ANALYSIS OF INDUCTION MOTOR PERFORMANCE AND ITS EFFICIENCY AT SAMB WATER TREATMENT PLANT

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This report is submitted
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DECLARATION

I declare that this project report entitled “Analysis of Induction Motor performance and its efficiency at SAMB water treatment plant.” is the result of my own work except as cited in the references

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Maintenance).

Signature :. .....

Name of Supervisor : .....

Date : .....

DEDICATION

"This thesis was dedicated especially to my beloved mother and father"

ABSTRACT

Energy efficiency is an important issue in the water pumping system. There are several ways to reduce energy costs in pumping applications. This report proposes a strategy to improve water pumping system performance by analyzing the pumping system curve and the performance of induction motor regarding of pumping system. The main advantage of the strategy is the capability of the simulated model to compute the overall pumping performance and estimate the saving on the electrical consumption. The first, and probably most important, is the application design. Well-designed systems are usually providing better performance in achieving the requirement. Secondly, motor efficiency can also have a significant impact and could reduce the energy consumption for a required water demand. Both combination of application design and motor efficiency could significantly increase the performance and reduce electrical consumption. To test the effectiveness of the proposed strategy, a numerical software simulator is set-up to emulate the actual existing pumping parameters and conditions, namely designed water demand, piping system and pump curve. The system curve and pump curve help to determine the best operating point and the best efficiency of the water pumping system. The finding of this study will help Syarikat Air Melaka Berhad (SAMB) to improve the pumping performance and hence reduces the energy lose.

ABSTRAK

Kecekapan tenaga adalah isu-isu penting dalam sistem pengepaman air. Terdapat beberapa cara untuk mengurangkan kos tenaga dalam aplikasi pengepam. Laporan ini mencadangkan satu strategi untuk meningkatkan prestasi sistem pengepaman air dengan menganalisis lengkung sistem pengepam. Kelebihan utama strategi ini adalah keupayaan model simulasi untuk mengira prestasi pam keseluruhan dan menganggarkan penjimatan kepada penggunaan elektrik. Yang pertama, dan mungkin yang paling penting, adalah reka bentuk aplikasi. Sistem yang direka dengan baik biasanya memberikan prestasi yang lebih baik dalam mencapai keperluan. Kedua, kecekapan motor juga boleh mempunyai kesan yang signifikan dan dapat mengurangkan penggunaan tenaga untuk permintaan air yang diperlukan. Kedua-dua gabungan aplikasi reka bentuk dan kecekapan motor ketara boleh meningkatkan prestasi dan mengurangkan penggunaan elektrik. Untuk menguji keberkesanan strategi yang dicadangkan, perisian simulator berangka adalah penyediaan untuk mencontohi parameter pengepam sebenar yang sedia ada mengikut keadaan sistem, permintaan air yang direka, sistem paip dan lengkung pam. Lengkung sistem dan lengkung pam membantu untuk menentukan titik operasi terbaik dan kecekapan yang terbaik daripada sistem pam air. Dapatan kajian ini akan membantu Syarikat Air Melaka Berhad (SAMB) untuk meningkatkan prestasi pam dan dengan itu mengurangkan pembaziran tenaga.

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CHAPTER 1

INTRODUCTION

1.1 Background

Water pumping system is a system to deliver water from water tank to reservoir. There is a lot of component needed when to deliver water through the system. Water pump and induction motor need to be powerful enough to deliver the water because water pressure will affect the smoothness of pumping system. The design use in system should match with the specification required by the SAMB. To delivering water in system, the selection motor pump required should be in high efficiency to avoid losses. Inability to follow a best application design will lead to motor inefficiency and hence will incur more cost on motor and pump operation and maintenance.

Figure 1.1 : The example of pumping system and induction motor TECO

In figure 1.1 shows the example of pumping system which integrating 2 or more motor pumps in a system. The induction motor which using 6 poles custom from Taiwan company TECO ELEC. & MACH. CO., LTD. The Specification for this squirrel cage is 50 Hz of frequency , 980 RPM , 6600 frequency range and 250kw of the HP .The motor is using a high power motor and use 3-phase AC supply to generating it through the system .When using 3-phase AC power supply, it is need to choose a suitable motor controller before supply electrical power to the motor .The 3-phase supply is being control by star-delta and auto transformer. The final year project is focused to the energy efficiency and performance induction motor water pump, which is to find lost in cost of maintenance, operating and energy used in water treatment at SAMB.

1.2 Motivation

The research on the project brings knowledge out of the mechanical field. Preventive maintenance of the squirrel cage induction motor is essentially a mechanical field which is being studied in order to estimate the life of the machine and perform the overhaul before it fails, and the knowledge of this project is needed in order to deal with industrial problems other than the mechanical field. The difficulties of this squirrel cage induction motor to efficiently produce movement to pump water supply will result in a lot of waste and customer satisfaction in SAMB services will be effected.

SAMB akan mula pam air Tasik Ayer Keroh untuk elak krisis air

Astro Awani | Februari 21, 2014 07:41 MYT

SAMB
SYARIKAT AIR MELAKA BERHAD

MELAKA: Syarikat Air Melaka Berhad (SAMB) akan mula mengepam air di Tasik Ayer Keroh bermula Isnin ini bagi memastikan Melaka tidak berlaku krisis air.

Ketua Pegawai Eksekutif SAMB, Datuk Ir Mohd Khalid Nasir berkata, air berkenaan akan dipam masuk ke sungai melaka bagi menampung keperluan penduduk negeri.

Setakat ini, SAMB bertindak mengepam dua kolam dari Kesang, Jasin sejak 14 Februari lalu rentetan keadaan cuaca panas dan tiada hujan yang melanda negeri sejak Januari.

Figure 1.2:SAMB pump water from Tasik Ayer Keroh to prevent water crisis(*Anshell Ayer Keroh*, n.d.)

From the figure 1.2 the article tells about increasing water demand because of increasing population in Melaka . The existing reservoir is not enough to support increasing population in area covers almost 13 district such as Lanchang , Merlimau, Chin- Chin ,Bertam and etc each year in Melaka . Increasing water demand leads to a best pumping system which can operate effectively to prevent current crisis. The current pumping system have a lot of losses and make it less efficiency to give its performance. With this case study the problem related to the pumping system at SAMB can be solved. An increases on the electrical consumption due to inefficiency performance of the pumping system and induction motor could be the prevented. This will save a lot of cost for maintain the current system used by SAMB

1.3 Problem Statement

In the water pumping system, there are many issues that can impact the energy efficiency of the water pump. The water friction in the piping system is one of the losses which will delay the delivery of water. Water pump application design which is not appropriate will reduce the efficiency of the entire water pumping system. The problem of unsuitable motor pump, which is a lot of water supply losses, makes maintenance costs higher and SAMB would raise the costumer 's billing rates. To that costs and increase energy efficiency both of these issues need to be solved.

The Analysis of water pumping system performance can help SAMB identify the particular issue that affects the overall efficiency of the water pump. Once all the problem is identified, an analysis will be carried out and, at the end of this project, the appropriate solution will be given to SAMB. SAMB and society around Malacca state will benefit from this initiative.

1.4 Objective

The objective of final year project are:

1. To study the performance of SAMB water pump for better water delivery quality.
2. To study and proposed new design strategies for water pumping system to increase motor performance used at SAMB.
3. To evaluate the current system and to propose an energy efficiency system with suggestions for solution

1.5 Scope and Limitation

This project is about induction motor research that effects water pumping efficiency. The water pump used for this project is the Weir, TOROSHIMA and Worthington type motor is TECO, SIEMENS and KIRLOSKAR. The water pumping system follows the standard water pumping system which SAMB provides. The speed of the pump required for operation must be higher than 1760 RPM and the motor must be higher than 1400 RPM in order to achieve its optimum efficiency and the selection of type pump and motor must be higher in order to support any high load during operation. The project will follow all of the data provided by SAMB to ensure that the energy efficiency goal is achieved. For developing design of water system, the measurement of the head and flow data is taken from the consultant. The collected data will be summarized in a table, and the next step is to compare the motor's performance curve with the system curve which must be achieved. Water system application design includes all types of devices, fitting (elbows, tees, y's, etc.), tanks, and reservoir sizes are analysed and simulated to better design a pumping system. Data collection is gathered with an actual pumping system to set up a simulator to emulate the real pumping system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Figure 2.1: Logo of SAMB (*logo*, n.d.)

Syarikat Air Melaka Berhad (SAMB) is a company in charge of the management of the Malacca State water supply which is in charge of the treatment and distribution of water supply in Malacca state. In 1993, when it was formed on July 1, 2006, Melaka Water Board changed its name from Perbadanan Air Melaka (PAM) to Syarikat Air Melaka Berhad (SAMB)(Ahmad, Bin, Azzlan, Chew, & Lau, 2016).Such initiatives were intended to improve public water supply, in line with the federal government's privatization ambitions. Syarikat Air Melaka Berhad was once a company with position and wide authority without jeopardizing Perbadanan Air Melaka's original activities. The State Government is trying to convince the people of this country in terms of its larger roles, goals, position and powers, the management and distribution of water supplies. At this moment, there are three dams constructed to meet the demand for Malacca water, Durian Tunggal, Jus and Asahan, which can carry up to 75 billion cubic liters of water. In addition to the dams, Malacca has three major reservoirs: the Kesang Satu, the Kesang Dua, and the Tasik Ayer Keroh. In addition, the state receives up to 100 million liters of raw water per day from Sungai Gerisik in Muar, as well as more than 54 million liters per day from Sungai Kesang, apart from Sungai's 300 million liters of raw water. Malacca has been estimated to need approximately 500 million liters of water every day and current capacity is only possible by 2017.Malacca also found another Tasik Biru water source in Chin Chin, Jasin, which could complement the state's water

needs. Malacca also plans to establish a new retention pond in Sungai Jernih, Alor Gajah that will meet water requirements in areas such as Kuala Sungai Baru, Simpang Ampat and Lubuk Cina.(SAMB, 2015)(Ahmad et al., 2016)

In this chapter it be more focus on water pumping system. The topic will be covered by control and specification used in water pumping system. This chapter also used to differentiate advantage and disadvantage using part and controller for the whole system such as squirrel cage and slip ring. From the analysis, there are two factors that influence the motor efficiency which is application design and motor efficiency. To define motor efficiency, a pump and induction motor is selected by according to pump curve. The figure shows the example of basic pump curve(Ahmad et al., 2016) (Rodriguez, 2015) (Chaurette, 2015)

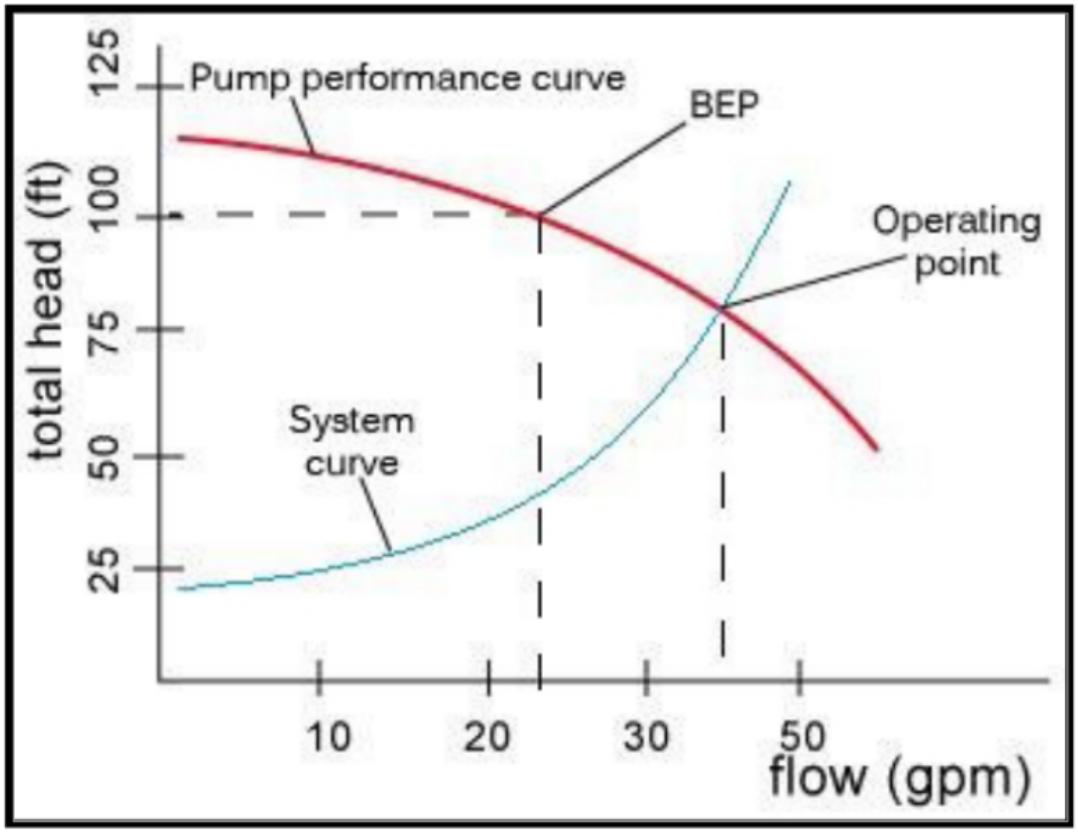

Figure 2.1 : Example of pump curve(Park et al., 2011)

From the figure 2.1, the pump curve shows the operating pointing that get from intersecting two curve which is pump performance curve and system curve. While pump efficiency is get from ratio power actually gained by fluid to the shaft power supplied. Combination of pump efficiency and operating point can be determined by suitable pump and motor used in system.

Application design of water pump and performance motor system needs to be consider in designing water pump system. The type of material, fitting(elbow,tees,stator,rotor,etc), water pressure will impact the whole system in delivering water. The best application design of water pump and induction motor will improve water flow of a water pump system.

2.2 Water Pump Application Design

There is different type of application design with different function.The suitable design of water pump is need to effectively supply water from reservoir to the tank.There several type of fitting to use to deliver water into the tank (Chaurette, 2015).

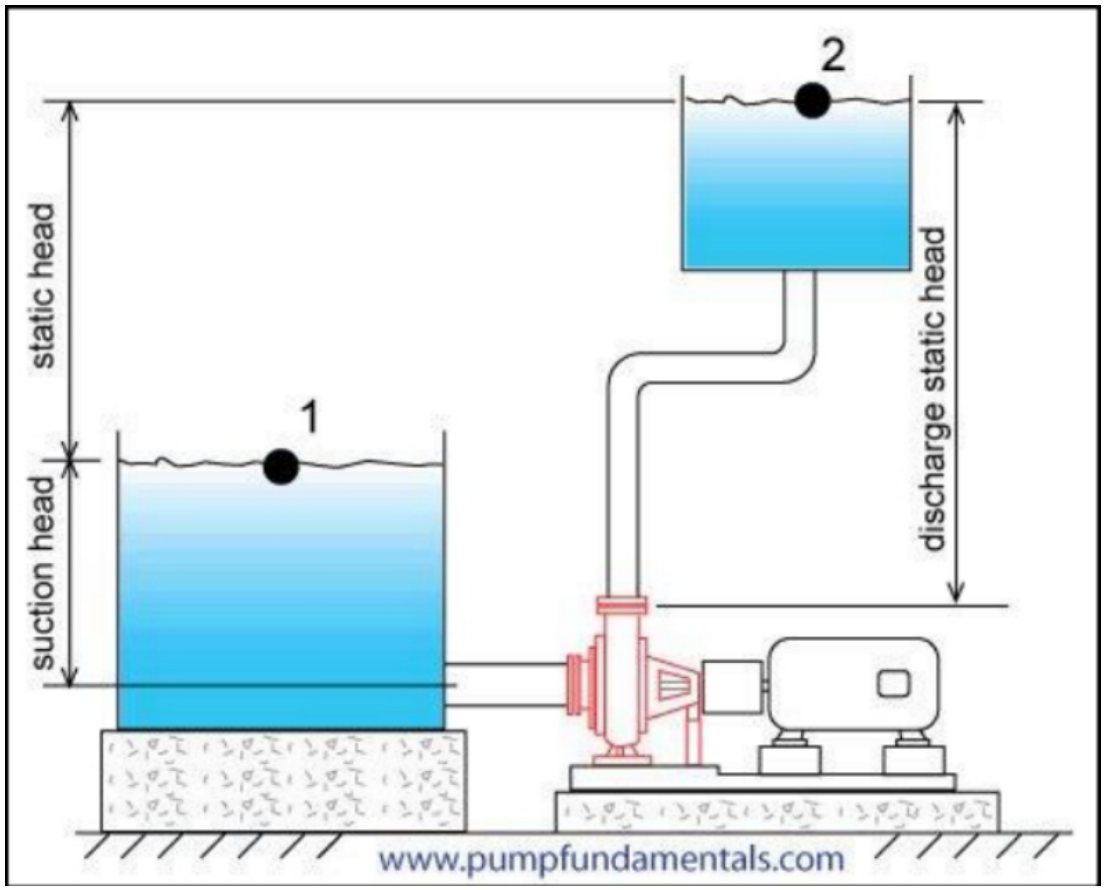

Figure 2.2: Basic application design of Water Pumping System

Figure 2.2 show the basic design of water pumping system .From the reservoir the suction pipe will suck water to the pump and the pump will rotate to deliver to the tank. There are use of several fitting in a system to reduce loses and improve water flow from suction reservoir to discharge reservoir. Water flow in a pipe have an internal pressure that need to minimize by using suitable fitting to prevent internal loses in a system.

2.3 Selection of Device

Water pump selection is important to fulfil desire of the system. According to Joon Sung Park (Park, 2011) before developing motor pump drive system the important factor to be considered is the operating temperature. The water pump usually place near to the engine room, so the ambient temperature of water pump is similarly to the temperature of engine room. Considering this condition, the high temperature devices for the water pump must be 8 used. The unable to select high temperature devices will brings damage to the control system and need a lot of cost to maintain the system.

2.4 Type of Induction motor

There a few types of induction motor which is squirrel cage and slip ring it also have few types of induction motor at SAMB including brands from TECO and Siemens.

2.4.1 OPERATION AND INSTALLATION INDUCTION MOTOR

Site and Environment for motor installation standard environment and site condition for the installation of motor are usually set as follow (Cage & Motors, n.d.) :

Ambient Temperature: -20 ~ +40 ℃

Humidity: For fully enclosed types, relative humidity should be under 95% RH and for semi-enclosed types below 80% RH.

Elevation: Below 1000 meter.

The foundation must be strong and free from vibration.

The ambient temperature shall not be less than 0- to ° C for these water-cooling motor or bearings with water-cooling coils, prevent danger from frost.

2.4.2 Reaction of horizontal motor

Horizontal motors with 4 bolt holding bodies the reactions to the design requirements are as follows:

(a) Static weight = weight of the motor / number of the bolt

(b) Rating motor (TR), reactions = weight of the motor / number of the bolt ± TR / 2L

(c) Maximum motor torque（Tmax）,

reactions = motor weight/bolt number ± Tmax/2L

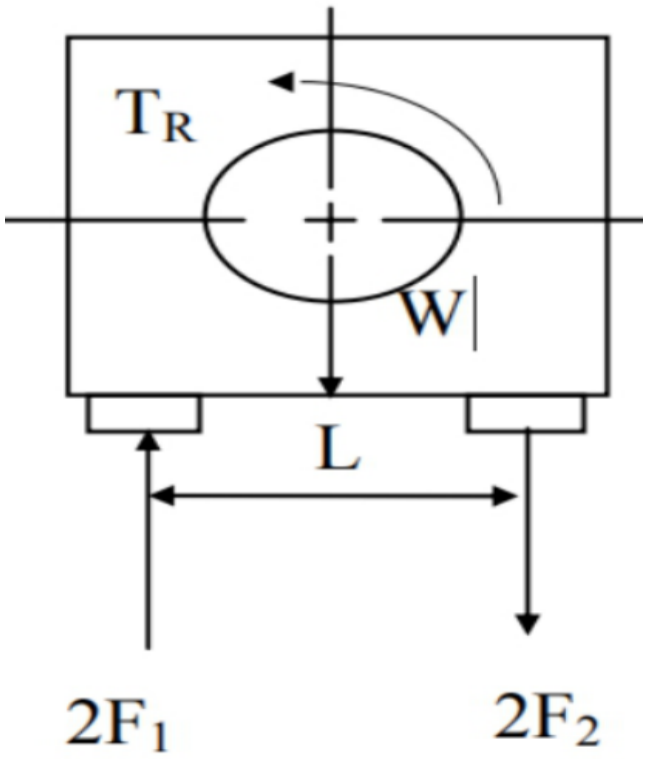

Figure 2.4: Example of diagram to calculate horizontal motor. (Electric & Co, n.d.)

Legend
F= Force
T=Torque