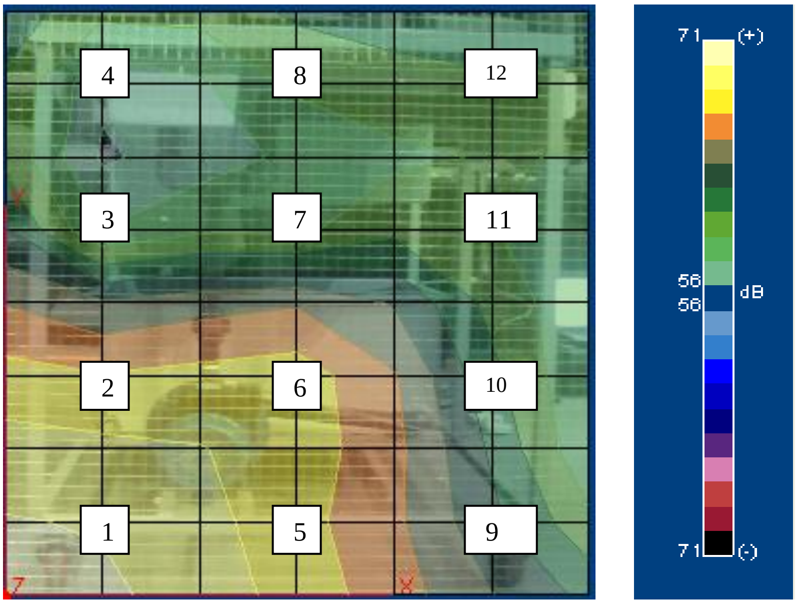


Figure 4.4: Sound intensity mapping for left side.

For the left side of hydraulic bench, yellow contour colour at figure 4.4 represent the highest part at hydraulic bench that produce sound power. The point that contribute to produce high value of sound power at point 1,2,5, and point 6. As indicated in Table

4.4, the range value sound power for left side is 56.328dB to 69.373dB and the highest value sound power that produces from hydraulic bench for front side is 69.373dB where the location is at point 1. The value of sound power produced is determined by placing the cursor at each point after the mapping was done.

Table 4.4: Value for each point sound power produced for left side.

Point	Sound power(dB)
1	69.373
2	66.619
3	57.548
4	56.328
5	67.063
6	67.314
7	58.639
8	59.266
9	62.394
10	60.937
11	59.078
12	60.245

From the analysis of the experiment, we can conclude that the source of noise at hydraulic bench comes from the pump. After the source of noise was identified, the next step can be continuing. The next step is to reduce the noise. The noise reduction will do at the pump of hydraulic bench because the main source of noise is come from pump base on the noise identification experiment.

4.3 DATA ANALYSIS AFTER NOISE REDUCTION

To reduce the noise, egg tray and fiber glass are use. Egg tray only use for shaped the fiber glass to get more surface absorption. The result for noise reduction are showed.

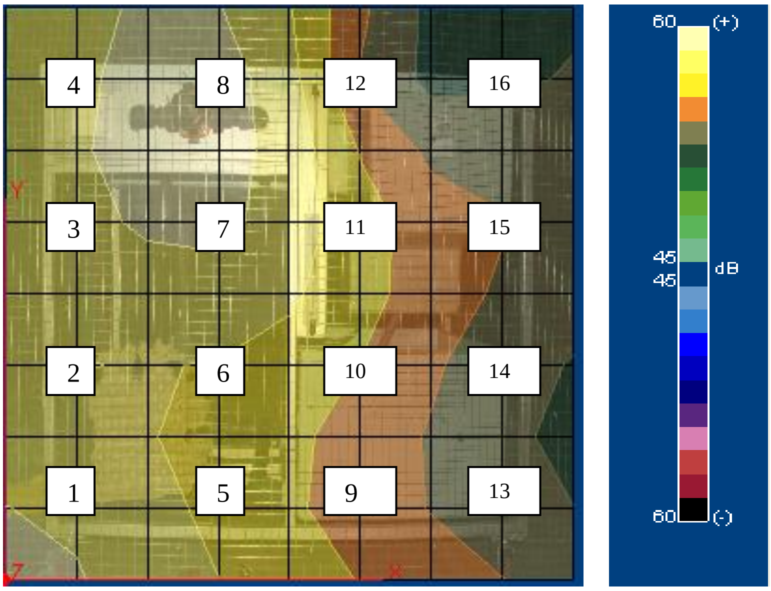


Figure 4.5: Sound intensity mapping for front side after noise reduction process

For the noise reduction analysis at front side, the contour colour at Figure 4.5 represents the value of sound power. As indicated in Table 4.5, the range value of sound power for front side after noise reduction process is about 50.675dB to 56.908dB. To make the comparison, the range value of sound power before noise reduction process is 53.590dB to 64.319dB and the highest value sound power that produces from hydraulic bench for front side before noise reduction process is 64.319dB where the location is at point 1. At point 1, the value of sound power is reducing from 64.319dB to 54.989dB. The value of sound power produced is determined by placing the cursor at each point after the mapping was done.

Table 4.5: Value for each point sound power produced for front side after noise reduction process

Point	**Sound power(dB)**
1	54.989
2	55.823
3	56.490
4	56.782
5	54.164
6	55.060
7	56.908
8	56.547

Table 4.5: Continued

Point	Sound power(dB)
9	53.111
10	53.501
11	53.636
12	53.468
13	51.862
14	52.272
15	52.205
16	50.675

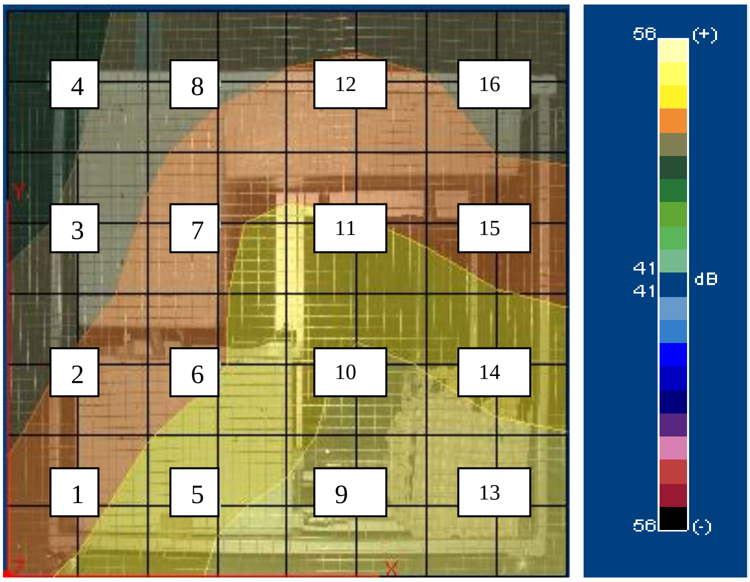


Figure 4.6: Sound intensity mapping for rear side after noise reduction process

After analysis for the front side, the analysis of noise reduction at the rear side was proceeding. As indicated in Table 4.6, the range value of sound power for rear side after noise reduction process is about 50.283dB to 55.625dB. To make the comparison for the rear side, the range value of sound power before noise reduction process is 52.455dB to 68.031dB and the highest value sound power that produces from hydraulic bench for rear side before noise reduction process is 68.031dB where the location is at point 13. At point 13, the value of sound power is reducing from 68.031dB to 55.625dB. The value of sound power produced is determined by placing the cursor at each point after the mapping was done.

Table 4.6: Value for each point sound power produced for rear side after noise reduction process

Point	Sound power(dB)
1	53.015
2	52.195
3	50.658
4	50.283
5	54.914
6	53.334
7	53.368
8	51.655
9	55.154
10	55.222
11	53.623
12	52.260
13	55.625
14	54.486
15	52.455
16	51.778

Figure 4.7: Sound intensity mapping for right side after noise reduction process.

After analysis for the rear side, the analysis of noise reduction at the right side was proceeding. As indicated in Table 4.7, the range value sound power for right side of hydraulic bench is about 50.095dB to 53.123dB. To make the comparison for the right side, the range value of sound power before noise reduction process is 52.239 dB to 55.138 dB and the highest value sound power that produces from hydraulic bench for right side before noise reduction process is 55.138 dB where the location is at point 5. At point 5, the value of sound power is reducing from 55.138 dB to 53.123 dB.The value of sound power produced is determined by placing the cursor at each point after the mapping was done.

Table 4.7: Value for each point sound power produced for right side after noise reduction process

Point	Sound power(dB)
1	51.602
2	50.692
3	51.982
4	51.032
5	53.123
6	51.780
7	52.761
8	51.573
9	52.150
10	51.970
11	51.243
12	50.095

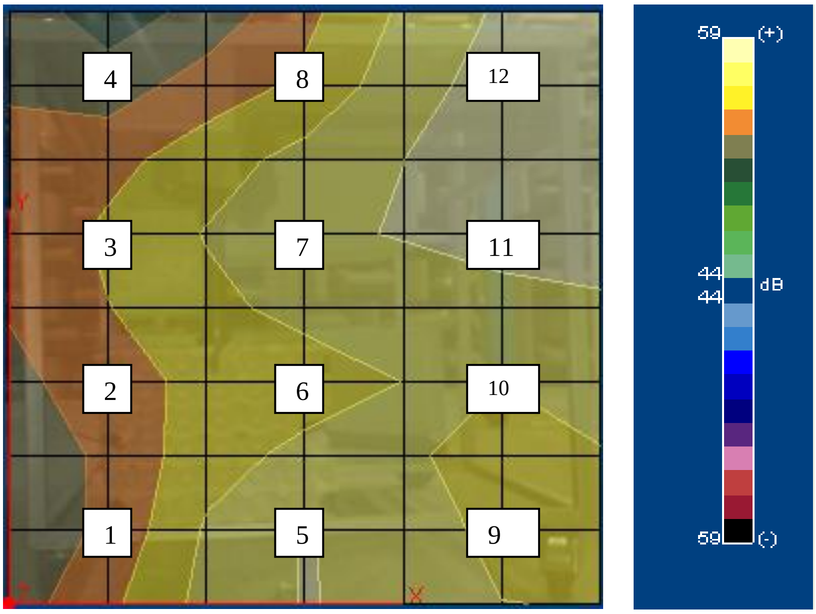


Figure 4.8: Sound intensity mapping for left side after noise reduction process

The last analysis for noise reduction process is at left side was proceeding. As indicated in Table 4.8, the range value sound power for this point is about 52.262dB to 58.128dB. To make the comparison for the left side, the range value of sound power before noise reduction process is 56.328dB to 69.373dB and the highest value sound power that produces from hydraulic bench for front side is 69.373dB where the location is at point 1. At point 1, the value of sound power is reducing from 69.373dB to 53.322dB. The value of sound power produced is determined by placing the cursor at each point after the mapping was done.

Table 4.8: Value for each point sound power produced for left side after noise reduction process

Point	**Sound power(dB)**
1	53.322
2	53.673
3	54.813
4	52.262
5	57.581
6	55.308
7	57.286
8	54.826
9	55.554
10	56.016
11	57.946
12	58.128

4.4 COMPARISON BEFORE AND AFTER NOISE REDUCTION

The value of sound power that was reduces by comparing between before and after noise reduction in this experiment. The comparisons between before and after noise reduction are shown in the table 4.9.

Table 4.9: Comparison before and after noise reduction for front side.

Point	Before	After	Point	Before	After
1	64.319	54.989	9	55.033	53.111
2	63.348	55.823	10	55.781	53.501
3	61.326	56.490	11	59.537	53.636
4	60.995	56.782	12	60.090	53.468
5	62.196	54.164	13	56.305	51.862
6	60.688	55.060	14	55.446	52.272
7	59.875	56.908	15	56.665	52.205
8	58.904	56.547	16	53.590	50.675

As indicated in the table 4.9, the highest value sound power that produces from hydraulic bench for front side before noise reduction process is 64.319 dB where the location is at point 1. At point 1, the value of sound power is reducing from 64.319dB to 54.989dB.

Table 4.10: Comparison before and after noise reduction for rear side.

Point	Before	After	Point	Before	After
1	56.283	53.015	9	62.417	55.154
2	58.514	52.195	10	61.868	55.222
3	59.117	50.658	11	59.415	53.623
4	56.715	50.283	12	56.773	52.260
5	56.716	54.914	13	68.031	55.625
6	58.601	53.334	14	64.108	54.486
7	56.287	53.368	15	60.304	52.455
8	52.455	51.655	16	58.128	51.778

As indicated in table 4.10, the highest value sound power that produces from hydraulic bench is 68.031dB where the location is at point 13. At point 13, the value of sound power is reducing from 68.031dB to 55.625dB.

Table 4.11: Comparison before and after noise reduction for right side.

Point	Before	After	Point	Before	After
1	54.316	51.602	7	54.714	52.761
2	55.019	50.692	8	53.209	51.573
3	55.033	51.982	9	54.996	52.150
4	52.371	51.032	10	54.434	51.970
5	55.138	53.123	11	53.511	51.243
6	54.891	51.780	12	52.239	50.095

As indicated in table 4.11, the highest value sound power that produces from hydraulic bench before noise reduction process is 55.138 dB where the location is at point 5. At point 5, the value of sound power is reducing from 55.138 dB to 53.123 dB.

Table 4.12: Comparison before and after noise reduction for left side.

Point	Before	After	Point	Before	After
1	69.373	53.322	7	58.639	57.286
2	66.619	53.673	8	59.266	54.826
3	57.548	54.813	9	62.394	55.554
4	56.328	52.262	10	60.937	56.016
5	67.063	57.581	11	59.078	57.946
6	67.314	55.308	12	60.245	58.128

As indicated in table 4.12, the highest value sound power that produces from hydraulic bench is 69.373dB where the location is at point 1. At point 1, the value of sound power is reducing from 69.373dB to 53.322dB.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter, all about the research that was explained in the previous chapter are summarized and some recommendation also provides to enhance the result of the experiment for future research.

5.2 CONCLUSION

Noise generated by hydraulic bench was measured with a view to find out the main source of noise. The main source of noise at hydraulic bench that was identified is at pump. The noise reduction was doing due to the main source of noise at hydraulic bench. Egg tray and fibre is use as the material for the noise reduction. The value of the sound power produced before and after noise reductions were done at hydraulic bench. For the front side, the value of sound power is reducing from 64.319dB to 54.989dB. For the rear side, the value of sound power is reducing from 68.031dB to 55.625dB. For the right side, the value of sound power is reducing from 55.138 dB to 53.123 dB. For the left side, the value of sound power is reducing from 69.373dB to 53.322dB. From the overall result, the noise can be reducing up to 15 dB. With full commitment and many trials, finally this project is completed successfully and achieved its objectives.

5.3 RECOMMENDATION

From the result at chapter 4, it has little defects. Maybe it related to the setup of the experiment. Below are some recommendation for experiment noise source identification using sound intensity probe.

(i) Use machine control to make fast test and to get accurate data.
(ii) Noise reductions not only do at part that contributes to main source of noise.
(iii) The temperature of pump must take before and after the egg tray placed to pump.
(iv) Use different material for sound absorbent. The material that will be choose must easy to get and cheap
(v) The material for noise reduction must easy to replace and not disturb the performance of pump
(vi) Design the material for noise reduction to have more surface absorption

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APPENDIX A1

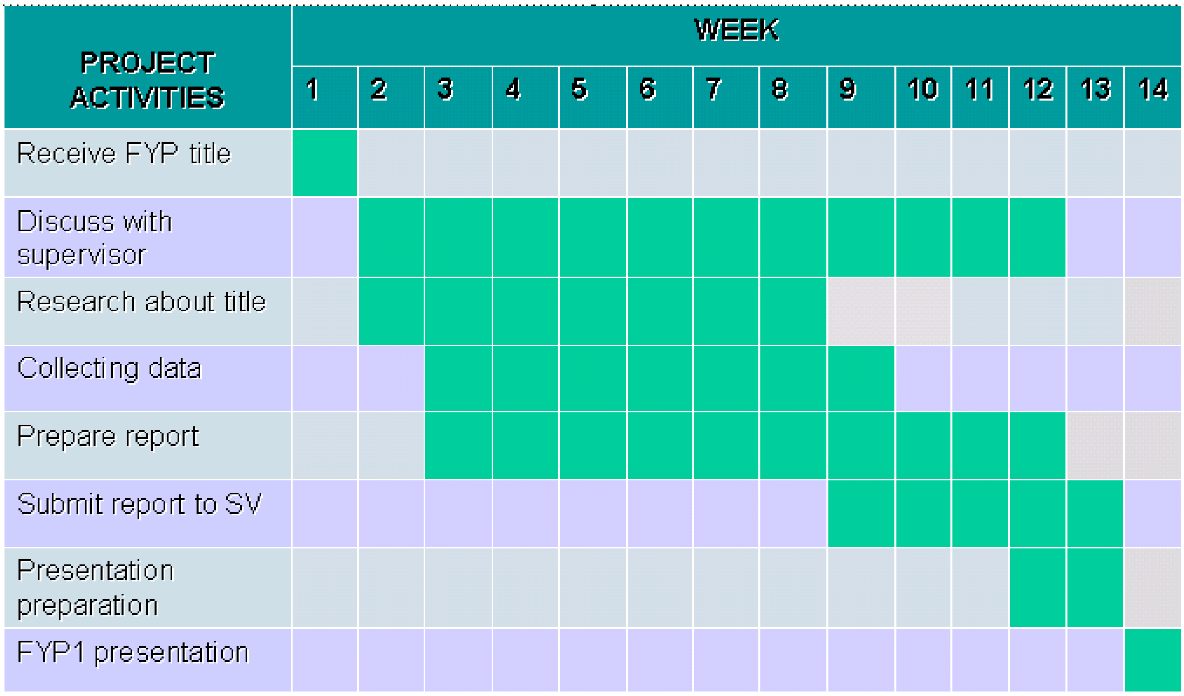

Figure : Gantt Chart for FYP 1

APPENDIX A2

PROJECT ACTIVITIES	WEEK														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Discuss with supervisor															
Run the experiment															
Collecting data															
Prepare report															
Submit draft 1 to SV															
Presentation preparation															
Submit draft 2															

Figure : Gantt Chart for FYP 2