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http://heanoti.com/index.php/hn RESEARCH ARTICLE URL of this article: http://heanoti.com/index.php/hn/article/view/hn1319 Design of Chlorinator Using Submersible Pump with Solar Cell for Flowing Water Disinfection Sujangi1, Rusmiati2, Beny Suyanto3(CA) 1Department of Environmental Health, Health Polytechnic of Surabaya, Indonesia 2Department of Environmental Health, Health Polytechnic of Surabaya, Indonesia; rustig63@gmail.com 3(CA)Department of Environmental Health, Health Polytechnic of Surabaya, Indonesia; benssuy@gmail.com (Corresponding Author) ABSTRACT The group of PAMSIMAS (rural clean water maintenance) in Panekan Village, Panekan Sub-District, Magetan District, uses water resource in 2 – 2.2 l/s with an easy polluted water resource preservation; The result of E Coli examination in the water resource in Panekan Village (240 E Coli germs in 100 ml/sample) is positive. This research aimed to create a chlorinator design performance using solar cell energy submersible pump to disinfect the flowing water with an appliance which can overcome the mentioned problem. This experimental research was using a method of creating chlorinator containing chlorine disinfectant and analyzing the performance the chlorinator applying 3 various distance (0 m, 500 m, 1000 m) and chlorinator A and B. The result of the research was: the need of chlorine was 185 g/day in 1 l/s water rate of the water resource. The performance of chlorinator: solar cell, circuit control mechanical box cell, voltage stabilizer, circuit cable, 1 unit chlorine tub for each, 6 units 12 volt batteries. submersible pump 3 watt (chlorinator A) and 6 watt (chlorinator B). The performance of chlorinator A, in a various distance of 0m, 500m and 1000m, respectively: chlorine residue: 0.58 ppm; 0.50 ppm; 0.2 ppm; E coli bacteria: 0; 0; 2 per 100 ml/sample; temperature: 25. 150C; 26. 140C; 25. 150C; pH: 7.14; 7.09; 7.04. The performance of chlorinator B in a various distance of 0 m, 500 m and 1000m, respectively: Chlorine residue: 0.62 ppm; 0.49 ppm; 0.18 ppm; E coli bacteria: 0; 0; 1.3 per 100 ml sample; temperature: 25. 460C; 25.99 0C; 25.31 0C; pH: 7.14; 7.08; 7.1. Overall, the result of the research fulfils the requirement of Permenkes RI 492/2010. Hopefully, needs further research to improve both the power of resistance and the performance of the instrument especially for the greater rate of water. Keywords: Chlorinator, Chlorine, Water resource, E coli INTRODUCTION Water pollution is the addition or the condition of being added of living things, substances, energy and / or other components into the water by human activities, so that the quality of the water comes down to a certain level that causes water does not work in accordance with its designation(1). Water contamination occurs when the water has deviated from its normal condition(2). Standard deviation happens when disposal waste thrown away into the water environment. The mechanism of water source pollution is influenced by the following factors: Distribution of pollutants in the main soil of bacteria around the source, environmental damage, porosity, texture and groundwater flow in geological spectrum(3). The supply of clean water for the social community is intended for the community both in rural and urban areas to get consumable water, fulfil the health requirements and in the sufficient quantity(4). Need to be aware when the water consumed by society is not eligible, it will be able to cause various problems, especially the spread of stomach diseases such as: typhus, cholera, dysentery, vomiting and so on. PAMSIMAS Group in Magetan Regency Generally, in Magetan District, the springs are susceptible to pollution, disinfection facility is not available and are manually managed. E Coli assessment in Panekan shows that the springs in that village positively contains 38-240 E coli in 100 ml/sample along 300 m of distribution route. To overcome these conditions, chlorinator with active chlorine is used. It is cheap, useful, using local materials, easy to make, simple operation and maintenance. The concept of chlorination is an attempt to disinfect water from the life of microorganisms in water using chlorine. Chlorination aims to keep the water in good condition or to improve the physical and chemical condition, taste and odor of the water. In addition to eradicate bacteria and microorganisms such as amoeba, algae and others, Chlor can also oxidize metal ions such as Fe2+, Mn2+ to Fe3+, Mn4+. Chlor is derived from Chlor (Cl2), NaOCl, Ca (OCl)2, (Chlorine) gas or HOCl (Hypochloric acid) solution. There would be a quick hydrolysis reaction when the compounds react or dissolve into water(5). But it should be understood that using excessive chlorine will cause irritation of the body, causing unpleasant odor and taste in water. In the form of powders, easily carried by the wind(6). The objective of the research was to design chlorinator performance for the flowing springs with appropriate technology which can overcome the above problems. METHODS The experimental study is to make chlorinator with chlorine disinfectant and analyze the performance of chlorinator by using 3 variation of distance (0 ppm, 500 m and 1000 m) and 2 chlorinator type A and B with submersible pump of 3 watt and 6 watt power. The pump power uses solar cell energy because the location of the water source is far from the power source. To determine chlorinator performance, series of tests are undergone in examine: flow discharge, chlorine requirement, chlorine capturing power (DSC), chlor residue <7 ppm(4), chlor tank capacity, submersible pump capacity, E coli in water. One-group pre-and post-test design study, where the researcher performs measurements before and after treatment. Polpulation and sample research: water from water source in Panekan village, Panekan Sub-district, Magetan District. Research procedure was: 1. Preparation phase: Site survey, debit measurement and tool supply, treatment chlorinator material 2. Chlorinator treatment designing phase 3. Calculating the need of chlorine solution, tank capacity KK = (DSC + SC) (Q) (%KpxDs) Note: KK = chlorine requirement (kg) DSC = chlor capturing power (ppm) SC = residual chlorine % Kp = percentage of active chlorine xat Ds = Density (kg / l) Q = water source discharge (l / s) Chlorine and water ratio = 1: 9 Discharge of chlorine solution droplets (ml / min) Stage design chlorinator can be described the image below. Chlorine tank Solar cell Pump Battery Light Charger Figure 1. Chlorinator tool block diagram Information: Solar cells as inputs can deliver a voltage of 21.6 volts to a charger battery that functions as a charger for battery / battery 12 / 7.5 Ah. The power of the battery is used to move the submersible DC pump which will produce the discharge of the chlorine solution as required from the chlorine tank into the water which will be disinfected. Based on the calculation, the dimensions of solar energy chlorinator tool described at table 1. The steps of implementation were: 1. Preparing tools and materials 2. Measuring the water source discharge Cipolity weir Q = 1.859 L H 3/2 3. Checking the residual chlorine, DSC, pH, temperature, coli bacteria, odor and taste, of water source before chlorine disinfection 4. Measuring the chlorine requirement as disinfectant to keep the remaining chlor in the source water < 7 ppm 5. Making a solution of water and chlorine for 2 day-need. 6. Installing a type A chlorinator device at a water source to produce residual chlorine < 7 ppm with replication of 10 times each. 7. Checking the content of chlorine, DSC, pH, temperature, coli bacteria, odor and taste, in water source after chlorinator disinfection with variation of location (distance): (at water source: 0 m; 500 m and 1000 m) 8. Entering the examination results in the table to analyze the effectiveness and capacity of chlorinator type A. 9. Repeating the above procedure to chlorinator type B Table 1. Details of type A and B solar energy chlorinators with equipment specifications No Unit Specification 1 Water discharge 1.0 lt/s 2 chlorine Disinfectant material (50% active ingredient) powder form and Chlorine requirement in accordance with laboratory test 3 Disinfection tub Disinfection tub capacity: 50 l; Unit of fittings and accessories of pipe ¼ dim PVC; Flexible hose 4 Chlorinator type A with Type of submersible; 3 watt power; Voltage 3 to 6 volt; Max discharge: 2 l/min; submersible pump for Maximum discharge heat of 3 m; Ø 7 mm nozzle; Dimensions: 24 mm x 45 mm x chlorine distribution. 33 mm 5 Chlorinator type B with Type of submersible; Power 6 Watt; Voltage 6 to 9 volt; Discharge 4 l / min; pump for the maximum discharge heat 6 m; Ø nozzle 7 mm; Dimensions: 90 mm x 55 mm x 55 distribution of chlorine. mm 6 Flash mixing (Chlorine stirrer) Type of submersible; 4.2 watt power; 12 volts; Discharge 240 l / h; max heat section 3 m; Ø 8 mm nozzle; dimensions: 24 mm x 45 mm x 33 mm 7 Unit of battery battery Size 12 volt / 21 Ah; Type of dry battey; Number of 6 pieces, parallel circuit 8 Unit solar cell Set / Unit control: 1 piece; Max Voltage: 17.8 V; Current at pmak (IMP): 1 A; Hort circuit current (isc): 0.63 A; Dimensions: 550 mm; 450 mm and: 35 mm; Pole buffer: 1 unit 9 Cell circuit control 1 unit Dimensions: 2.4 cm; width 13 cm and height: 8 cm; mechanic box 10 Voltage stabilizer Unit stabilizer: I fruit; Power: 12 watt; Dimensions: 200 mm; 75 mm; 100 mm RESULTS Flow Discharge and Chlorine Need {Q) x (DSC + SC) The average water discharge entering the reservoir was 1.0 L / s and was required = KK = = [(1 L /s) x (0.55 ppm + 0.5 ppm)] = 2.1 mg / L 50% Mechanism of The Tool Working mechanism of solar energy chlorinator type A and B is principally the same and can be explained as follows: The received heat of sunlight will be converted into energy inserted in battery through digital cell circuit control mechanic box. This cell circuit control mechanic box is set to be off if the battery has been fully 14 volts and if battery down to 10.9 volts. At the range of 10.9 to 14 volt batteries the device will charge the battery simultaneously supplying power to the submersible pump during sunlight. The submersible pump supplies a chlorine solution with a continuously determined flowrate at the source water flowing in the reservoir pipe. The balance between chlorine and disinfected water discharge must result in <7ppm chlor residue and should not be 0 ppm(4). This solar energy chlorinator is equipped with a Voltage Stabilizer that functions as an energy storage as well as a current stabilizer. Solar Energy Chlorinator The type A and B solar energy chlorinator devices have the same components. What makes them different principally is submersible pumping power. Type A solar energy chlorinator uses 3 submersible pumps. The produced discharge of the device, operationally, can be used to penetrate the chlorine solution and the excessive discharge of the pump returns to chlorine tank functions as stirrer. The advantage of this device is a smaller pump power than the type B solar energy chlorinator. Thus, it needs less battery energy supply. In normal sunlight conditions solar cell heating takes 3 - 4 hours for the battery to be fully charged and can be used for 24 hour- operation without running out of battery power. Principally, both chlorinator type A and B are the same. What makes them different is that chlorinator type B uses 6 watt-submersible pump power. The specialty of this tool was more powerful so it has greater power of mixing. In normal sunlight conditions solar cell heating takes 4 - 5 hours for the battery to be fully charged and can be used for 24 hour- operation without running out of battery power. Voltage 14.4 13.9 13.4 voltage 12.9 12.4 11.9 11.4 10.9 10.4 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 dalam jam 20 21 22 (in hour) Figure 2. The relation between battery charging and pump performance in chlorinator type A Voltage 14.4 13.9 13.4 voltage 12.9 12.4 11.9 11.4 10.9 10.4 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 dalam jam 18 19 20 21 22 (in hour) Figure 3. The relation of battery charging to pump performance on type B chlorinator device The result recapitulation Table 2. Recapitulation of measurement results on Temperature, pH, Odor and E coli bacteria on resevoir and household piping network using Chlorinator type A and B Chlorinator type The measured parameters were performed 10 times replication with the mean result at the distance (m) Temperature (0C) pH) Temperature (0C) Chlor residual E coli/100 ml 0 500 1000 0 500 1000 0 500 1000 0 500 1000 0 500 1000 A 25.15 26.14 25.15 7.14 7.09 7.04 Tbs Tb Tb 0 0 2 0.58 0.50 0.20 B 25.46 25.99 25.31 7.14 7.08 7.1 Tbs Tb Tb 0 0 1.3 0.62 0.49 0.18 DISCUSSION Based on the results, it is described as follows: Temperature The results of the average temperature measurements at a distance of 0 m, 500 m and 1000 m range between 25.15 to 26.140 C both on the use of chlorinator type A and B. Based on Permenkes 492/2010(4), even the temperature is still eligible but it appears cold as Panekan village is located on the eastern slope of Lawu mountain and north of Magetan. pH The use of type A and B chlorinator in table 2 shows the average ph measurements in the measurements of 0 m, 500 m and 1000 m ranging from (7.04 till 7. 1400 C) and in this condition pH (neutral), the water still qualifies as drinking water(4). According to Amen, et al. (2012) that the effectiveness of chlorine is also influenced by the pH (acidity) of water. Chlorination will not be effective if the water pH is more than 7.2 or less than 6.8(6). Smell The result of odor measurement in Table 4.7 shows that after treatment of type A and B chlorinator, there is little odor of chlor at a distance of 0 m and the residual chlor ranged from 0.58 to 0.62 ppm. While lower concentration occurs at a distance of 500 m and 1000 does not effect on odor. E. coli bacteria It appears at a distance of 1000 m with residual chlor 0.18 to 0.20 per 100 ml sample. While at a distance of 0 m and 500 m there is no bacteria E coli because the residual chlor range from 0.49 to 0.62 ppm. This shows that when the remaining chlorine in water is more than 0.49 ppm, it is free of coli bacteria but the rest of chlorine should not be more than 0.7 ppm(4). Thus, the farther the water flows, the less the remaining chlor will be, as well as the disinfectant effectiveness. The existence of chlorine residue in the water indicates the loss of pathogenic bacteria such as coliform, E coli. In Disinfection the speed and effectiveness of disinfectant depends on several factors(7) ie type of microorganism, number of microorganism, age of microorganism, spread pattern, type and concentration disinfectant, contact time, environmental factor (temperature, ph, water quality) Supporting factors The availability of location as a place of research got rock PAMSIMAS chairman (public water supply) and leader of Panekan Village. Constraint factor 1. Weather, sunlight solar cell energy sources affect battery charging performance as submersible pump resources. 2. Location: middle of rice field far from settlement need safety concern of tool (included in tandon room except solar cell). 3. The variation of fluctuation of the discharge, need calculation of chlorine solution fulfill the requirement <7 ppm(4). 4. The corrosive properties of chlorine should be noted the use of metal-containing equipment and the use of chlorine powder will occur sediment and foam that can clog the pipe CONCLUSION Based on the results of research and discussion, it can be concluded as follows: 1. Chlorinator type A (submersible 3 watts) and type B (submersible 6 watt submersible pump) consist of solar cell, mechanical box control circuit cell, Voltage stabilizer, cable circuit, and chlorine 2. Performer chlorinator type A residual chlor at a distance of 0 m sd 1000 m is 0.58 ppm sd 0.2 ppm and type B residual chlor at a distance of 0 m sd 1000 m is 0.62 ppm to 0.18 ppm in an effort provision of clean water that is suitable for public consumption according to Permenkes No 492, 2010. From the data research results, it should be further investigated how long the durability, lifetime, operation and maintenance of the chlorinator tool, improve Chlorinator performance, use of chlorine type. REFERENCES 1. Pemerintah RI. 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