Making equipment to process paddy water for providing drinking water by using Ozone-UVC & Ultrafiltration

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Abstract. This study focuses on making equipment which is useful to process paddy water to be consumable as drinking water by using ozone-UVC and ultrafiltration. The equipment which is made by the process of ozone-UVC and ultrafiltration or reverse osmosis is driven by electric power generated from solar panels. In the experiment, reverse osmosis system with ozone-UVC reactor proves to be good enough in producing high quality drinking water.

1. Introduction
The problem of clean water for small industries and home industries are felt in the suburbs and surrounding countryside. Natural water such as well water and river water is most likely contaminated by agricultural chemicals (such as pesticides, herbicides, and fungicides), household chemicals (such as detergents and other cleaning agents), mining chemicals such as mercury, and industrial chemicals which mostly contain heavy metal elements. On the other hand, the surrounding suburbs and rural areas have the potential to develop households and small industries associated with agricultural products, especially in the form of processed food. It requires a water treatment technique that is relatively simple, cheap, and easy to operate.

In recent years, ultrafiltration (UF) membrane of surface water for drinking water treatment has become a more attractive technology worldwide as a possible alternative treatment than conventional clarification [1]. The technique of purification and boiling technique, however, is not sufficient to deal with this pollution problem. Both of these techniques still leave insoluble toxic materials in the water. Purifying technique will undoubtedly eliminate the ingredients that cause turbidity, but may not necessarily eliminate toxic soluble ingredients well in the water. On the other hand, boiling technique will certainly kill bacteria, viruses and fungi but will not eliminate the bacteria, viruses, fungi, and toxic materials it produced. Compared to the conventional treatment, Ultrafiltration process seems to have many advantages such as smaller space requirements, invariable quality of produced water, saving the water purification chemicals and operation cost, and easy automation [2].

This research involves three technological aspects of solar-panel electric technology, ozone-UVC reactor, and reverse Osmosis filtration technique. Electricity from solar panels is used to provide the required electrical energy with the dynamics of rural natural conditions. The ozone-UVC reactor should be adapted to a form that is capable to treat water with mild and moderate levels of pollution. The ability of reverse osmosis filters must also be in line with the dynamics of need.
Ozone-UVC has a very strong oxidizing ability \[3,4,5,18\]. So far, there are only few publications discusses the use of ozonation processes in conjunction with membrane filters \[6-8\]. This advanced oxidation technique, in addition, has not only high oxidation potential but also high reaction capacity. Ozone is the most effective and economical way to disinfect water; however, it is unreasonably expensive to be used.

Instead of filtration or bulk BOD/COD removal. Most of the ultrafiltration systems could easily become breeding grounds for bacteria and viruses\[9\]. The research \[3,5\] concluded that solar panels can provide excellent efficiency if directly used in the form of direct electricity (dc), without going through the process of converting to alternating current (ac) 220 Vac. Efficiency can still be raised, if the excess electricity generated (usually in the middle of a hot day) is stored into the accelerator and directly used as dc power. The power efficiency becomes significantly decreased if electricity is stored in the low potential accumulator and is used after converting to 220 Vac electricity. Power efficiency can be increased if electricity from 20 solar panels is stored at a potential of 240 Vdc. This conclusion provides direction for using solar panels as dc power plants that are directly used in the equipment \[10,19, 20,21\].

The objective of this study is making equipment that will be able to process paddy water into consumable drinking water by using ozone-UVC and ultrafiltration. The equipment which is made by the process of ozone-UVC and ultrafiltration or reverse osmosis is driven by electric power generated from solar panels.

2. Research Method

The study was conducted in 4 (four) stages. The first stage is the preparation of solar panels that must generate enough resources for equipment needs. The second stage is the rearrangement of the UVC-ozone reactor, which should be easy to operate and has stable position. The third stage is the preparation of a reverse ultra/ osmosis filtration system that must be operated in rural setting. The fourth stage is to combine and modify all three design tools that have been produced. Combining the above three units of equipment plus the water pump unit into a compact, easy-to-carry, and easy-to-operate integrated form.

The complete scheme of the whole series of experiments in this study can be seen in Figure (a). below. While the Figure (b) shows the real form of the equipment.

![Figure 1](image1.png)

Figure 1. (a) The Scheme of Experiments and (b) The Real form of the Equipment
Before and after treatment, the water is physically, chemically and microbiologically analyzed. Physical and chemical parameters refer to SNI 2009, while the biological parameters refer to the standard method 2005 [23].

This 4th phase experiment, also accompanied by equipment testing in paddy fields in Kabandungan I, Sirmagalih Village, Ciomas Subdistrict, Bogor Regency-Indonesia.

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Research on the electrical aspects of solar panels, mainly involves strong power generated taking into account the weather conditions, the need for electricity to operate the air pumps, the need for electricity for peristaltic pump needs, the need for electricity to operate the ozone generator, and the electrical needs to operate the UVC lamps. The electricity generated by a solar panel is dc electricity (direct current) with a potential of 12 volts. The electrical requirement for the peristaltic pump is 24 volts dc, and the electricity requirement for ozone generator and UVC lamp is 220 volt ac. It takes two units of solar panels and a 24 volt dc (or 12 Vdc) power converter unit to power 220 volt ac.

Ozone reactors are not possible to be made using non-rust steel materials, as the price and weight of the equipment will increase sharply. If PVC material is used then it is necessary to protect the material against the influence of UVC radiation that can cause the PVC material becomes brittle. This condition requires observation to look for a relatively inexpensive type of material but meets the requirements of resistance to the effects of UVC radiation.

The reverse osmosis filtration technique, usually begins with a sediment filter system. Colloidal materials in wetland water, proven to cause sediment filters easily clogged so it must be replaced frequently. This condition is clearly not possible for rural communities. Availability of backup filters will definitely be a problem. Therefore, the colloidal materials disposal system must be modified. The techniques to be tried are centrifugal drainage and bottom drainage system to remove separate deposits. On the other hand, sunlight can cause the piping system (nylon hoses and teflon) reverse osmosis becomes brittle and trigger the growth of fungus. These two conditions are also incorporated into the scope of the research to be observed.

The whole of this research leads to a concise, portable, and working construction with no State Electricity Company and Drinking Water Company.

3. **Results and Discussion**

3.1. **Research result**

The incorporation of experimental units into one form of paddy water treatment equipment into drinking water, gives better-than-expected results. In plain view, the water produced from the UVC-UVC processing unit already provides clear water. It is likely that the water produced from this treatment meets the drinking water requirements. This condition is possible because ozone-UVC is a very strong oxidizer [18]. The injection of both oxygen and ozone is thought to increase the turbulence of the water stream thereby removing or thinning the deposition layer on the membrane surface and, with ozone, also breaking down large molecules and particles. The hypothesis that organic molecules are destroyed during ozonation is supported by atomic force microscope [11].

To verify the result in this process, a chemical analysis in test laboratory is necessary. The analysis is to investigate whether the aerator and water circulation pump fish pond provide excellent performance. In this research, tested water quality in the analytical laboratory were inlet water samples from the Ozone-UVC processing unit and outlet water from Ultrafiltration unit [17]. Table 1. contains the main parameters of the results of before and after treatment water analysis to from the treatment unit.
3.2. Discussion
From the implementation, there are some observations obtained, such as the hoses used are degraded when exposed directly to sunlight. The used of clear filter (transparent) causes the moss to grow inside the filter house. It is more recommended to use opaque filter houses for filters than sediment filters. The electricity capacity generated from two solar panels of 1000 watt.hour (or an average of 100 watts) proved too large for UVC-ozone reactors and reverse osmosis or ultrafiltration equipment. Two solar panels with 500 watts.hour power are sufficient. The research [12-14] showed that the modular structure of the RO process increases flexibility in building desalination plants within a wide range of capacities. The specific energy requirement is significantly low at 3-9.4 kW h/m³ product and the process is electrically driven, hence, it is readily adaptable to powering the solar panels. The solar panel unit can be mounted on top of the reverse osmosis unit. Two solar panels of 500 watts hour or average power of 50 watts are enough to be placed parallel on top of the tool framework. Consequently, producing cheap fresh water is possible [15,16]. The ozone generator unit, UVC lamp unit, and air pump are placed attached to the ozone reactor. This position links the shortest distance between these three units.

The research of paddy water processing equipment for providing drinking water based on ozone-UVC and ultrafiltration provides satisfactory results. Device design is simplified, yet, completed with performance improvements. According to Table 1, the water quality test parameters are physically, before and after processing, there are increase in water qualities which was indicated by loss of odor and taste, as well as decrease in color, turbidity, and Total Dissolved Solid (TDS) significantly. Meanwhile for chemical test results, it is seen that the rice water which initially acidic, turned into neutral, the BOD and COD became decrease in value after going through the processing. Similarly, biological water quality test results show that after going through the process, it does not contain bacteria. Therefore, all the main parameters have fulfill the requirements of drinking water quality standards based on the regulation of Ministry of Health of the Republic of Indonesia number 492/Menkes/Per/IV/2010 dated 19 April 2010 [22].

4. Conclusions
It can be concluded that for the purposes of treating paddy water into consumable drinking water with a flow rates of 1,500 liters per hour, requires ozone reactor with capacity of 4 grams per hour (gph). The electric power which is required for ozon-UVC and ultrafiltration units is quite enough produced from two solar panels of 500 Watts hour. The quality of water produced from the paddy water
treatment unit meets the drinking water standards based on the regulation of Ministry of Health of the Republic of Indonesia number 492/Menkes/Per/IV/2010 dated 19 April 2010.

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