DESIGN AND DEVELOP AN EFFICIENT AERATION SYSTEM FOR TASIK UTeM – AERATION DEVICE

SYAZWAN ARIFF BIN MOHD YUNUS
B041110140
BMCA
Email: syazwanariff22@gmail.com

Draft Final Report
Projek Sarjana Muda II

Supervisor: PROF. MADYA IR. DR TALIB BIN DIN

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

MEI 2015

SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis 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 (Automotive)"

Signature : .....

Supervisor : .....

Date : .....

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature : .....

Author : .....

Date : .....

ACKNOWLEDGEMENT

First of all, I am grateful to Allah S.W.T for the grace and kindness given the time and space as I to complete my project successfully. Also, I would like to give a round of applause to UTeM (Universiti Teknikal Malaysia Melaka) and FKM (Fakulti Kejuruteraan Mekanikal) specifically for given us the chance to carry out the project and ease us in order to get the reference materials about this topic by providing a lot of facility and convenience like library and cafeteria.

Secondly, a lot sincere and thanks to supervisor, Prof. Madya. Ir. Dr. Abdul Talib bin Din for his perfect guidance and good explanation from the beginning of this project until it is completed. Furthermore, I also want to thanks to you for your commitment and trust to us to get this task done.

Not to mention my parents who give a ton of supports and encouragements and also pocket money as the money don't grow on trees this day as to accomplish this project.

Lastly in a nutshell, I hope that the project that have been done can enhance our knowledge as a student and hopefully as an engineers in the near future. Besides that, I hope that this project can provide a lot of information and benefit to the society and to the world.

ABSTRACT

The main objective of the project is to design and develop an efficient aeration system for Tasik UTeM which reduce BOD and COD, and increasing the dissolve oxygen - aeration device. The key factor that should be taken when carrying out this project is to choose the most suitable aeration system while having the efficiency of air distribution based on quality of water, the depth, and the flow of lake. To achieve this task, a relevant research on existing aeration system such as fountain aerator, propeller aerator, paddlewheel and diffuser aerator. To provide the maximum dissolve oxygen to the Tasik UTeM, water quality must be analysed and the pressure in water is determined so that the blower pump can deliver enough air through the piping system. At the same time, mechanical factors and other characteristic should be taken in order to develop and design the aeration such as the loss of air pressure, air flow, types of pipe and so forth. Besides, the design of this system not prevent the flows of streams as well as the cost no too expensive.

ABSTRAK

Tujuan utama projek ini adalah untuk mereka bentuk dan membangunkan sistem pengudaraan bagi Tasik UTeM – alat pengudaraan air. Faktor utama ketika menjalankan projek ini adalah pemilihan pengudaraan yang paling sesuai disamping mempunyai kadar kecekapan pengagihan udara yang paling maksimum berdasarkan beberapa factor lain seperti kadar kualiti air, faktor kedalaman, dan aliran tasik. Bagi proses pemilihan sistem yang sesuai, kajjian dijalankan berkaitan dengan sistem pengudaraan yang sedia ada seperti pengudaraan jenis pancutan udara ("fountain aerator"), pengudaraan di permukaan dengan kaedah kayuhan ("paddlewheel") dan kaedah udara terlarut melalui sistem paip ("diffuser aerator"). Dalam usaha untuk membekalkan keperluan oksigen yang maksimum untuk Tasik UTeM, kadar kualiti air harus diketahui terlebih dahulu dan seterusnya tekanan udara di dalam air supaya pam udara dapat menyalurkan udara yang mencukupi melalui sistem paip. Pada masa yang sama, ciri-ciri dan faktor-faktor mekanikal harus diambil kira bagi tujuan mereka sistem pengudaraan seperti kadar kehilangan tekanan udara, kelancaran pengaliran udara di dalam paip, jenis paip dan sebagainya. Selain daripada itu, reka bentuk sistem ini hendaklah tidak menganggu pengaliran arus disamping kos pembangunan yang tidak terlalu mahal.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

UTeM	-	Universiti Teknikal Malaysia Melaka
FKM	-	Fakulti Kejuruteraan Mekanikal (Faculty of Mechanical Engineering)
BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
Pa	-	Pascal's
DO	-	Dissolve Oxygen
CAD	-	Computer Aided Design
CFD	-	Computational Fluid Dynamic
MATLAB	-	Matrix laboratory
W	-	Watt
V	-	Volt
N	-	Newton
J	-	Joule
cm	-	centimetre
m	-	metre
mm	-	milimetre
in	-	inch
kg	-	kilogram
mg	-	miligram
L	-	Litre

mL	-	Mililitre
HP	-	Horse Power
min	-	minute
ºF	-	Degree Fahrenheit
ºC	-	Degree Celsius
K	-	Kelvin
Ø	-	Diameter
ft	-	feet
ppm	-	Parts per million
Hg	-	Mercury
FAS	-	Ferrous ammonium
QFD	-	Quality Function Development
HoQ	-	House of Quality
SOTR	-	Standard Oxygen Transfer Rate
R	-	Rating
WR	-	Weighted Rating
IW	-	Importance Weight

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

There are six titles will be provided in this chapter. First of all is the background study followed by the objective, scope and problem statement provided early of the semester. Then, it will be continued with idea concept design which indicate the basic concept of water aeration and research methodology.

1.1 BACKGROUND STUDY

Water is most precious resource in daily life and lake is one the resource to obtain besides river and mountain. Lake is categorized as an area that surrounded by land apart from any river. It is also vary in shape, depth and exists at different elevations. Some measure only a few square meter and small to fit the backyard referred as ponds. Lakes can be contrasted with rivers or streams, which are usually flowing. However most lakes are fed and drained by rivers and streams. The water in lakes comes from rain, stream and groundwater. Usually most lakes contain freshwater.

Now, in the modern day, lakes are constructed for industrial and agricultural purpose. Besides, it is used for generate power like hydro-electric power generation

or domestic water supply. At the same time, lake is also use for recreational activities. In this project, the scope, objective and problem statement according to Tasik UTeM. Figure 1.1 shows the map of Tasik UTeM A and B. The area of Lake A and B is 26148.1m^2 and 48076.8m^2 respectively.

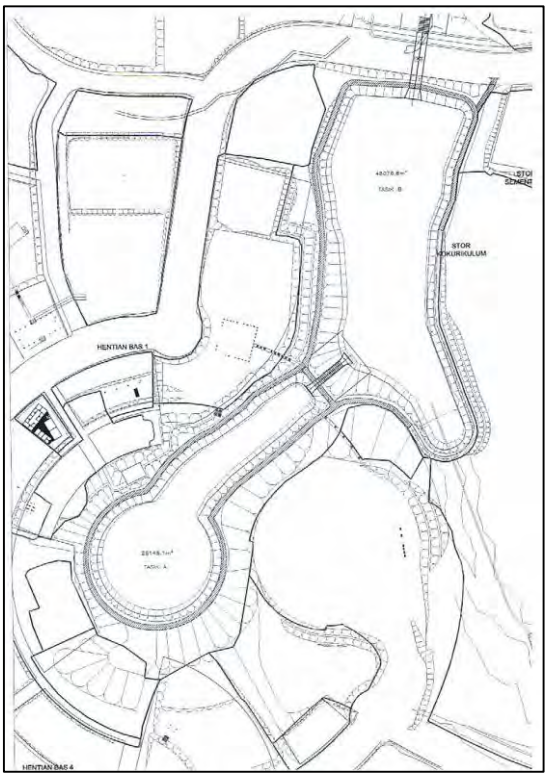

Figure 1.1: Map of Tasik UTeM

1.2 OBJECTIVE

To design and develop an efficient aeration system for Tasik UTeM which reduce BOD and COD, and increasing the dissolve oxygen - aeration device

1.3 SCOPE

Literature review on water quality at Tasik UTeM water focus on the parameter of dissolve oxygen (DO).

1.4 PROBLEM STATEMENT

Throughout this project, there are several aspects and factor that need to be considered. First of all is to design a suitable aeration system included the blower, automatic switch which suitable on decreasing biological oxygen demand (BOD) and chemical oxygen demand (COD) and increasing the dissolve oxygen. However, some precaution need to be done on the model so that it is durable and not having any pressure loss in order to provide the oxygenation need for Tasik UTeM

Next, the level of BOD and COD in Tasik UTeM need to be determined so the correct amount of oxygen can be provided by the aeration system. Besides, a precise pressure level in the water also has to be determined so that the blower can provide enough air through underwater piping. Lastly, the installation process of the aeration system must correctly install.

1.5 Concept Designs

Diffused air type will be used for this project where by a tube will be place in the middle at the bottom of the lake. Apart from that, there are branching structures of the main channel to the overall sides for aeration. A blower house will be located and equipped with two mechanical blowers which operate intermittently to provide air for aeration process. The blower operated automatically controlled by switch depends on BOD and COD of the water. The figure below shows the basic concept diffuse air that will be install at Tasik UTeM.

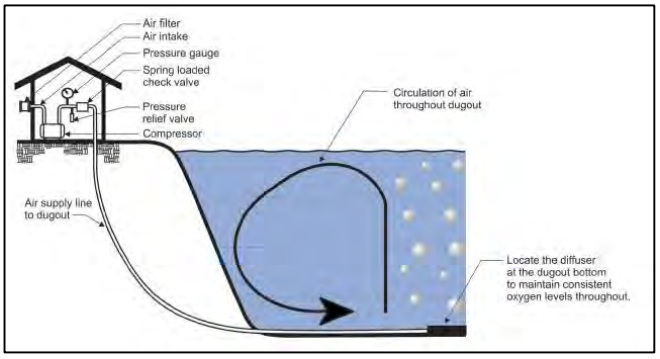

Figure 1.2: Basic diffused aeration concept.

1.6 Research Methodology

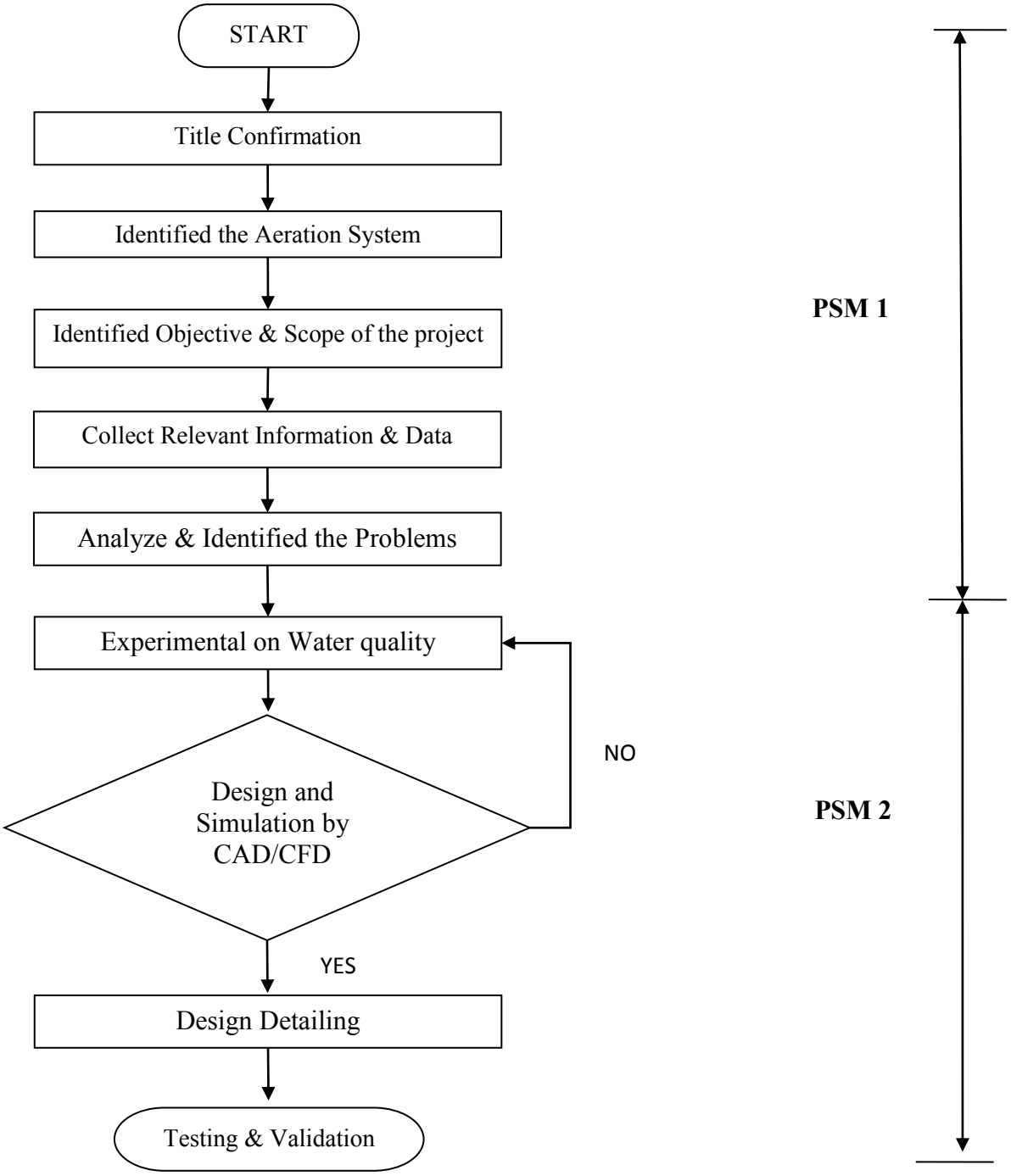

Figure 1.3: Flow process for PSM

CHAPTER 2

LITERATURE REVIEW

2.0 BACKGROUND STUDY

Aeration is the process which area of the contact between water and air is increased, by natural or mechanical devices for oxygenation process. This process is the most efficient techniques frequently apply in the improvement of the physical and chemical properties and characteristics of water. The function of aeration improves the taste and odor of the water, such as lake and river by supplying the enough oxygen, rescuing the free carbon dioxide and eliminating much of the hydrogen sulfide and other odorous presents. Besides that, removal of iron and manganese from such oxygen deficient waters also usually requires aeration as an initial step. This initial step allows for the lower oxides of these minerals that are dissolved in the water and combined with carbon dioxide to be converted to higher insoluble oxides and in turn removed by subsequent sedimentation, contact or filtration. The benefit from aeration are:

- Improve overall water quality.
- Increase the population of fish.
- Cause circulation currents that might create favorable conditions for more desirable algae to out compete blue green algae.
- Reduce the mortality of aquatic life due to low oxygen levels.
- Speed up the rate of organic decomposition.

The efficiency of the aeration process depends on almost entirely on the amount of surface contact between the air and water. This contact is controlled primarily by the size of the water droplet or air bubbles. The goal of an aerator is to increase the surface area of water coming in contact with air so that more air can react with the water. As air or water is broken up into smaller drops/bubbles or into thin sheets, the same volume of either substance has a larger surface area. Figure 2.1 below shows the basic process of aeration

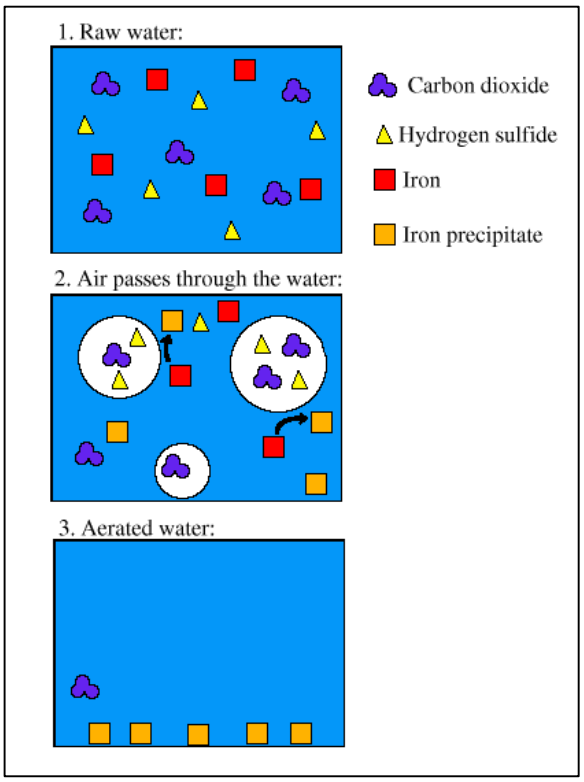

Figure 2.1: Basic Aeration Process

Aeration removes or modifies the constituents of water using two methods which are scrubbing action and oxidation. Scrubbing action is caused by turbulence which results when the water and air mix together. The scrubbing action physically removes gases from solution in the water, allowing them to escape into the surrounding air. Based on the figure above, carbon dioxide and hydrogen sulfide are shown being removed by scrubbing action. Scrubbing action will remove tastes and odors from water if the problem is caused by relatively volatile gases and organic compounds.

Oxidation is the other process through which aeration purifies water. Oxidation is the addition of oxygen, the removal of hydrogen, or the removal of electrons from an element or compound. When air is mixed with water, some impurities in the water, such as iron and manganese, become oxidized. Once oxidized, these chemicals fall out of solution and become suspended in the water. The suspended material can then be removed later in the treatment process through filtration.

2.1 TYPES OF AERATION SYSTEM

There are several types of aeration system used for wastewater treatment. The system used depends on the function to be performed, type and geometry of the reactor, and cost to install and operate the system.

2.1.1 Fountains Aerator

For this kind of aerator, it works very well in small pond and relatively shallow. Fountains improve a pond's aesthetic appeal and recirculate the water near the pond's surface. Fountains are generally ineffective because it does not recirculate the water near the bottom of the pond.

Figure 2.2: Fountain type aerator

In most cases, water near the pond's surface usually has enough oxygen to support the plants and animals found near the water surface. A fountain should be in the middle of the

pond, and the waves creates by the fountain should dissipate before reach the edge. This system is not efficient because energy is used to create the display.

2.1.2 Propeller Aerator

This propeller aerator was specially developed for intensive production of fish in tanks and ponds. This unit employs a float, motor, and prop to splash at the water surface with fairly decent oxygen transfer rate. The maintenance free, heavy duty, motor (230 or 380 Volt) with low power consumption (0.18-1.00 kW) has a mounted propeller which allows a high water circulation of up to 50-180 m^3/h (splash height 60-90 cm and splash diameter 160-250 cm). The small float size, compact and lightweight system make it fast and easy to install. This aeration system is not efficient at moving water at deeper level.

Figure 2.3: Propeller Type Aerator

The following types are available as standard:

Table 2.1: Table indicates types available at standard

Power consumption kw/HP	0.18/0.2	0.37/0.5	0.75/1.0
Water circulation m^3/h	50	100	180
Water splash Ø cm	160	180	250
Splash height cm	60	75	90
weight kg	26	28	30