

TOTAL DESIGN OF WATER TANK LEANING ROBOT (WATCLEAR)

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**This thesis submission is to fulfill the requirement for
Bachelor Degree of Mechanical Engineering (Design & Innovation)
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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 degree of Bachelor of Mechanical Engineering (Design and Innovation)”

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 acknowledge”

Signature:

Author:

Date:

Dedicated to
my beloved father and mother

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I would like to show my dearest gratitude to both of my parent who provided and supported me until this day. The highest gratitude is for the one god that I believe and the His messenger that brings the truth.

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ABSTRACT

Water Tank Cleaning Robot (WATCLEAR) is a robotic solution for cleaning water tanks. Water tanks are mostly located above ground, underground or even at a top of a high structure such as water tower. Water tanks structure and design are unique and accord to their location. The solution for development of WATCLEAR is to replacing or excelling the current human labour method that were commonly used in Malaysia. The current method is considered as obsolete and dangerous activities due to the exposed contaminations that the personnel may suffer during an operation. The aim of this project is to develop a WATCLEAR or a robotic solution for the local user. The development of WATCLEAR is strictly guided by the product development process which all the data, results and information obtain will be documented.

ABSTRAK

Robot pembersih tangki air (WATCLEAR) merupakan penyelesaian secara robotic bagi masalah pembersihan tangki. Tangki air umum mengetahui, selalunya terletak di bawah tanah, atas permukaan mahupun di struktur bangunan yang tinggi seperti menara tangki. Keadaan struktur dan reka bentuk tangki air dipengaruhi oleh kedudukan tangki air itu sendiri. Tujuan pembangunan WATCLEAR adalah untuk menggantikan atau menandingi kaedah pembersihan tangki semasa iaitu dengan menggunakan tenaga buruh manusia. Kaedah ini boleh dianggap sebagai lapuk dan berbahaya disebabkan keadaan pekerjaannya yang mudah terdedah dengan pencemaran dalam persekitaran kerja. Tujuan pembangunan WATCLEAR juga adalah bagi menghasilkan kaedah robotik bagi tujuan kegunaan pengguna tempatan. Pembangunan WATCLEAR adalah mengikuti proses pembangunan produk dimana setiap data, hasil kajian dan informasi yang didapati akan di dokumentasikan.

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LIST OF SYMBOLS

d	=	Diameter, mm
ω_i	=	Critical speed of the shaft, rad/s
E	=	modulus of elasticity, Pa
l	=	Total length, mm
m	=	Mass per unit length, N/mm
I	=	Second moment of inertia
N_i	=	Revolution critical speed of the shaft, rpm
N_s	=	Revolution critical speed of the design, rpm
V_s	=	Velocity of the design, m/s
A_i	=	Area of the surface, mm^2
r_i	=	Centre point, mm
\bar{r}	=	Centre of gravity, mm
V	=	Volume, mm^3
h	=	Height, mm
ρ	=	fluid density of water which is 1000 (kg/m^3)
g	=	gravitational due to the acceleration 9.81 (m/s^2)
P	=	Pressure, Pa
F_{water}	=	Force exerted by the water, N
A	=	Area of the surface, mm^2
F_{weight}	=	Force exerted by the weight, N

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In cleaning the water tank, there are two main methods that are commonly used by the cleaning companies, which are the manual human labor method or the automated robotic method. Both methods have their advantages and disadvantages. Many prefer the manual method due to the facts that they are much easier to access and the services can be easily be found. The robotic solution however, is not widely used in some countries thus it is hard for the user to access the technology.

1.2 PROBLEM STATEMENT

In Malaysia, the automated robotic method or robotic solution is not widely used as in the other countries in the world. The developed countries as united state of America and Japan have been using the robotic method to clean their water tanks. Other countries are also trying to following their trends. The reason is due to the limited access of the technology and also there is not many local water tank cleaning robot (WATCLEAR) to support the domestic demands. For that reason, a local design must be made to fulfill the local demands.

1.3 OBJECTIVES

This project is to design a WATCLEAR for the domestic use in Malaysia. At the end of this project a prototype will be created to be tested on the actual situation and environment for validation of performance.

1.4 SCOPE OF WORK

This project will provide the development process of the WATCLEAR for understanding and reference. All the design engineering methods will be described in details and are supported with related documents. This project also will create a prototype for testing and evaluation.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this section, all of the related information will be given to enlighten the understanding about this project. The information given is from previous studies that have been conducted in different fields and expertise. All the studies are combined together to support the understanding and the objectives of this project. Each of the important terms will be explained in details in this section. The principles, ideas, and concepts of the related information will be shared.

2.2 WATER SOURCE

Water is the main essential of life. Without water the life form on earth cannot survive and extinction will happen. Our earth is mostly consisting of dry land and sea. Despite its importance, water is a finite natural resource and cannot be created. Instead the hydrological cycle recycles water through the atmosphere. The fact that our supply is finite has dire implications of our world population of nearly seven billion people and growing. The global water consumption rate doubles every twenty years, a pace that is double the rate of population growth (Population Institute. 2010).

Water is so important to the life on earth that they are very dependable on the continuous flow of water. The movement of water through the hydrological cycle is the largest contributor to the water source on earth. It is estimated that over 110,000 cubic kilometers of water are delivered to the land in the forms of snow and rainfall (Jackson, 2001). In the Mediterranean or mostly Asian countries the water mainly arrived to the land in the form of rainfall during the monsoon season,

Although the earth are covered with 70 percent of water and the other 30 percent of dry land, the seawater cannot be considered as undrinkable water. The inexhaustible resources of seawater cannot be beneficial to the human due to the facts that the average seawater contains 1,000 times the salt that the human body can withstand (Dutang, 2005). However there is a method for the human to manipulate the seawater to be safe for consume and drinking. The method is called desalination.

Desalination is the process of removing salt from seawater or generally saline water. According the World Health Organization (WHO) the permissible limit of salinity in water is 500 parts per million while the most seawater contains salinity over 10,000 parts per million. The purpose of desalination system is to clean and purify the water into permissible limit of 500 parts per million or less (Kalogirou, 2005). Although the method can bring benefit to the life on earth, the technology is not yet widely implemented due to the facts of the costs and the limited accesses of the technology. Therefore the mankind still relies on the freshwater as the source of drinkable fluid.

The water source in our earth is considerably limited and not all can have the advantage to gain full access. In the global situation, the water source for the entire world depends on only the 3 percent of the freshwater while other 97 percent is the seawater. Of this 3 percent of freshwater over 2.5 percent is frozen in the forms of glaciers on the Antarctica and the Arctic. Thus humanity received only 0.5 percent of usable freshwater (Martin, 2006).

Not all the countries in the world have the benefits of having constant channel of water supply like Malaysia and other tropic countries. Many countries are entering the era of severe water shortage. Not all the countries of the world have high rate of water scarcity (Seckler, 1998). The figure 2.1 below will represent better understanding of the world countries access to water.

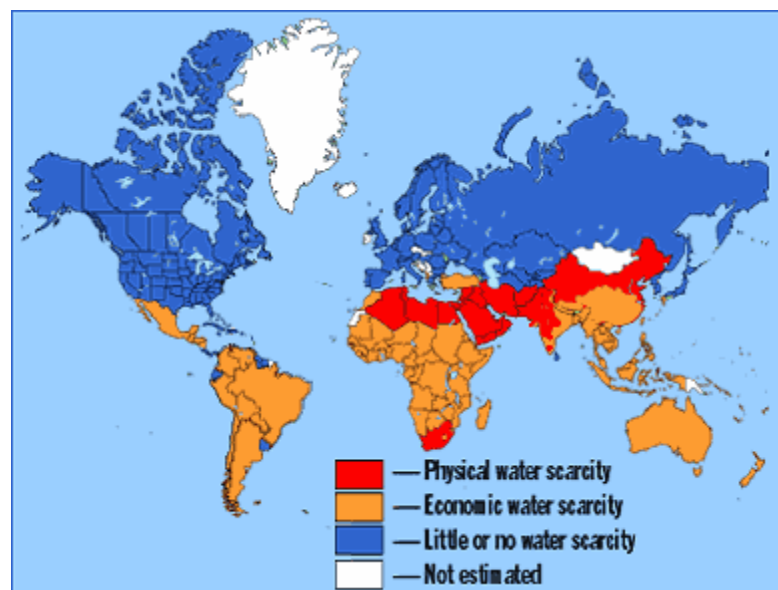


Figure 2.1: Water scarcity in the world (whyfiles.org, 2012)

The limited water sources are worsened with the climate changes in the world nowadays. It is a fact that the water is the primary medium which climate change influences earth's ecosystem and also the life forms in it. The effects of the global warming that is caused by the human mostly begin to irritate the life on earth. The global warming effects will caused the changes to the seawater and freshwater temperature into heating and accelerate the global hydrological cycle. This causes the water source to changes in form to other undrinkable and unusable form of liquid or solid. This will affect the water resources (UN, 2012).

The importance of water is making the world to appreciate more of the natural resource. Due to that, the conservation of this natural resource is very concerned by the developed countries all over the world. Among the process for conservation of water sources is by reuse the waste water by treating it in a treatment plant.

The concerns of hygienically drinking water have been evolving with the evolution of the mankind. The need is due to the existing reserves are reducing due to a continuous intense pollution and water shortage all over the world (Besic, 2011). Every day, around two million tons of sewage, industrial, and agricultural waste are discharged into the world's water. The lack of sanitation causes contaminations to the water and it is considered as the most significant forms of water pollution. If this

behavior continues the world will suffer total water contamination thus reducing more of the water storage (Ross, 2010).

Therefore the water sanitations process is very important to ensure the continuity of the water supply to the world. Among the reasons to apply water sanitations are (Ministry of Agriculture. 2008):

- Contribute towards improved health and quality of life
- Ensure an hygienic environment
- Protect water source from pollution
- Promote conservation of water
- Stimulate economic growth

Realizing the importance of the water source, the modern society nowadays has precautions method to ensure the continuous water supply to their home and premises. Among the method is by having water storage for case of emergency. The water storage, store the water until the user want to use it and ensure the water will be kept in clean and hygienic for consume purpose.

2.3 WATER TANK

Storage tanks are common in daily life whether we realized it or not, they played an important role in our life. Storage tanks function as a storage that store water, liquid petroleum, petroleum products and similar liquids (Sahoo, 2008). Tanks sometime also can be used to store hazardous chemical substances due to their structural strength and versatility. (Solid Waste and Emergency Response, 2005). The structural or the design of the storage tanks may vary due their functions and positions. Storage tanks or more can be located at above ground, underground or even at elevated heights. All storage tanks are designed to be crack free and can contain the materials or substances that are needed to be stored inside. For the storage tanks that need to contain a sensitive or hazardous chemical such as petroleum or corrosive substances, a special membrane needed to be applied to stop the substances from flowing outside (Sahoo, 2008).

In this project the main attention will be one of the storage tanks types which are the water tanks. Water tanks as the storage tanks stores substances mostly water. The common tank shapes of the water tanks are cylindrical, square, rectangular and octagonal. In the industries water tanks mostly used as the mixing chamber of water and other substances to create a product. The water tanks are largely used worldwide in industries such as agricultural, water waste management, medical, oil and gas and many more. Water tanks also can be used in large industrial buildings as fire water storage tanks. Fire water storage tanks have been contributed to the fire protection service since a long time ago. The design of the fire water storage tanks are mostly circular in shape and are made from steel, wood, concrete, coated fabrics or even fiberglass reinforced plastics tanks. The structures commonly are situated at an elevated heights above the buildings itself and are supported with a reinforced steel or concrete tower (Walter, 2012). Figure 2.2 shows the example of a fire water storage tank.



Figure 2.2: The fire water storage tank (Walter, 2012)

In domestic usage the water tanks are commonly used as water storage in household or office. There are two types of water storage in domestic usages which are the water storage facilities and also the individual water storage tanks. In water storage facilities, the water that was treated in the treatment plant is delivered to an integrated water distribution system. The integrated water distribution system consists of multiple large water tanks to store the treated water, which then will be supplied to the user by complex piping linkage (Bhardwaj, 2012). Figure 2.3 below shows the volume classifications of storage reservoirs tank and their functions are as follows: