

**DESIGN AND DEVELOPMENT OF CHLORINE CONTROL SYSTEM FOR  
SWIMMING POOL APPLICATION**

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DESIGN AND DEVELOPMENT OF CHLORINE CONTROL  
SYSTEM FOR SWIMMING POOL APPLICATION**

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**This report is submitted in partial fulfilment of the requirements  
for the degree of  
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I declare that this report entitled "DESIGN AND DEVELOPMENT OF CHLORINE CONTROL SYSTEM FOR SWIMMING POOL APPLICATION" is the result of my own work except for quotes as cited in the references.

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## APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature : .....  
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# DEDICATION

Specially dedicated to,  
My beloved parents Ang Hwee Hock and Tan Han See,  
My siblings Ang Chee Yang and Ang Chee Xuan,  
Cousins and Friends,  
And  
Supervisor Dr Ahmad Sadhiqin Bin Mohd Isira

## ABSTRACT

Chlorine which is commonly used in the swimming pool can disinfect unwanted bacteria and algae and oxidizes other unwanted materials such as dirt and chloramines. Hence, the amount of the chlorine used is crucial to determine the quality of the water. However, there is less number of systems that can measure the level of chlorine automatically. Because of this, swimming pool workers normally applied an inaccurate amount of chlorine whether it is too high or otherwise. Excessive use of chlorine may lead to a serious health problem such as cancer. Therefore, this project aims to design a chlorine control system to be used in swimming pools that controls the alkaline and acidity attributes of the water to a healthy pH level. An acrylic chlorine control system had been made to control the pH level in a small tank representing a swimming pool. The data from the pH sensors are processed and transferred to an automated system that forces the pH level of the water to a specify healthy level. It can be observed that the system was able to control the level of the pH and the acidity of the water to the level needed. In addition, the validity of the results are verified with litmus paper and another type of pH sensor. This shows the system is able to provide a solution to the chlorine control problem for water compartment applications such as swimming pool, water tanks etc.

## **ABSTRAK**

*Klorin yang biasa digunakan di kolam renang boleh membasmi bakteria dan alga yang tidak diinginkan dan mengoksidakan bahan-bahan lain yang tidak diinginkan seperti kotoran dan chloramines. Oleh itu, jumlah klorin yang digunakan adalah penting untuk menentukan kualiti air. Walau bagaimanapun, terdapat kurang banyak sistem yang dapat mengukur tahap klorin secara automatik. Kerana ini, pekerja kolam renang biasanya menggunakan jumlah klorin yang tidak tepat sama ada ia terlalu tinggi atau sebaliknya. Penggunaan berlebihan klorin boleh mengakibatkan masalah kesihatan yang serius seperti kanser. Oleh itu, projek ini bertujuan untuk merekabentuk sistem kawalan klorin untuk digunakan di kolam renang yang mengawal atribut alkali dan keasidan air ke tahap pH yang sihat. Sistem kawalan klorin akrilik telah dibuat untuk mengawal tahap pH dalam tangki kecil yang mewakili kolam renang. Data dari pH sensor diproses dan dipindahkan ke sistem automatik yang memaksa tahap pH air untuk menentukan tahap yang sihat. Ia dapat diperhatikan bahawa sistem ini dapat mengawal tahap pH dan keasidan air ke tahap yang diperlukan. Di samping itu, kesahan hasilnya disahkan dengan kertas litmus dan satu lagi jenis sensor pH. Ini menunjukkan sistem mampu menyediakan penyelesaian kepada masalah kawalan klorin untuk aplikasi petak air seperti kolam renang, tangki air dan sebagainya.*



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# CHAPTER 1

## INTRODUCTION

### 1.1 Motivation

The most common chemical used in the treatment of swimming pool is chlorine. It not only eliminates bacteria and algae by disinfection action, it also oxidizes other materials such as dirt and chloramines. If we did not have chlorine in our swimming pool then the potential exists that harmful serious and even fatal bacteria can grown in the water. There is a lot of people look towards trying to reduce their exposure to chlorine by looking to chlorine alternatives to see whats is available but in the reality is that the chlorine is kind of the lesser of two evils. Chlorine is actually fairly benign especially in lower doses, and it also is the kind of the chemical that can do everything compare to mixing other two or more chemicals to use in the swimming pool to get the same effect. For example, bromine has the same effect compare to chlorine but bromine costs five times as much money as chlorine, this is one of the reason why chlorine is the most popular chemical to use in the swimming pool. On the other hand, chlorine is a very helpful chemical to maintain the swimming pool, but if we never

control the dose that we pour in the swimming pool, it will be harmful to human body. Hence, chlorine can create side effects to human body for example red eyes, dry skin and hair and a strong odor. Besides that, chlorine can also cause health issues such as increased risk of developing allergies or asthma in kids. And among adults, exposure to chlorine in pool has been linked to bladder and rectal cancer and increased risk of coronary heart disease. This is because chlorine gets absorbed directly into human skin, it does not help to just keep human mouth closed and not swallow or breathe the chlorine. According to a report published by the Centers for Disease Control and Prevention, there is more than 27000 people in the US have gotten sick and 8 people have died because of chlorine in the past 15 years. Therefore, it is very important that every swimming pool to have a chlorine control system to control the pH of swimming and also the dose of chlorine should be used in the particular swimming pool based on the amount of water in the swimming pool.

## **1.2 Problem Statement**

In Malaysia, chlorine will be poured in the swimming pool manually but not automatically. This will cause a big problem that the doses of chlorine cannot be measured properly before the worker pour into the swimming pool because it is inefficient for a human being to supervise a large scale swimming pool. Besides that, the previous problem will bring out another problem that the quality of the water in the swimming pool is not stable and consistent in terms of pH value and chlorine level. These two problems will cause some side effects to the swimming pool user such as itchy skin and also health issues such as bladder cancer.

## **1.3 Scope of Project**

This project is to design and develop a chlorine control system in swimming pool. An 37cm x 22cm x 20cm acrylic aquarium will be used in this project, the acrylic aquarium will insert two bronze valves which can function in 12 DC voltage and 0.02-0.8 Mpa. On the other hand, Arduino language IDE will be used throughout my project, which will interface the pH sensor on a Arduino UNO board which input is 5V. The result

of the coding of pH sensor will be compared by the litmus paper. Once the result is correct, the interfacing step will be carried on by interfacing the hardware which is the aquarium and the valve and the software which is the pH sensors. After that, the analysis part can go on which is to determine the time taken for a acidic and alkaline water to reach a healthy pH level.

## **1.4 Project Objective**

The aim of this project is to design a chlorine control system for swimming pool application to control the pH level. Besides that, it also aims to verify the chlorine control system in terms of pH value. Lastly, to analyse the time taken for a acid water and alkaline water to reach the healthy level.

## **1.5 Arrangement of the Chapters**

Throughout the report, it will consists total 5 chapters. Chapter 1 is Introduction, it will briefly explain the motivation of this project based on the previous research and also data collected in the internet, problem statement of this project, scope of project and also the objectives of this project. Chapter 2 will explain the literature review based on the hardware and software and also techniques that will be used in my projects. Chapter 3 is about methodology, this chapter will explain clearly all of the components and techniques that had been used in the projects. Chapter 4 is results and discussion, all of the results may be presented in graph, table, or in words to clearly show to reader what had been done and discuss the result by comparing with previous research. Lastly, Chapter 5 is conclusion which will highlight the outcome of the project. It concludes what is considered as an essence of every chapter and what is the significance the project has delivered. Some recommendations for future works are also described.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Overview**

Today, more and more people are concerning about their own health due to working overtime and overload. People spend much time in the office in which interpersonal relationship is massively built. They are busy getting money to survive in this cruel world but they are neglecting the signal that their body has given out such as muscle pain, back pain and so on. Doctor always says that, an apple a day, keep the doctor away. But, without doing exercise, our muscle will become weaker when our age is increasing. Therefore, doctor always emphasize that the most efficient sport is swimming because it is an exercise that will move your whole body against the resistance of the water and will reduce the impact from the gravitational force due to buoyancy force in the water. So, to make sure everyone can enjoy swimming, the chlorine control system is playing an important role to maintain the quality of water in swimming pool to protect the users are in healthy level.

## 2.2 Chlorine

Chlorine was used as a warfare agent in World War 1 in the past and recently in Iraq and Syria [7]. Besides that, chlorine was also widely used industrially and as a disinfectant and bleach. Hence, chlorine is a strong oxidizing agent that hydrolyzes in water to form hydrochloric and hypochlorous acids [8]. Moreover, chlorine can be in gas form, which will produce a toxic gas to harm to human being, and this is why chlorine gas had been widely used in World War 1 and World War 2 to punish the prisoners of wars. Then, chlorine can be in liquid form, which function is to bleach and kill the bacteria in the water. Therefore, the swimming pool are usually use chlorine with estimate doses to kill the bacteria in the swimming pool. Figure 2.1 shows chlorine in gas form and Figure 2.2 shows chlorine in liquid form.



Figure 2.1: Chlorine in Gas Form



Figure 2.2: Chlorine in Liquid Form (Courtesy from <https://bit.ly/2JCVRk0>)

Chlorine is the contaminant in drinking water. While the chemical is added as a means to purify water and kill off microorganisms and other waterborne pathogens, it has several harmful effects as well. Unfortunately, chlorine treatment does not guarantee the drinking water coming out of a faucet is free from unhealthy microorganisms. Besides that, chlorine is a naturally occurring element with many uses, from purifying water to disinfecting and bleaching. In small quantity, exposure to chlorine gas or liquid can be poisonous. Chlorine as a type gas of gas has a pale green color with a smelly odor. Inhaling the gas can cause difficulty in breathing. Moreover, chlorine ion is abundant in nature and can be found in large amounts in salts. Therefore, there is always good side and bad side for the chlorine. Figure 2.3 shows the chemical reaction of chlorine disinfection.

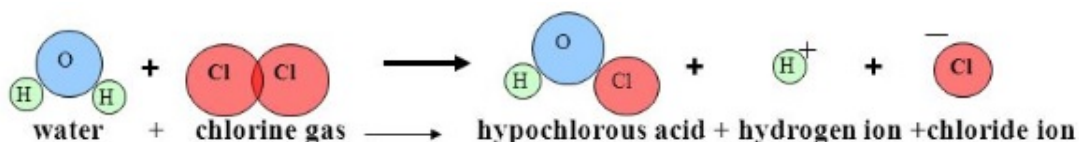


Figure 2.3: Chlorine Disinfection

Chlorine is widely used in drinking water disinfection and is also effectiveness in removing antibiotics. In recent years, the use of chlorine dioxide as a disinfectant has increased due to its effectiveness in minimizing the formation of disinfection byproducts [9]. Around the world, chlorine is the most commonly used oxidant or disinfectant in swimming pools. In United States, chlorine is continuously applied to

pool waters to satisfy the oxidant or disinfectant demand. Chlorine dioxide is a strong oxidant rather than a chlorinating reagent. Oxidation of chlorine dioxide is through one electron exchange mechanism, and it attacks the electron rich centers of organic molecules [10]. Moreover, WHO has recommended that the use of chlorine has brought a more safer drinking water to the human being due to its function of disinfecting the bacteria in the water.[Role]. This is why chlorine is the best chemical to use in killing bacteria in water no matter in swimming pools, drinking waters or in aquariums.

Over the years, the researches have found that people who are exposed to chlorinated water over long periods of time, have a greater risk of contracting bladder cancer. Scientists claim that other chlorinated by-products also play a role in causing cancer. If the doses of chlorine is not correct, then the users might increase the risk of asthma, cell damage, result in heart problem, bad taste and odor. This is because drinking chlorine contaminated water and swimming in chlorinated pools which are overdose in using chlorine, it is very dangerous to the users.

According to the Environment Protection Agency(EPA), chlorine is present in most disinfected drinking-water at concentrations of 0.2 to 1 mg/liter. In March 30, 2010 by Christ Wiant, MPH, PhD, the Environment Protection Agency (EPA) claimed that most people do not need to treat their drinking water at home to make it safe. If it tastes is primary concern, an inexpensive pitcher, refrigerator or faucet attachment with a carbon filter will likely help. The EPA said that to treat the tap water to have a detectable level of chlorine to help prevent contamination. The allowable chlorine levels in drinking water is about a quarter of the total amount of raw water. For example, if the raw water has 10 liters, so the maximum chlorine are allowed to use in the raw water is about 2.5 liters to make sure the water is healthy to be used. Moreover, Chris Wiant also stated that over 98 percent of U.S water supply systems that disinfect drinking water use chlorine. In U.S, the people there had depended on chlorine as their drinking water disinfectant and it also been supported by the Public Health Officials in U.S. Figure 2.4 shows the example of drinking water.