

Development of Portable Water Sterilizer

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Abstract

The Portable Water Sterilizer was developed to eliminate bacteria present in drinking water that cause illnesses to people especially the children. The device used ozonation in eliminating contaminants in water such as total coliform and e.coli Ozone (O₃) is the main by-product of the prototype created by injecting ambient air to the corona discharge. In order to control ozonation, a PIC microcontroller was used as switching device. The functionality and reliability of the developed prototype was attested by the laboratory results of the samples submitted to an accredited Department of Health Water Testing Laboratory. The Philippine National Standard for Drinking Water 2007 was used as the basis for bacteriological analysis of the water testing laboratory. The device was rated "Excellent" by the respondents using the Technological University of the Philippines Evaluation Instrument for Developed Prototype. The Portable Water Sterilizer proves that it is an effective tool in eliminating harmful bacteria in water and a better alternative in disinfecting water.

Keywords – microcontroller, water sterilizer, water bacteria

I. INTRODUCTION

All living creatures, including humankind, need water for survival. Humans directly and indirectly consume water for drinking, cooking, and food production. People use it for bathing and cleaning the body, some industries and manufacturing firms uses water as ingredient to their products. Humans also use water environments for recreation, tourism, and ecosystem management. Without food, a person in excellent physical condition might survive three (3) weeks but only eight (8) days without water. Dieticians recommend that adults drink

eight (8) glasses of water daily. To assure good health this adequate intake of water must be of satisfactory sanitary quality. People nowadays convinced that ordinary tap water provided by the local water distributor is no longer safe to drink. This has fueled tremendous growth in the bottled water industry Millions and millions of pesos are spent on advertising campaign to give the perception that these bottled waters come from some pristine mountain spring when in reality many of them come from a municipality water system just like the tap water does. The regulations that govern bottled water only require it to be as good as tap water. There is no assurance or requirements that bottled are of any higher quality than tap.

The Department of Health showed that diarrhea and gastroenteritis placed number three (3) among leading causes of child mortality ages 1-4 years. The data showed that there are 1,231 cases of child's death in 2006 because of contaminated water. This is 16.14% rate per 100,000 of corresponding age-group (www.doh.gov.ph). Multitude of different microorganisms, or microbes, can affect the quality of a water supply. Microbes found in water fall into four categories: bacteria, protozoa, viruses, and helminths. These microbes have great effects to human health. Some of the diseases that can be brought by contaminated water are diarrhea, typhoid fever, dysentery, cholera, amoebiasis and other fatal

illnesses. These sickness will lead to death if not diagnose early. Safe water and the prevention of waterborne disease are public health priorities in most countries, where clean water generally is available for about onethird of the world's population. However, water-related human health problems in developing countries are daunting. Considering the problem cited, a Portable Water Sterilizer tends to reduce the sickness caused by contaminated water. During calamities like typhoons and other disasters where the sources of water are contaminated with bacteria, the portable water sterilizer can use to purify the drinking water. The community may gain from this by actually reducing the possibility of outbreak/ illnesses that cause by the contaminated water.

II. PROBLEM STATEMENT

The general objective of the study is to develop a Portable Water Sterilizer that eliminates all forms of bacteria in water. Specifically, the study aimed to Design and construct a portable water sterilizer prototype that eliminates bacteria using corona discharge method; Test and improve the prototype in terms of functionality and reliability based on the standards of the Department of Health (DOH) for water bacteriology testing; and Evaluate the performance of the system in term of functionality, aesthetic, workability, durability, economy and safety.

III. Conceptual Model of the Study

On the basis of the foregoing concepts, theories, and findings of related literature,

studies presented, and insights taken from them, a conceptual model was developed as shown below

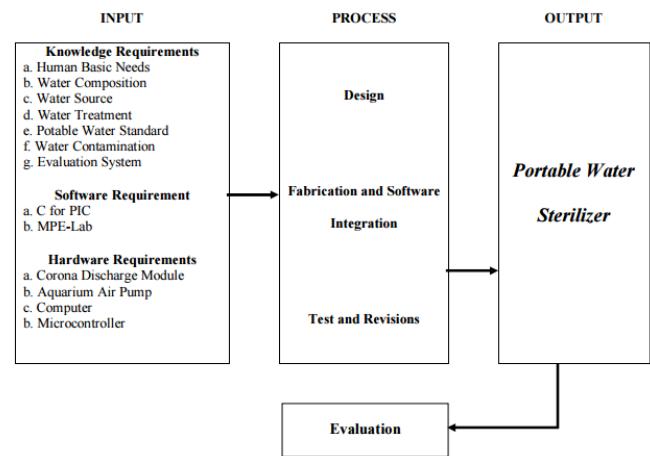


Figure 1. Conceptual Model of the Study

The conceptual model presented is based on the input-process-output model of developmental study. The input includes human basic needs, water composition, water composition, water source, water treatment, water standard, and water contamination. Software requirements include assembly language. Hardware requirements include computer and microcontroller. The process includes design, development, and implementation. The output is an portable water sterilizer.

IV. METHODOLOGY

The Portable Water Sterilizer is a prototype that eliminates harmful bacteria in water. Figure 6 shows the framework of the system. The project works by placing the hose of the prototype to the contaminated water. The corresponding switch is pressed to start ozonation.

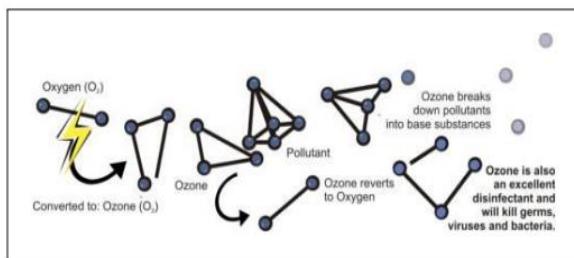


Figure 2 Process Flow of Ozone (O₃)

Figure 3 shows the schematic diagram of the switching device module. The main component used is the PIC16F873AT-I/SO microcontroller. C programming for PIC and MPLab were the software used for the programs of the prototype. It has four (4) push button switches to control time of ozonation and LED indicators. The switching device module is powered by a 5V DC supply

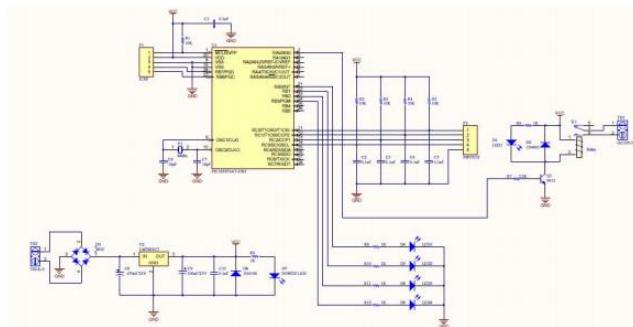


Figure 3 Schematic Diagram of the Switching Device

V. RESULTS AND DISCUSSION

The Portable Water Sterilizer shown in Figure 11 is a prototype that eliminates all forms of bacteria in water. The prototype uses corona discharge method and an air pump. There are two modules, ozonator module and switching device module. The ozonator module involves generating a high voltage electrical charge and

then blowing air pass on it. The switching device module used PIC microcontroller for controlling the four (4) switch buttons. The prototype needs to be plug-in to a 220V power supply.

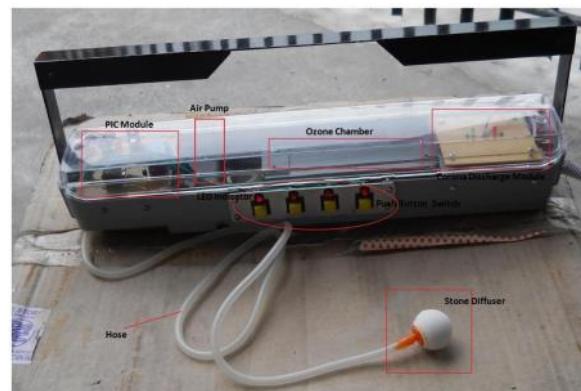


Figure 4 The Portable Water Sterilizer

There are four (4) major switches in the system. The first switch is to ozonate a typical 240 ml (8 oz) of tap water in five (5) minutes. The second switch is to ozonate 500 ml of water for 10 minutes and the third switch is to ozonate 1000 ml of water for 15 minutes. The prototype will automatically stops upon reaching the required time of ozonation. The last button is an open time switch where the user can actually ozonate water that is more than one (1) liter. The project works by pressing the corresponding button. Once pressed, the aquarium air pump brings out air that passes through the corona discharge chamber and an ozone (O₃) is being produced. The hose is placed on the water to sterilize.

To verify the functionality and reliability of the prototype, a Department of Health (DOH) accredited Water Testing Laboratory was determined. The "Regional Water Laboratory" located in Carmona, Cavite was identified. The

RWL is a government owned facility tasked to periodically analyze water in their town and nearby cities and municipalities including industrial companies. Water samples submitted by their clients underwent bacteriological analysis to identify contaminants and are subject of the researcher testing. One company in the First Cavite Industrial Estate (FCIE) failed the water bacteriological analysis, as shown in Table 5. Two (2) liters of sample water were drawn from the said company and divided into three (3) volume 240 ml, 500 ml and 1000 ml. These samples underwent the process of ozonation and the result of the bacteriological examination is shown in Table 1.

Table 1 Bacteriological Examination Result of Water Sample before Ozonation

Result of Analysis			Remarks
Total Coliforms	Fecal Coliforms	HPC efu/ml	
>8	>8		FAILED

Table 2 showed that the water sample has more than 8 counts of total coliform and more than 8 counts of e.coli. More than eight counts is not suitable for human consumption.

Table 2 Bacteriological Examination Result of Water Sample after Ozonation

Volume	Time of Ozonation	Total Coliforms	Fecal Coliforms	Remarks
240m l	5 mins	<1.1	<1.1	Passed

240m l	10 mins	<1.1	<1.1	Passed
500m l	10 mins	<1.1	<1.1	Passed
1000 ml	10 mins	<1.1	<1.1	Passed
1000 ml	15 mins	<1.1	<1.1	Passed

Table 2 shows the bacteriological examination result after the contaminated water is treated by ozonation process. The two (2) 240 ml of samples were ozonated for 5 and 10 minutes, respectively. Total coliform and e.coli read is less than 1 count of bacteria. Below 1.1 counts of water bacteria means the water is safe to drink as far as bacteriological aspect is concerned.

The second sample which is 500 ml ozonated for 10 minutes, the result also showed that minimum count of bacteria has been established. Lastly, the 1000 ml of water sample ozonated for 10 minutes and another 1000 ml also treated for 15 minutes passed the bacteriological test. Upon analyzing the results, best time of ozonation for a typical one (1) glass of water (240 ml.) is 5 minutes, 500 ml. sample is 10 minutes and 1000 ml. or 1 liter is 15 minutes, as shown in Figure 14. If the user wishes to ozonate more than 1 liter, 15 minutes of ozonation time should be added for every liter of water.



Figure 5. Actual Ozonation Process and Testing at Regional Water Analysis in Carmona, Cavite

Project Evaluation To evaluate the functionality and performance of the prototype, prototype was subjected to a performance evaluation result using the TUP Evaluation Instrument for Prototype. The criteria are functionality, aesthetic, workability, durability, economy, safety and saleability. Eighteen (18) evaluator/respondents evaluated the prototype comprised of three (3) health professionals, five (5) IT experts and ten (10) from Cavite City and Carmona, Cavite.

Table 7 Summary of Evaluation Results

Criteria	Mean	Qualitative Interpretation
Functionality	4.56	Excellent
Aesthetic	4.50	Very good
Workability	4.56	Excellent
Durability	4.57	Excellent
Economy	4.54	Excellent
Safety	4.30	Very good
Saleability	4.56	Excellent
Overall mean	4.51	Excellent

VI. SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The Portable Water Sterilizer is a prototype capable of eliminating harmful bacteria using the corona discharge method to generate

ozone. The ozonator module works by supplying air from the pump to the corona discharge chamber. At the chamber, the usual oxygen (O₂) having 2 atom is mixed with another atom and therefore created ozone (O₃). The switch module used PIC16F873AT-I/SO that serves as the timer having corresponding time of ozonation depending on the amounts of water that will undergo the process.

The ozonated water was subjected to bacteriology test at the Regional Water Laboratory in Carmona, Cavite. Results showed that there are less than 1.1 counts of total coliforms and e.coli present in ozonated water. In addition, the developed prototype can dispel the strong odor of chlorine in tap water. Because of its portability, the prototype can be brought to places where there is no good source of drinking water.

The performance evaluation of the sterilizer resulted to an overall mean of 4.51 with a descriptive rating of "Excellent".

VII. Conclusion

In consideration of the objectives of the study and the results of testing and evaluation carried out, the following conclusions were derived:

1. The Portable Water Sterilizer was successfully developed to eliminate bacteria in water using the corona discharge method and locally available materials;
2. The bacteriological result after the process of ozonation revealed that the water sample passed and eliminated total coliform and e.coli.

The result was attested by Regional Water Laboratory in Carmona, Cavite; and 3. The performance of the project was rated "Excellent" by the respondents which proves that the prototype is an effective tool for sterilizing water.

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