DIAGNOSIS OF CENTRIFUGAL PUMP FAILURES USING VIBRATION ANALYSIS

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SUPERVISOR DECLARATION

'I hereby that I read this dissertation and found its content and form to meet acceptable presentation standards of scholarly work for the award of Bachelor of Mechanical Engineering (Design and Innovation) with honours'

Signature :……

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DECLARATION

I hereby, declare this project entitled “
Diagnosis of Centrifugal Pump Failures Using Vibration Analysis
” is the result of my own research except as cited in the reference.

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For my beloved parents, siblings and friends

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ABSTRACT

Condition based maintenance (CBM) or predictive maintenance is the technology to detect early faults before they reach catastrophic failure. It is allow the maintenance personnel to do only the right things, minimizing system downtime, spare parts cost and time spent on maintenance. Vibration analysis is one of the CBM techniques to detect potential failure in dynamic monitoring such as failure in centrifugal pump. This report elaborates on diagnoses the centrifugal pump failure by using vibration analysis. The research tries to establish onset failure of centrifugal pump. The method will be artificially damaging the impeller of the pump gradually and detect the vibration signal produces by the impeller. The experimental procedure is completely prepared which consisting of early of experimental setup for vibration sensor and centrifugal pump until experiment done. The good and deterioration impeller had been used and all the data were be analyzed. This experiment had been conducted on a simple model of centrifugal pump. All of the data had been finalized and the monitoring software had been developed as the warning system for condition based maintenance.

ABSTRAK

Penyelenggaran berdasarkan keadaan atau penyelenggaraan ramalan ialah teknologi untuk mengesan kerosakan mesin pada peringkat awal. Ia membolehkan perancangan penyelenggaraan hanya dilakukan dengan betul, meminimumkan masa peberhentian mesin, kos alat ganti dan masa yang dibelanjakan untuk penyelenggaraan. Analisis getaran merupakan salah satu teknik untuk mengesan kegagalan mesin dalam pemantauan gerakan seperti kegagalan dalam pam empar. Laporan ini menghuraikan tentang diagnosis kegagalan pam empar dengan menggunakan analisis getaran. Penyelidikan yang cuba untuk dikaji ialah kegagalan permulaan pam empar. Kaedah yang digunakan ialah tiruan merosakkan bilah kipas pam secara beransur-ansur dan mengesan isyarat getaran yang terhasil olehnya. Prosedur eksperimen disediakan yang terdiri daripada awal persediaan eksperimen bagi pengesan gegaran dan pam empar sehingga eksperimen dilakukan. Bilah kipas yang baik dan rosak telah digunakan dan semua data telah pun dianalisis. Eksperimen ini telah dijalankan ke atas model pam empar yang ringkas. Semua data yang telah dikaji digunakan bagi perisian pemantauan yang telah dibangunkan sebagai sistem amaran untuk penyelenggaran berdasarkan keadaan.

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LIST OF SYMBOLS

Hz	=	frequency unit
In/s	=	inch per second
m^3/s	=	meter cube per second
N	=	pump speed
Nm	=	newton meter
P	=	pump discharge pressure
Pa	=	Pascal
Pk	=	peak
Q	=	flow rate
Q_T	=	pump theoretical flow-rate
Rev/s	=	Revolution per Second
T_A	=	actual torque delivered to pump
T_m	=	torque motor
W	=	Watt

LIST OF ABBREVIATION

CAD	=	computer aided design
CBM	=	condition based monitoring
Eq	=	equation
FFT	=	Fast Fourier Transform
hd	=	discharge head
hf	=	friction head
hS	=	suction head
ISO	=	international standard organization
NPSH	=	Net Pump Suction Performance
NPSHA	=	Net Positive Suction Head Available
NPSHR	=	NPSH Required
PVC	=	Polyvinyl chloride
RPM	=	revolution per minute
VB	=	Visual Basic

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.0 RESEARCH OVERVIEW

In this chapter, brief introduction on centrifugal pump failure and vibration analysis. Problem statement, objectives, scope and the organization of the report are also highlighted.

1.1 CENTRIFUGAL PUMP FAILURE AND VIBRATION ANALYSIS

A centrifugal pump, also known as a centrifuge pump, uses an impeller as the primary source for its pumping action. The impeller is similar to a fan with a housing that has one small intake and a larger output, which is simply an opening. The impeller is connected to a spinning rotor that must be moved with mechanical power, in order to displace fluid. The impeller is inside a housing that lets fluid escape to a discharge pipe, where the fluid is pushed after being displaced by the impeller.

Vibration problems are most commonly associated with centrifugal pumps. The sources of vibration in centrifugal pumps can be categorized into three types such as Mechanical causes, Hydraulic causes & Peripheral causes. Level of imbalance and the level of misalignment are the important reasons of mechanical and hydraulic causes. The peripheral causes of vibration include Harmonic vibration from nearby equipment or drivers, operating the pump at critical speed. Problems with any of these issues will show up as symptoms, which include higher than normal vibration at certain key frequencies.

1.2 PROBLEM STATEMENT

For many years and in many plants still today, the set of views and theories which machinery system simply run the plant until a machine failed, deal with it and get up and running once again. If machine failed, they were repaired or a spare part was used. Little thought was given to improve equipment reliability or predicting failures. Hence, the maintenance department was a huge cost sink, and that was considered a standard part of running the business.

Include in pumping system, the pump subject to wear, erosion, cavitation, and leakage. Many pumping system problems can result from improper pump selection and operation resulting in severe deterioration of their performance and finally lead to a significant increase of operational and maintenance costs.

Fortunately, there are technologies available that can objectively measure all of these quantities in order to help us diagnose the mechanical condition of machines as well as in centrifugal pump.

As such, there is a need to apply of vibration analysis technique for monitoring the centrifugal pumps. Vibration analysis is convenient and reliable in determining the failures in their early stages and can avoid unscheduled shutdowns and expensive repair costs.

Therefore, this report highlighted the diagnoses of centrifugal pump failure by using vibration analysis.

1.3 RESEARCH OBJECTIVES

In order to accommodate the main concern and challenge stated in the problem statement, the following objectives are set up to be finding the optimum solution. These designated objectives will serve as the basis of the problem solving and also as a guideline and reference in order to complete the study. The objectives are as listed below:

a) To find the onset failure of centrifugal pump.
b) To implement condition monitoring system of centrifugal pump health.
c) To develop an efficient procedure for monitoring and maintaining health of centrifugal pump

1.4 RESEARCH SCOPE

To achieve the above objective, the scope of this work generally involved the following:

a) Research on centrifugal pump application.
b) Use vibration analysis to determine centrifugal pump failure.
c) Use simple model of centrifugal pump for simulation and analysis.
d) Analyze on impeller deterioration.
e) Use a single speed pump motor of 2900 RPM.

1.5 ORGANIZATION OF THE REPORT

The report consists of six chapters, where each chapter represents an important build for general construction of the report.

Chapter one presents an overview and brief introduction on centrifugal pump failure and vibration analysis. Problem statement, objectives and the organization of the thesis are also highlighted.

Chapter two presents a literature review which covered the general information regarding centrifugal pump and application including its general component and impeller types, followed by the literature review on basic principle and performance of centrifugal pump. In addition, an overview of centrifugal pump problem is provided in this chapter. Information of vibration analysis is also discussed in detail. The last section then consists of the measuring vibration and it benefit.

Chapter three presents about the project methodology used in this study. Section one described two main equipment that been used throughout this research. Next section is the explanation on experimental work which starting with list of apparatus, vibration analysis procedure, the condition of impeller and lastly the performance analysis procedure. Next the data collection will finalize and develop monitoring software by using software. Then it is followed with the schematic flow diagram which showing the overall activities carried out in this research.

Chapter four presents the experimental results and discussion consisting of five main sections with starting with spectrum analysis description. Next section is result from the vibration analysis and the result from the performance analysis. Than the section show the monitoring system from the Visual Basic software and the last section is developing an efficient procedure for health monitoring system to detect fault in centrifugal pump.

Chapter five presents on how to perform high quality maintenance on the equipment. Firstly, the primary focus should be to increase on pump reliability, thus decreasing maintenance time and costs which is started from proper installation steps, processing vibration monitoring steps, and reassemble step. The result is improved uptime and profits.

Chapter six finally presents the conclusions that reflect the achievements of all the objectives which were obtained throughout the study as well as the recommendations for the future research. These recommendations offered the significance and importance related to the present research.

CHAPTER 2

LITERATURE REVIEW

2.1 CENTRIFUGAL PUMP

Centrifugal pumps is a kinetic device used to move fluids which is transport fluids and liquids through piping systems that come from one reservoir or tank to a different reservoir or tank. This pump also considered to be roto-dynamic pumps because they operate via a revolving rotary impeller. One of the simplest components of equipment is centrifugal pump in process plant [1].

The mechanical energy is converting to hydraulic energy by the centrifugal force of the impeller blade for handling fluid to get a certain height or place [2].

2.1.1 Principle of Centrifugal Pump Work

A centrifugal pump is a kinetic device which is liquid entering the pump receives kinetic energy from the rotating impeller. The input power of centrifugal pump is the mechanical energy. The electrical motor is use to drive shaft driven by the prime mover or small engine and the output energy is hydraulic energy of the fluid being raised.