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AN AUTOMATED DOMESTIC WATER PURIFICATION SYSTEM

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"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Power Electronic & Drives)."

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"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references.."

Signature : .....
Name : Siti Aidah bt Wardi
Date : 5th May 2008

Dedicated to my beloved mother, family and friends …

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ABSTRACT

Water purification system consist a number of stage for purification process of water for domestic usage. These stages are important to produce good quality of water. In this project, an automated domestic water purification system was developed to produce water that saves to be used. This project consist of two parts, part one is the flows of the untreated water to become treated water where has filtering by using water filter. The water filter was used to remove chlorine, bio chemicals, and odors. Second part is functional hardware to become automated. This automated system including part to control hardware such as a water pump, ozone generator, water level sensor, and valve and activate carbon filter. An Activated carbon filter was used to neutralize the ozone to its original form. Ozone generator was used to produce ozone, and water pump for pumping the water. Water level sensor was used to detect the level of the water and send the signal to PLC while the valve used to give pressure the water to flow when receive signal. Programmable logic controller was used in this project. PLC was used as controlling part for automated system. For that purpose, OMRON CQMH 21 model of PLC used to install this system with other hardware. CX-Programmer was used as software for writing PLC program. This program was downloaded into OMRON CQMPH 21 and functioning as the controller. The prototype of automated domestic water purification using PLC system will produce clean and safe drinking water for domestic use.

ABSTRAK

Sistem penulenen air mempunyai beberapa kaedah untuk proses penulenen air bagi kegunaan domestik. Kaedah ini banyak digunakan oleh syarikat perawatan air untuk menghasilkan kualiti air yang baik. Dalam projek ini, sistem penulenan air secara automatik dibangunkan untuk menghasilkan air yang selamat untuk digunakan. Dalam projek ini terdapat dua bahagian, bahagian pertama adalah air yang belum dirawat akan menjadi air terawat yang ditapis oleh system penapisan air. Penapis air digunakan untuk menyingkirkan klorin, bahan kimia, dan bau. Bahagian kedua ialah perkakasan yang berfungsi secara automatik. Sistem automatik ini terdiri daripada beberapa perkakasan yang dikawal secara automatik seperti pam air, penjana ozon, penderia aras air, injap air dan penapis karbon aktif. Penapis karbon aktif digunakan untuk meneutralkan ozon kepada bentuk asal. Penjana ozon digunakan untuk menghasilkan ozon, pam air digunakan untuk mengepam air. penderia aras air digunakan untuk mengesan paras air dan menghantar isyarat ke PLC manakala injap diguna untuk memberi tekanan kepada air untuk mengalir bila di beri isyarat keatasnya. *Programmable Logic Controller* digunakan dalam projek ini. PLC digunakan untuk sistem kawalan automatik. Untuk tujuan itu, model PLC OMRON CQMH 21 diguna dan dipasang dalam sistem bersama perkakasan. *CX-Programmer* digunakan untuk menulis aturcara, program ini akan dipindahkan ke dalam OMRON CQMPH 21 yang berfungsi sebagai kawalan. Prototaip sistem penulenan air domestik secara automatik menggunakan sistem PLC dapat menghasilkan air yang bersih dan selamat untuk diminum bagi kegunaan domestik.

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ABBREVIATION

PLC - Programmable Logic Controller

CPU - Central Processing Unit

PPM - Part Per Million

I/O - Input/Output

ROM - Read-Only Memory

RAM - Random Access Memory

EPROM - Erasable Programmable Read Only Memory

EEPROM - Electrically Erasable Programmable Read Only Memory

VAC - Voltage Alternating Current

VDC - Voltage Direct Current

CHAPTER I

INTRODUCTION

This chapter presents about the objective of the project, scope of the project and lastly about the problem statement.

1.1 Objective

Objective of this project are:-

i. To produce the clean, healthy and safe drinking water using ozone treatment technologies.
ii. To improve the conventional system of water purification in the market.
iii. To develop an automated water purification system.
iv. To understand about control system, programming, automated part to control and the function of each component of water purification system.
v. To obtain the basic knowledge of PLC and develop the program *(CX-Programmer)*

1.2 Scope

Scopes of this project are:

1. Designing a water treatment by using ozone system as one of the method in water purification.
2. Automatically functioned water purification system using Programmable Logic Controller (PLC).
3. An automated domestic water purification system to produce clean and safe drinking water.

1.3 Problem Statement

i. Water from the tap is not clean; it contains contaminants from natural and man-made sources such as dirt, rust, chlorine, virus and bacteria. These contaminants are harmful and can affect our health.

ii. As usual, some water filters will be used in filtering water in this project such as carbon filter, activated carbon filter and 1 Micron filter which have their own function. For example, carbon filter can removes chlorine, bio-chemicals and odors while 1 Micron filter used to remove mud, dirt and rust. Figure 1.1 and Figure 1.2 showed the example of water problems from domestic water supplies which rust and stain stuck after through water filter. These also can show the quality of our daily water supplies which are not safe for drinking and can harmful our health.

iii. The several methods that are used in water treatment such as reverse osmosis, activated carbon and ozonation. These methods come in difference advantages on producing clean and safe drinking water.

iv. In this project, ozone system is applied as method of water treatment. Ozone system comes from ozone generator that will produce ozone to removes bacteria and sterilize the water. Ozone operates according the principle of oxidation. When the static loaded ozone molecule (O_3) contacts with something, the charge of the ozone molecule will directly flow over. This is because ozone is very unstable and likes to turn back in its original form (O_2). Ozone can oxidize with all kinds of materials such as odor and microorganisms like viruses and bacteria. The extra oxygen atom releases from the ozone molecule and binds with the other material. Eventually remains only the pure and stable oxygen molecule.

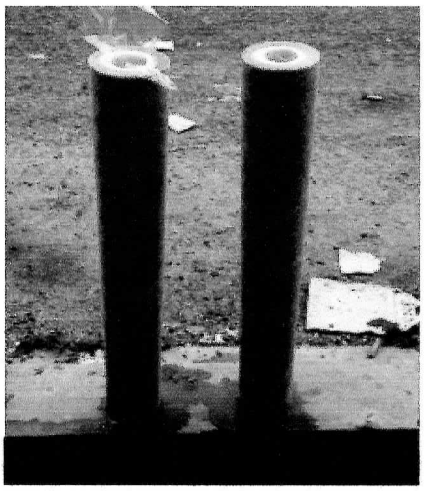

Figure 1.1: Rust and Stain that comes from direct water supplies

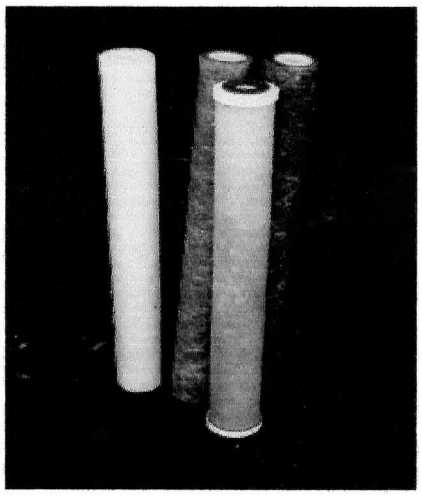

Figure 1.2: Difference between new and a week usage of water filter

CHAPTER II

LITERATURE REVIEW

This chapter reviews existing project created to get an idea about the project design, conception, specification, and any information that related to improve the project. In later of this chapter, some review about an automated domestic water purification system that proposed to fulfill this project will also be reported.

2.1 Previous Water Treatment Method

Literature search on the internet indicates various types of water treatment method and their control system which supports manufacturing, construction and control system. Purification of drinking water is a very important problem in environmental engineering. Purification of drinking water is typically achieved via adding a disinfectant. Chlorine is the most common disinfectant used in drinking water purification systems because it is inexpensive and destroys a large number of pathogens.

The purification of drinking water involves several stages of treatment of the raw water for the removal of suspended solids, color, and bacteria before entering the distribution network. Clarification, disinfection, pH adjustment, filtration and taste and odor removal are part of the stages of treatment. The quality of drinking water is altered by the use of nitrogen-based fertilizers commonly used in agriculture or products of domestic use.

2.1.1 Reverses Osmosis Method

Tipsuwanporn, V.; Anotaiadikoon, J. [1] have produce a pure and drinking water system is universally employed in industry, reverse osmosis system (ROS) has been becoming increasingly popular due to its efficiency in salt and organic rejection. However the membrane system needs regular cleaning. In their research find the method for automation cleaning of reverse osmosis system using computer monitoring process, analyze the trend of membrane performance and discuss automation cleaning. The membrane performance consists of TDS, water flow, pressure and temperature. These variables are analyzed for automation cleaning in order to maintain productivity and performance of RO system.

2.1.2 Method of Ozone Generator

Another example of water treatment method is created by Robinson J.A. and Cairans W.L. [2]. From their research, ozone has been found to be effective in many forms of water treatment. As concerns about the safety of alternate methods of water treatment increase (in particular, chlorination), ozone, which is already extensively used in Europe, offers an effective option. On their research describes a new method of ozone generation particularly suited for use in water purification. Most current industrial ozone production is based on "silent" electrical discharges in a gap between concentric electrodes separated by a glass or ceramic dielectric barrier. The author's present experimental results obtained using parallel-plate discharge geometry. The lower electrode consists of a grounded "pool" of still water separated by a discharge gap from an upper insulated planar electrode. When the electrode is energized by an AC high voltage, a multitude of "Taylor cones" forms on the water surface. The Taylor cones form and collapse randomly and continuously, depending on the electric field. The tips of the cones provide points for electrical discharge pulses which initiate ozone generation. This method generates ozone in close proximity to the water surface. Laboratory experiments show efficiencies for gaseous ozone production as high as 110 g/kWh.

2.1.3 Generation Of Ozone In Water Treatment

In other journal, S O' Kettle, G Dolly, and C Fitzpatrick [3] from University of limerick Ireland, from their research ozone is increasingly being used for a wide range of germicidal applications, including sterilization of water supplies, sterilization of contaminants in controlled air supplies and environmental packaging of food products. Ozone is gradually replacing chlorine in water systems, as the products of oxidation of organic impurities are less troublesome in the case of ozone sterilization. This approach has been effective in the extermination of water-borne bacteria and viruses, e.g. cryptosporidium, which can exist in chlorinated water supplies for up to 40 minutes. The control of these processes requires that ozone concentrations be monitored in the reaction vessel and effluent. Additionally, it may be required to mount a sensor in close proximity to the ozone-producing source so that's its ozone producing effectiveness can be monitored. Ozone often produced in electromagnetically harsh environments, e.g. near electrical discharges and the immunity of optical fibers to electrical discharges means that such a sensor may be used in a wide range of applications. Novel techniques for the generation of ozone using high power microwave plasma ultraviolet lamps also renders conventional semiconductor detectors useless due to the intense electromagnetic fields in their proximity. Existing optical techniques for the detection of ozone involves free space optics, which are unsuitable for accessing restricted spaces due to their unwieldy size, lack of durability and cost.

2.1.4 Function Ozone as a Water Treatment Method

Ana Bran [4] from Ionic Water Tec Pty Ltd, in her research ozone has many uses ranging from industrial sectors, including treatment of municipal water, wastewater, cooling towers, industrial process water, effluent water treatment, food processing, through to water fit for consumption and marine life. Industrial sectors that are known to use ozone as a side unit as part of their process include the treatment of municipal water, wastewater, cooling towers, industrial process water and effluent water treatment. Other industries such as food processing, odor control, beverage industries, ultra pure water, swimming pools and bottled water industries, use ozone directly into the process itself. Marine applications of ozone include complete disinfection of the water. However, in most systems, the ozone is only required to maintain organisms below a certain level. Uses in the marine sector include; marine aquaria, plants, aquaculture, depuration of shellfish, oxidation of colour, producing organics and toxins, improvement of filtration, control of microbial contamination in aquaria and aquaculture and control of befouling in cooling water systems. Ozone is also considered to be effective in the disinfection of viruses, bacteria, fungi, algae, and protozoa in freshwater systems. It should be noted that the effectiveness of ozone in seawater differs. This difference can be accounted by the presence of bromide in the water, which is known to reduce ozone, resulting in a very short half-life. However, the bromine produced is also an effective disinfectant, although its presence is known to have detrimental effects on the marine life in the treated water.

2.2 Conclusion Of Literature Review

From the journal research that shown above; there are some similarities between four water treatment methods of water purification. In this literature review, ozone has been recognized to be effective in many forms of water treatment concepts in water purification. Ozone has many uses ranging from industrial sectors, including treatment of municipal water, wastewater, cooling towers, industrial process water, effluent water treatment, food processing, through to water fit for consumption and marine life. Specific selection about usage parts will be reviewed later in next chapter.