INDUSTRIAL VIBRATION AND NOISE ANALYSIS OF CONVENTIONAL DRILLING MACHINE ON DIFFERENT TYPE OF MATERIALS

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ABSTRACT

Nowadays, machines used everywhere in the industry from the basic level of industry until large industry. These machines as well as drilling machine will produce vibration and noise either in low or high frequency. Using the specific way, the vibration and noise data can be collected and the next step the data can be very useful to control the behavior of the machines. This thesis present the way of collecting the vibration and noise data by using specific software and device. The Pulse LabShop version 11.1 will be used to develop the interface and to obtain the data acquired between computer and the drilling machine by using sensors. The data produces when drilling operation will convert into the velocity spectrum and sound mapping. As a result, the vibration and noise data will be used as the guide to monitor a machine especially in condition monitoring.

ABSTRAK

Pada masa sekarang, di industri, mesin digunakan dimana-mana daripada industri tahap asas sehingga industri yang besar. Mesin-mesin ini seperti mesin gerudi akan menghasilkan getaran dan bunyi bising sama ada frekuensi rendah ataupun tinggi. Dengan menggunakan cara yang spesifik, data gegaran dan bunyi bising ini boleh diperoleh dan seterusnya data ini mungkin sangat berguna untuk mengawal kelakuan mesin-mesin ini. Tesis ini akan mendedahkan cara untuk mengumpulkan data gegaran dan bunyi bising ini dengan menggunakan alatan dan perisian tertentu. Pulse LabShop versi 11.1 akan digunakan untuk membina satu ruang hubung kait dan memperoleh data yang diperlukan antara komputer dan mesin gerudi dengan menggunakan sensor. Data yang dihasilkan semasa menggerudi akan ditukarkan kepada spektrum halaju dan pemetaan bunyi. Sebagai keputusannya, data gegaran dan bunyi bising ini akan digunakan sebagai panduan untuk pemerhatian pada mesin terutamanya untuk pemerhatian keadaan.

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LIST OF SYMBOLS

m	-	millimeter
n	-	nanometer
dB	-	decibel

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CHAPTER 1

INTRODUCTION

1.1 What is Machine Vibration?

Machine vibration is simply the back-and-forth movement of machines or machine components. Any component that moves back and forth or oscillates is vibrating [1].

Machine vibration can take various forms. A machine component may vibrate over large or small distance, quickly or slowly, and with or without perceptible sound or heat. Machine vibration can often be intentionally designed and so have a functional purpose [1]. At other time machine vibration can be unintended and lead to machine damage. Not all kind of machine vibration is undesirable. For example, conveyors, surface finisher and compactors are often used in the industry.

1.2 Sound and Noise

Sound is defined as any pressure variation that the ear can detect ranging from the weakest sounds to sound levels which can damage hearing [2].

The study of sound is called Acoustics and covers all fields of sound production, sound propagation and sound reception, whether created and received by human beings or by machines and measuring instruments.

Noise is an avoidable part of everyday life and technological development has resulted in an increase in noise level from machines. Before noise measurements are undertaken, it is important to be familiar with the terminology and the basic principles of sound measurement.

1.3 Problem Statement

Vibrations will occur when there are forces applied onto structures and machines. Vibration or oscillation is the any motion that repeats itself after an interval of time [3]. Besides, vibration also results in noise and hence, noise and vibration problems are inter-related. This phenomenon will leads to excessive deflections and failure.

Vibration signals from machining processes contain very useful information and offer excellent possibilities for the analysis. Therefore, the vibration and noise analysis will be carried out on one of the machines which are the conventional drilling machine to collect the signals and perform the analysis of the particular results.

1.4 Objectives

The objectives of this project are state as below:

1.4.1 To study and make an analysis on vibration and noise when conventional drilling machine operated.

1.4.2 To differentiate between the analysis result of two different types of materials: Aluminum and Steel.

1.5 Scopes

In order to ensure the project is always on track with its objective, the scope of the project has been determined as follows:

(a) Perform the study on the vibration and noise signals on the conventional machine.

(b) Prepare the materials that will be used which are Aluminium and Steel for the work piece.

(c) Prepare the machine and the parameter for the drilling operation for the Pillar drills GDM120BX and based on drill diameter and drill depth.

(d) Collect the vibration and analysis data by using Accelerometer and Sound Intensity device and transform into waveform by FFT analyzer.

(e) Analyze the result and compared all of the results.

1.6 Chapter Outline

Chapter 1 – This chapter explain about introduction of the project, in this chapter also include the objective and scope of the project.

Chapter 2 – This chapter discussed on the literature review of the vibration and noise signals for the analysis, the characteristic and also the measurement instrument that will be used in the analysis. This study is based on the journal and text books.

Chapter 3 – This chapter provides the project methodology for the whole project progress which includes the vibration testing for drilling machine. This chapter also includes the flow chart of the project according to Gantt chart.

Chapter 4 – This chapter shows the result and analysis of the testing in the project.

Chapter 5 – This chapter will conclude the analysis and the whole project.

CHAPTER 2

LITERATURE REVIEW

2.1 Vibration and Noise Study

Most human activities involve vibration in one form or other. For example, we hear because of our eardrums vibrate and see because light waves undergo vibration. Breathing is associated with the vibration of lungs and walking involves (periodic) oscillatory motion of legs and hands. We speak due to the oscillatory motion of larynges (and tongues). In recent times, many investigations have been motivated by the engineering applications of vibration, such as the design of machines, foundations, structures, engines, turbines, and control systems [4].

Naturally, the structures designed to support heavy centrifugal machines, like motors and turbines, or reciprocating machines, like steam and gas engines and reciprocating pumps, are also subjected to vibration. In all these situations, the structure or machine component subjected to vibration can fail because of material fatigue resulting from the cyclic variation of the induced stress [4]. Furthermore, the vibration causes more rapid wear of machines parts such as bearings and gears and also creates excessive noise. In machines, vibration causes fasteners such as nuts to become loose. In metal cutting processes, vibration can cause chatter, which leads to a poor surface finish.

Whenever the natural frequency of vibration of a machine or structure coincides with the frequency of the external excitation, there occurs a phenomenon known as resonance, which leads to excessive deflections and failure [4]. Because of the devastating effects that vibrations can have on machines and structures, vibration testing and analysis has become a standard procedure in the design and development of most engineering systems. The vibration and noise generated by machines causes annoyance to people and, sometimes, damage to property.

A body is said to vibrate when it describes an oscillating motion about a reference position. The number of times a complete motion cycle takes place during the period of one second is called the Frequency and is measured in Hertz (Hz)[6].

The motion can consists of a single component occurring at a single frequency, as with a tuning fork, or of several components occurring at different frequencies simultaneously, as for example, with the piston motion of an internal combustion engine.

2.2 Vibration Signals

Vibration signals in practice usually consist of very many frequencies occurring simultaneously so that we cannot immediately see just by looking at the amplitude-time pattern, how many components there are, and at what frequencies they occur.

These components can be revealed by plotting vibration amplitude against frequency. The breaking down of vibration signals into individual frequency components is called frequency analysis, a technique which may be considered the cornerstone of diagnostic vibration measurements.

When frequency analyzing machine vibrations we normally find a number of prominent periodic frequency components which are directly related to the fundamental movements of various parts of the machine. With frequency analysis we are therefore able to track down the source of undesirable vibration.

2.3 Vibration Analysis Procedure

A vibration system is a dynamic system for which the variables such as the excitations (inputs) and responses (outputs) are time-dependent [4]. The response of a vibrating system generally depends on the initial conditions as well as the external excitations. Most practical vibrating systems are very complex, and it is impossible to consider all the details for a mathematical analysis. Only the most important features are considered in the analysis to predict the behavior of the system under specified input conditions. Often the overall behavior of the system can be determined by considering even a simple model of the complex physical system. Thus the analysis of a vibrating system usually involves mathematical modeling, derivation of the governing equations, solution of the equations, and interpretation of the results.

2.4 Vibration and Noise: Cause and Effect

Vibration and noise in the environment or in industry are caused by particular processes where dynamic forces excite structures [5].

The effects of vibration and noise range from annoyance, fatigue and reduced comfort, to safety and even health hazards. On machines, vehicles and buildings the effect may be wear, reduced performance, faulty operation or any degree of irreversible damage.

Vibration and noise are closely related. Noise is simply part of the vibrational energy of a structure transformed into air pressure variations. Most vibration and noise problems are related to resonance phenomena. Resonance occurs when the dynamic forces in a process excite the natural frequencies, or modes of vibration, in the surrounding structures.

2.5 How to describe Machine Vibration

We can sometimes roughly determine the severity of the vibration by watching, feeling and listening. We may observe that certain kinds of machine vibration appear "rough", others "noticeable", and yet others "negligible". We can also touch a vibrating bearing and feel that it is "hot", or hear that is "noisy", and so conclude that something is going wrong.

Describing machine vibration with these general terms is however imprecise and depends on the person making the assessment [1]. What appears rough to one person may appear acceptable to another. Verbal description is usually unreliable.

The two most important numerical descriptors of machine vibration are:

2.5.1 Amplitude
2.5.2 Frequency

2.5.1 Amplitude

The amplitude of vibration is the magnitude of vibration. A machine with large vibration amplitude is one that experiences large, fast, or forceful vibratory movements. The larger the amplitude, the more movement or stress is experienced by the machine, and the more prone the machine is to damage. Vibration amplitude is thus an indication of the severity of vibration [1].

In general, the severity or amplitude of vibration relates to:

(i) The size of the vibratory movement
(ii) The speed of the movement
(iii) The force associated with the movement

In most situations, it is the speed or velocity amplitude of a machine that gives the most useful information about the condition of machine.

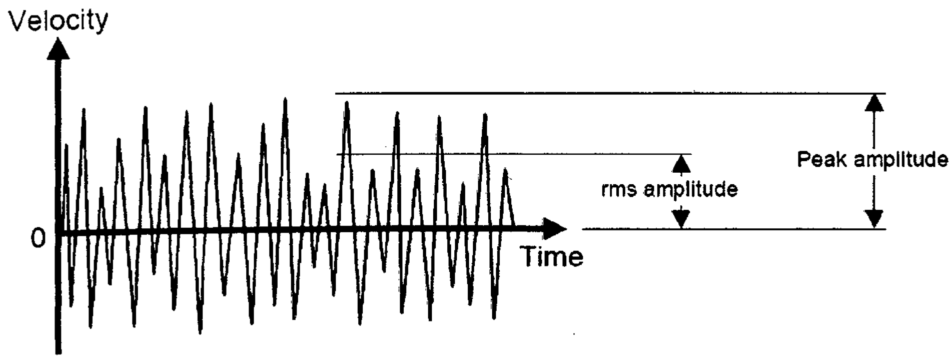

Figure 2.1: Velocity Amplitude

2.5.2 Frequency

A vibrating machine component oscillates, that is, it goes through repeated cycles of movement. Depending on the force causing the vibration, a machine component may oscillate rapidly and slowly. The rate at which a machine component oscillates is called its oscillation or vibration frequency [1]. The higher the vibration frequency, the faster the oscillation.

The frequency of a vibrating component is determined by counting the number of oscillation cycles that are completed every second. For example, a component going through 5 vibration cycles every second is said to be vibrating at a frequency of 5 cycles per second. Frequency, as with amplitude, is always expressed with a unit. Commonly used frequency units are cps (cycles per second), Hz (Hertz), and cpm (cycles per minute). Hertz is a unit equivalent to "cycles per second". One Hz is equal to one cps, or 60 cpm.

2.6 Vibration Analysis Instrument

Before a vibration measurement can be taken, a vibration sensor that can detect vibration behavior needs to be attached to the machine that is being measured. Various types of vibration sensors are available, but a type called accelerometer is normally used, as it offers advantages over other sensors. An accelerometer is a sensor that produces an electrical signal that is proportional to the acceleration of the vibrating component to which the accelerometer is attached [1].

The acceleration signal produced by the accelerometer is passed on to the instrument that in turn converts the signal to a velocity signal. Depending on the user's choice, the signal can be displayed as either a velocity waveform or a velocity spectrum. A velocity spectrum is derived from a velocity waveform by means of a mathematical calculation known as the Fast Fourier Transform or FFT.

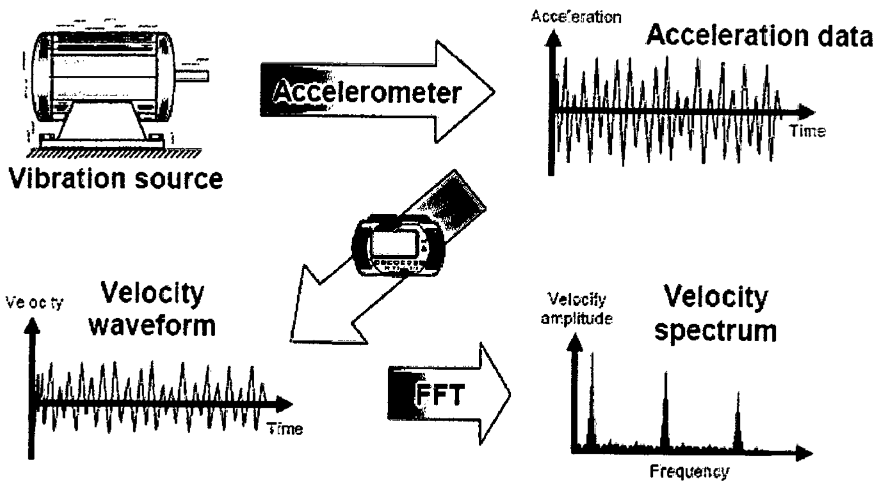

Figure 2.2 How Vibration Data is Acquired

Most machines involve rotary mechanisms. Motors, pumps, compressors, fans, belt conveyors, gearboxes, all involve rotary mechanisms and are frequently used in machines. Most rotary mechanisms in turn have bearings that support the weight of rotary parts and bear the forces associated with rotary motion and vibration. In general, large amounts of force are borne by bearings. It is not surprising that bearings are often the place where damage occurs and where symptoms first develop. Vibration measurements are thus usually taken at the bearings of machines with accelerometers mounted at or near the bearings.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will introduces the method and procedures that will be used during the whole experiment process, starting from the preparation of machine, tools and work piece, the drilling test, data collection and finally, analyzing the data and results. However, the discussed methods here are not yet been performed, as it is only recommended way to perform the experiment based on few references and recommendations. Thus, it can be modified later and will be set to permanent only after the experiment has been performed.

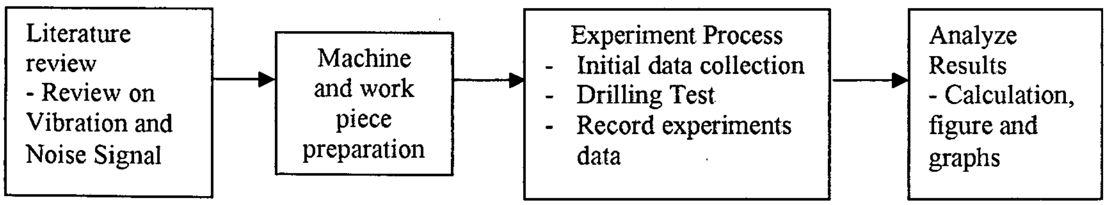

Figure 3.1 Methodology Flow for the Project

3.2 Literature Review

Vibration and noise signals carry a great deal of information about system condition. The vibration signatures of machines processes have been investigated as potential sources for an in-process monitoring tool [1]. Vibration monitoring presents a unique and attractive opportunity for condition monitoring. The purpose of the project literature review is to study the vibration and noise signal produce by the Conventional Drilling Machine. The objective and scopes of the project must be cleared first and the problems involved that needs the experiment to be executed must be determined. Before proceeding with the drilling test, the work piece that will be used and the parameter of testing must be specified first.

3.3 Machine Set Up and Specification

The Machine that will be used in the project analysis must related to the vibration problem and signals. The machine that will be used in the project experiment is drilling machine which is Pillar Drill Model GDM120BX. These 16 speed drills are suitable for light industrial, agricultural and woodworking applications. Each drill is fitted with a flip-up safety guard and 'No-Volts Release' switches which prevents accidental restart after a mains power interruption. A rack and pinion feed shaft with preset depth control for repetitive work is also included. Work clamps, vices and mortising attachments are available for these drills.

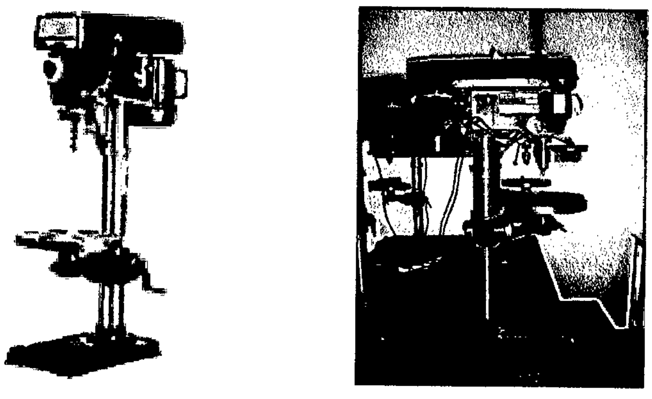

Figure 3.2 Pillar Drill Machine Model GDM120BX

The technical specifications are stated as follows:

Table 3.1: Technical Specifications for Pillar Drills GDM120BX

Model	GDM120BX
Chuck Size (mm)	16
Spindle Nose Taper	MT2
Swing (mm)	394
Chuck to Upright Face (mm)	162
Spindle Travel (mm)	80
Number of Speeds	16
Speed Range (rpm)	210-3340
Spindle to Table – max. (mm)	460
Spindle To Base – max. (mm)	640
Working Table Diameter (mm)	310
Working Base (mm)	200 × 185
Overall Base (mm)	420 × 250
Column Diameter (mm)	70
Overall Height (mm)	1000
Collar Diameter (mm)	55
Voltage (AC)	230
Motor (Watts)	550

(Instruction Manual for Pillar Drills by Sealey Quality Machinery)

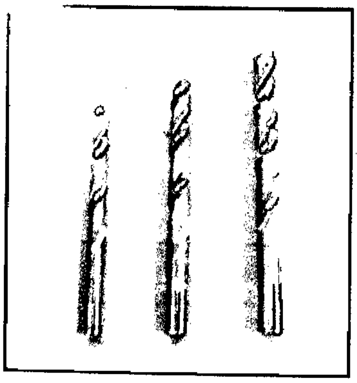

Figure 3.3 Drilling Bit and Tools