Conference Paper

Photolysis Technology Application to Overcome the Lack of Water in the Countryside

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Abstract

Sendang was a village of Subdistrict Penanggungan Trawas Mojokerto, that has ground water source. However, with its rapidly increasing population growth, it made bad impact for the quality of water resources. Disposal of garbage and animal husbandry activities that were above the water source, has a contribution as a polluter of water resources. *Escherichia coli* was an important parameter as an indication of contamination of ground water or potable water. By providing knowledge and technology for the people of Sendang, helped them to get ground water. Photolysis technology applied in Sendang was a disinfection technology. The process kills bacteria by using ultra violet light. The energy used to power the ultra violet light is derived from solar energy. Solar Cell used to capture solar energy which is then stored into the dry battery (batteries) to provide energy in ultra violet light. So the villagers are not burdened by the cost of electricity for this technology. Disinfectant process by using photolysis technology could removal *E. coli* bacteria till 75 % for 80 minutes. Removal of *E. coli* increase by exposure of Ultra violet on long time. "Applying Technology to Solve Water Shortage Photolysis Clean countryside" in Sendang Village Penanggungan District of Trawas Mojokerto, done in KKN PPM activities. KKN PPM was a joint activity between students, villagers, lecturers and youth in the village. The application of photolysis technology can benefit the surrounding community.

Keywords: groundwater, photolysis technology

INTRODUCTION

Ground water is a major need for daily activity. Lately ground water could not use as drinking water. This was caused the place of ground water near the river and a septic tank. This condition found in densely populated areas, where the distance between the wells with septic tanks were very close. Lack of knowledge of the public about environmental sanitation, even many community activities that lead to pollution of surface water. The contaminations of surface water was caused by people activities, for examples, washing, waste from kitchen and bathroom.

Contamination of ground water by pathogenic bacteria which was indicated by *Escherichia coli*, it caused ground water could not be consumed as potable water. According to Permenkes 492/2010, that the concentration of *E. coli* is 0 the number per 100 ml of the sample in its designation as drinking water. Removal of *E. coli* has been done using addition of chemicals but the impact is not good for health. The addition of chemicals caused the formation desinfectan by-products and residues from the bacteria itself. Irradiating ultraviolet light rays and

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X-Ray as well as the use of catalysts is an excellent method as a disinfectant in drinking water in developing countries (Al-Rousan et al., 2008). Removal \( E. \text{coli} \) reached 77.3\% simply by exposure to ultra violet rays without a catalyst. \( E. \text{coli} \) per cent removal to 84\% in 80 minutes using TiO2 catalyst and exposure to ultraviolet light (Kabir et al., 2003).

Sendang was a village of Trawas Penanggungan Mojoketo has potential source of abundant water. The contour of the land in the region irregular and orderly spatial designation. In general, residents of settlements and activities including agriculture, farm situated on the hill and produces domestic waste, while the springs are in the valley. This resulted in contamination of water resources consumed by the residents of the domestic waste seepage.

This contaminated water sources was causing public health problems which indicated the onset of diarrhea and hives (skin disease). Based on that condition, treated ground water was needed by the public for daily activities.

Based on observations, it can be identified some problems that exist in the Sendang hamlet, among others:

1. There is a large potential source of water in the village Penanggungan District of Trawas but underutilized so largely wasted
2. Existing water sources need to be processed into ground water

Photolysis technology is disinfecting technology, where the water looks clear, has not been entirely free of pathogenic bacteria. While some chemicals are used mainly as a disinfectant has residue. The residue is harmful to the body if consumed by humans. Exposure by UV light didn’t produced residue. But still could inactivate \( E. \text{coli} \). Solar cell was used as energy to disinfection process by UV lamp. This technology was low cost, because people didn’t pay the electricity.

**METHODS**

Photolysis application of a disinfecting process. Where raw water obtained from a source of water. Figure 1 below shows the origin of the raw water source until the process of disinfection by photolysis technology.

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**Figure 1. Flow Diagram of Photolysis Process**
Photolysis implementation process is as follows:

1. Assembling tool solar cell consisting of solar cell and battery control regulator
2. After the solar cell is attached above, began to connect the regulator to control battery storage battery (batteries).
3. Connect the battery to the inverter to convert the DC current into AC heading lights Ultra Violet (UV Lamp).
4. Start filling water into the tendon, from the inlet immediately taken initial samples.
5. Analysis of Total Coliform for the initial sample.
6. After exposure to ultraviolet light in the tendon, grab samples after 12 hours, then did an initial analysis total coliform.

RESULT AND DISCUSSION

Effectiveness of disinfecting using photolysis technology can be seen from the analysis of the ground water. The analysis were conducted at several sample points. The first point made on the water inlet before the exposure process occurs, that means the process was beginning before the UV lamp is operated or when will start up. After running processes, namely the process of exposure to UV light, the sampling is done in a different time. The results of the preliminary analysis of *E. coli* indicates effectiveness the photolysis unit. Figure 3 and 4 describes the ability of *E. coli* removal based on a certain time of the day.
Table 1. Removal Percentage of \textit{E. coli} at the Time of Start-up

| No. | Sampling Time | Elimination (%) |
|-----|---------------|-----------------|
| 1.  | 16.00         | 60              |
| 2.  | 17.00         | 75              |
| 3.  | 18.00         | 76              |
| 4.  | 19.00         | 78              |
| 5.  | 20.00         | 78              |
| 6.  | 21.00         | 80              |
| 7.  | 22.00         | 80              |
| 8.  | 23.00         | 80              |

Figure 3. Influence of Sampling Time and Removal Percentage of \textit{E. coli}

Water samples were taken based on the activities of the community. Where on the morning of the community has been the activity of cooking, washing, etc. So that the residence time of water in the reservoir is relatively short. This resulted in a decreased percent removal for \textit{E. coli} due to water contact time to UV rays shorter.

Sampling was first performed at the inlet reservoir at 15.00 hours, in the moments before the start-up or before photolysis unit will be in the running. The analysis shows the number of \textit{E. coli} of 1600 MPN/100mL. Figure 3 shows the percent removal during the first hour after running, which starts at 16:00 hours until 23:00 hours. Increased percent removal showed the decreasing number of \textit{E. coli} by exposure to UV light.
Table 2. Percentage Removal of *E. coli* on different day and time

| Sampling Time | 2\(^{nd}\) Sampling Elimination (%) | 3\(^{rd}\) Sampling (%) | 4\(^{th}\) Sampling (%) | 5\(^{th}\) Sampling (%) | 6\(^{th}\) Sampling (%) |
|---------------|-------------------------------------|------------------------|------------------------|------------------------|------------------------|
| 04.00         | 87                                  | 85                     | 83                     | 90                     | 95                     |
| 05.00         | 85                                  | 83                     | 81                     | 88                     | 93                     |
| 06.00         | 85                                  | 83                     | 81                     | 88                     | 93                     |
| 07.00         | 83                                  | 81                     | 79                     | 86                     | 91                     |
| 08.00         | 82                                  | 80                     | 78                     | 85                     | 90                     |
| 12.00         | 85                                  | 83                     | 81                     | 88                     | 91                     |
| 13.00         | 87                                  | 85                     | 83                     | 89                     | 91                     |
| 15.00         | 85                                  | 83                     | 81                     | 88                     | 90                     |
| 16.00         | 85                                  | 83                     | 81                     | 88                     | 90                     |
| 17.00         | 82                                  | 80                     | 78                     | 85                     | 90                     |
| 18.00         | 80                                  | 78                     | 76                     | 83                     | 88                     |
| 19.00         | 79                                  | 77                     | 75                     | 82                     | 87                     |
| 20.00         | 81                                  | 79                     | 77                     | 84                     | 89                     |
| 21.00         | 84                                  | 82                     | 80                     | 87                     | 92                     |
| 22.00         | 86                                  | 84                     | 82                     | 89                     | 94                     |
| 23.00         | 87                                  | 85                     | 83                     | 90                     | 95                     |

Water sampling is done on the second day to the sixth day in a different time and day. Table 2 and Figure 4 shows the variations percent removal for *E. coli*. Sampling was done at peak hours, the hours in which the activities of the community increases, ie. at 04:00 until 08:00, 15:00 until 19:00. Sampling was also conducted on the hour at which the activities of society is reduced eg. at 12:00 to 14:00 and 20:00 to 23:00.

At peak hours contact time between the water with UV rays are relatively short. This is because water needs are increasing, and the short contact time in the tank, so that exposure to UV rays is rapid, while on the clock where community activities decreased, the contact time between the water with UV rays are relatively more effective. This is due to the speed of the water flow from the inlet to the outlet is very slow compared during peak hours. So time is relatively long exposure to water. Decrease in removal for *E. coli* is not significant, it indicates cent decrease in the removal is still above 70%.

Removal of *E. coli* increased to 95% at the time of public activity is reduced or decreased water demand. This decrease in activity occurs during the day, which many people indulge in the fields, and at night. This resulted in the contact time between UV rays and water in the reservoir is getting old. But these two conditions do not degrade the efficiency of photolysis unit the disinfecting process, because of the time removal of *E. coli* in previous studies has been exceeded. Past research has stated that the provision of *E. coli* by irradiating UV lamp for 80 minutes can be designated *E. coli* up to 77.3% (Kabir et al., 2003). While sampling and analysis is conducted every 60 minutes.
CONCLUSION

Based on observations of the exposure time and the results of laboratory analysis Total Coliform. So we can conclude:

1. Unit Photolysis a disinfection process that is safe for the community because without producing residues. Percent of allowance is significant even in peak hours.
2. Percentage effectiveness photolysis in Total Coliform removal above 80% even on the peak time.
3. Determine the condition of the treated water such as water or as a drinking water.

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