UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SIGNAL DETECTION FOR CENTRIFUGAL PUMP USING SIGNAL ANALYSIS OF DATA ACQUISITION

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in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this Choose an item. entitled " SIGNAL DETECTION FOR CENTRIFUGAL PUMP USING SIGNAL ANALYSIS OF DATA ACQUISITION " is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours.

Signature : 

Supervisor Name : PUAN SITI NORBAYA BINTI SAHADAN

Date : 31 JAN 2023

DEDICATION

To my beloved parent Che Hamdan Bin Ahmad and Noraini Binti Othman for your patience and absolutely everything with love. To my brother and sister, for their continuous support and encouragement, while I have been away from home.

ABSTRACT

The continuously increasing industrial productivity has resulted in a great breakthrough in the field of maintenance on centrifugal pumps in order to ensure their optimum operation under different operating conditions such as industry and cover a significant percentage of the total energy consumption of a power plant. This fact makes the application of efficient maintenance tools to be of crucial importance and obliges researchers and engineers to develop reliable detection methods for special types of malfunctions, such as cavitation to date, there is limited published information on the application of sound detection to incipient centrifugal failure. The importance of this research is to analyse signal detection for centrifugal pumps using signal analysis of data acquisition using microphone and software analysis. Then, another important thing is identifying the signal behaviour between the sound and vibration condition of the centrifugal pump and comparing the vibrational signal with the sound signal for sound signal reliabilities. In this research, a sample of a centrifugal pump will analyse with a microphone and obtain a sound signal. The analysis obtains the global statistical parameter and signal processing method. The global statistical parameter that uses is kurtosis, skewness, standard deviation, Root Mean Square and crest factor. The signal processing method involves being time domain, frequency domain, and I-Kaz coefficient. This result research will support the advantage of the analysis in the centrifugal pump industry.

ABSTRAK

Produktiviti industri yang terus meningkat telah menghasilkan satu kejayaan besar dalam bidang penyelenggaraan pada pam emparan untuk memastikan operasi optimumnya di bawah keadaan operasi yang berbeza seperti industri dan meliputi peratusan yang ketara daripada jumlah penggunaan tenaga sesebuah loji kuasa. Fakta ini menjadikan penggunaan alat penyelenggaraan yang cekap menjadi sangat penting dan mewajibkan penyelidik dan jurutera untuk membangunkan kaedah pengesanan yang boleh dipercayai untuk jenis kerosakan khas, seperti peronggaan setakat ini, terdapat maklumat yang diterbitkan terhad mengenai penggunaan pengesanan bunyi pada emparan baru. kegagalan. Kepentingan penyelidikan ini adalah untuk menganalisis pengesanan isyarat bagi pam emparan menggunakan analisis isyarat pemerolehan data menggunakan analisis mikrofon dan perisian. Kemudian, satu lagi perkara penting ialah mengenal pasti tingkah laku isyarat antara bunyi dan keadaan getaran pam emparan dan membandingkan isyarat getaran dengan isyarat bunyi untuk kebolehpercayaan isyarat bunyi. Dalam penyelidikan ini, sampel pam emparan akan menganalisis dengan mikrofon dan mendapatkan isyarat bunyi. Analisis memperoleh parameter statistik global dan kaedah pemprosesan isyarat. Parameter statistik global yang digunakan ialah kurtosis, pencongan, sisihan piawai, Root Mean Square dan faktor puncak. Kaedah pemprosesan isyarat melibatkan domain masa, domain frekuensi, dan pekali I-Kaz. Kajian hasil ini akan menyokong kelebihan analisis dalam industri pam emparan.

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CHAPTER 1

INTRODUCTION

1.1 Background

Centrifugal pumps belong to the subclass of dynamic axisymmetric work-absorbing turbomachinery. Centrifugal pumps are used to transfer fluids by converting the kinetic energy of rotation into the hydrodynamic energy of the fluid flow. Typically, engines or electric motors provide the rotational energy. The fluid enters the impeller of the pump along or near the rotational axis and is driven by the impeller, moving radially outward into a diffuser or volute chamber (casing) from which it departs. As with most pumps, a centrifugal pump transforms rotational energy, typically from a motor, into fluid-moving energy.

A fraction of the energy is converted to the fluid's kinetic energy. Fluid enters axially through the casing's eye, is captured by the impeller blades, and is tangentially and radially whirling outward until it exits through all circumferential sections of the impeller and into the diffuser portion of the casing. Passing through the impeller, the fluid gains both velocity and pressure. The casing's doughnut-shaped diffuser or scroll decelerates the flow and further increases the pressure.

Data acquisition requires sensors and data storage, while data analysis for data acquired in the first stage is a postprocessing stage. There are a variety of techniques for detecting failure in rotary machines, including as energy harvesting, time series analysis, and global statistics. In this project, the sound signal is duplicated and employed as a diagnostic indicator for rotary machine failures.

Utilizing microphones and MATLAB computer software, the data gathering procedure begins with the collection and storage of the essential data. Later, the collected and saved data will be reloaded and analysed using the time domain, the frequency domain, and the global statistical analysis. By comparing each of these signals, we may identify the pattern or fault signal that can be utilised to analyse the system's condition without detaching to locate the issue.

1.2 Problem Statement

Power stations, chemical processing facilities, and the petroleum sector all often use centrifugal pumps in their operations. The considerable impact that centrifugal pump failures have on such significant sectors makes them a serious problem. In particular, because the core, pump components, bearings, and impellers are susceptible to different types of corrosion, and because defects in these elements can seriously impair pump performance and result in production failure. Therefore, utilising signal detection of condition-based monitoring to detect these kinds of faults early will give information for prompt preventative action.

The early identification of a variety of fault types is made possible by looking at the vibration excitation noise excitation processes connected with each sort of typical pump issues, such as impeller leakages, impeller blockages, bearing inner race defects, and bearing outrace defects. Subsequently, a range of fault detection analyses, including Wavelet Transform (WT), Kurtosis (K), Time-Domain Analysis, Frequency-Domain Analysis, Envelope Analysis, and modulation signal spectrum, were utilised for fault diagnosis (MSB). All of these techniques can detect and diagnose defects that are manually introduced to the test pump.

From the study's investigation of the vibration signal's mean and root-mean-square (RMS) amplitudes, it was determined that distinct broadband frequency ranges have varied amplitude characteristics. Using a low-frequency band between 1kHz and 2kHz to accurately anticipate cavitation in the pump was demonstrated by the results. By raising the value of vibration amplitude, one can determine the severity of cavitation. It provides a decent indication of the degree of cavitation occurring within a centrifugal pump. Therefore, it is conceivable to employ an accelerometer with a limited frequency range, which would reduce the cost of the sensor in comparison to a sensor with a high frequency range (Al-Obaidi, 2019). According to research on time and domain analysis, even while the analysis of raw measured data provides some initial signs of the presence of cavitation, they cannot serve as an immediate detection criterion. The reason for this is that these signs are obscured by machine noise and cannot be readily observed in the early phases of cavitation formation.

In order to uncover and quantify new information regarding the fault mechanism, its interaction with conditions and machine components. Sound analysis is new development of research to detect failure of centrifugal pump. Sound analysis is non-contact laboratory that can reduce the inability of another vibration analysis and signal analysis. The increase of noise due to failure of centrifugal pump can detect early by the sound signal wit analysing of waveform that obtain after the data is processing and the data acquisition.

Overall, condition-based maintenance signal analysis has contributed to the advancement of centrifugal pump technology. According to the research, even if each signal analysis has drawbacks, it also has many benefits. In CBM, the maintenance approach is determined by correlating experimentally collected data with the asset's real state. Using data classification methods and methodologies, one can determine the relationship between the data and the asset state. New strategies are being rapidly developed to enhance the classifier's

performance. Researchers have attempted to develop a variety of ways to address the issue at hand. The selection of the signal for data collection is of utmost importance for identifying the pressure, acceleration, and motor line defects. Current signals convey the majority of information pertaining to the condition of the centrifugal pump.

1.3 Research Objective

The main aim of this research about signal for centrifugal pump using signal analysis of data acquisition is to:

a) To identify the signal behaviour of sound and vibration analysis of centrifugal pump.

b) To analyse signal detection for centrifugal pump using signal analysis of data acquisition using microphone and software analysis.

c) To compare vibrational signal with sound signal for reliability of sound analysis as a non-destructive technique.

1.4 Scope of Research

The scope of this research are as follows:

- Analyse signal detection for centrifugal pump using signal analysis of data acquisition using microphone and software analysis.
- The microphone is located beside centrifugal pump to provide sound signal that generated to detect abnormal condition.

- The sample of centrifugal pump located at vibration analysis laboratory, factory 1, Technology Campus of Universiti Teknikal Malaysia Melaka (UteM)

1.5 Hypothesis of Research

The study shows that the failure of centrifugal using signal detection can obtain the data acquisition that generated by computer software. The hypothesis of this research are:

- If the sound and vibration signal spectrum show a pattern, then the pattern is analysed.
- If the signal detection obtains abnormal condition of centrifugal pump, then the maintenance need to be schedule.
- If the sound signal and vibration signal obtain same analysis then the data that obtain from research are approved.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A stationary pump casing and an impeller are the two components that make up a centrifugal pump. The main purpose of the pump is to transform the energy given to a prime mover (electric motor) first into kinetic energy (velocity), then into static pressure of the fluid being pumped. The main purpose of the pump is to direct the liquid from the suction nozzle in the centre of the impeller. The purpose of the volute is to gather liquid in the vicinity of the impeller's high speed and, by improving local flow, to gradually reduce fluid velocity. The liquid is then expelled from the pump using the vibration nozzle emissions, which are the most common problem with centrifugal pumps.

The fixed and rotating components of the centrifugal pump are separate components. A bearing, housing, cooling fan, and electric motor make up the stationary component. On the other hand, the spinning section has a shaft and a pump impeller. Based on how they operate, the causes of vibration in the pump may be divided into two categories: hydraulic and mechanical. Seal or bearing friction, as well as vibrations brought on by unbalanced rotating objects, are examples of mechanical causes of vibration. The hydraulic causes of vibration include changes in fluid flow within the pump and contact between rotor blades and stationary parts such guiding vanes and volute tongue.

2.1.1 Working Mechanism of Centrifugal Pump

A centrifugal pump is a machine that may increase the fluid's velocity by converting the electrical energy of an impeller into rotational energy. The diffuser or volute and the impeller, two of the pump's main parts, are in charge of shifting the energy. The rotating part of the motor that converts the motor's potential energy into kinetic energy is called the impeller. The diffuser or volute is a stationary part that converts kinetic energy into pressure energy. Additionally, as shown in Figure 2.1, the presence of the stationary volute tongue converts the fluid's kinetic energy into fluid pressure.

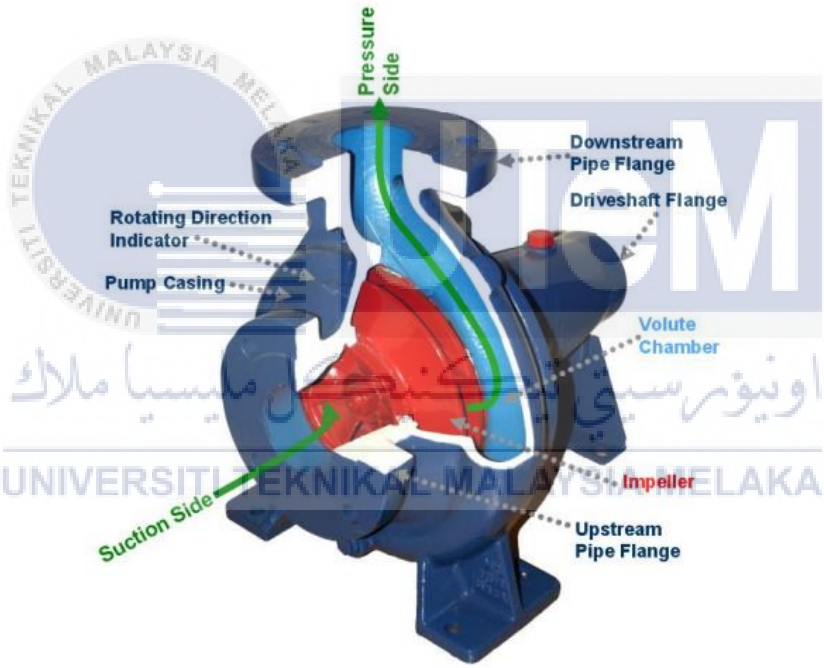

Figure 2.1The liquid flow path inside a centrifugal pump

2.1.2 Component of Centrifugal Pump

A centrifugal pump is a rotating machine that dynamically produces flow and pressure. Whether the design is rotational or reciprocating, the input and output are not separated, much like positive displacement pumps. The fluid is given energy by the centrifugal pump through variations in velocity that take place when it travels through the