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Study of Chlorine Use in Water Treatment at the Giri Menang Regional Drinking Water

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Abstract: Population growth causes the need for clean water to increase. Disinfectants that are often used in the water treatment process include Chlorine. The right Chlorine residue is one of the important aspects that ensures water reaches consumers with good quality. The purpose of this study is to conduct a study on the use of chlorine in raw water treatment at the Giri Menang Mataram regional drinking water company. This research is a study; this study was carried out in the working area of the Regional Drinking Water Company Giri Menang Mataram. This Research is a study on the suitability of chlorine levels in raw water at the Giri Menang Mataram Regional Drinking Water Company. The stages of the study begin with preparation, data collection, data analysis, discussion and producing study results to determine the suitability of chlorine levels with applicable regulations. From this research, the results obtained are that the manufacture of chlorine in the Giri Menang Mataram Regional Drinking Water Company is not in accordance with the calculation for chlorine needs in each water source, resulting in a lot of sediment. It is hoped that the Giri Menang Regional Drinking Water Company can review the use of chlorine in accordance with the appropriate dosage calculation.

Keywords: Chlorine; Disinfectants; Water Processing.

Introduction

Water is the most important element for human life besides air. The existence of a population in an area cannot be separated from the availability of clean water in that area. Management of water resources is a very important aspect for the success of development, because water is a primary need for human life. However, recently, the guarantee of water availability has become a global environmental problem, considering the increasing need for water while the population continues to grow. Contrary to the tendency of increasing water needs, the availability of water sources has decreased, especially since the availability of clean water is becoming increasingly rare. Rivers, which are the largest source of raw water for clean water, have been polluted by domestic and industrial waste [1].

The government has issued regulations regarding clean water quality standards, namely the Decree of the Minister of Health of the Republic of Indonesia No. 907/Menkes/SK/VII/2002 and updated with the Regulation of the Minister of Health of the Republic of Indonesia No. 492/Menkes/SK/IV/2010. This regulation must be met because water that does not meet clean water standards will be dangerous to health [2].

Water quality is usually the standard for drinking water companies when water enters the clean water treatment plant (WTP), then goes to the reservoir. However, water quality related to chlorine residue (disinfectant) and chlorine solution residue has not received good attention during planning or operation. Moreover, after the issuance of government regulations (PP No. 16 of 2005), it was required that in 2010 the clean water network become a drinking water network. Raw water or water that is not of drinking water quality (water that can be drunk directly) is not allowed to be distributed to the public [3].

With the regulation, it means a very significant change in standards that has consequences for changes in infrastructure and overall management, so it is necessary to think in that direction to change the paradigm of drinking water and management of water networks in pipes. The infrastructure in the form of a pipe network system that currently exists is mostly planned without considering various factors related to water quality while flowing in distribution pipes [4].

The content of pathogenic bacteria in water is an important parameter in determining the level of water quality, with the indicator commonly used being the amount of Escherichia coli content with a CFU value in 100 mL. In the process of processing clean water or drinking water itself, supervision is generally carried out on the presence of microorganisms in the water that has been treated, and the remaining chlorine available [5]. However, this supervision is not continued when the water has left the Reservoir and when it enters the distribution network. While in the distribution network pipe, water quality can decrease, causing the water to no longer meet drinking water quality standards when it reaches consumers [6].

The right residual chlorine is one of the important aspects to ensure that water reaches consumers with good quality, and it will have a direct impact on the content of microorganisms in the water. In addition, residual chlorine is a hazardous compound that will endanger human health if consumed. Trihalomethane (THM) is the largest element contained in residual chlorination products and is carcinogenic [7]. The higher the chlorine dose and the more

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organic material contained in the water, the greater the potential for the formation of disinfection residual products (DBPs). Based on the Regulation of the Indonesian Minister of Health No. 492/MENKES/PER/IV/2010 concerning Drinking Water Quality Standards, Chlorine levels must not exceed 5mg/L. [8]. In addition, high chlorine content often results in consumer complaints due to odor and taste. Therefore, proper management and supervision are needed to ensure that no residual solution is wasted into the surrounding area and to avoid excess chlorine residue [9]. The right comparison between microbiological quality and the right amount of residual chlorine addition can be used as an indicator of the success of the disinfection process in a drinking water treatment system [10].

Research Methods

This Research is a study on the suitability of chlorine levels in raw water at the Giri Menang Mataram Regional Drinking Water company, as many as 10 raw water source points, spread across 5 (five) sub-districts in West Lombok Regency, including Narmada, Lingsar, Gunungsari, Labuapi and Sekotong sub-districts. The 10 (ten) source points include: Royal Madinah Housing Borehole, Sembung WTP, Telagsari Reservoir, Montong Spring, Orong Petung Spring, Saraswaka Spring, Langko Reservoir, Penimbung SPL, Graha Permata City Borehole and Sekotong Reservoir

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Tools

To support the experimental procedures in this research, several tools and equipment were utilized, including stationery, a meter, weighing scales, a 25-liter bucket, a stirrer, rubber gloves, safety glasses, and protective clothing.

Materials

The Materials used in this research include 15kg of Chlorine Powder and Water. How to make a chlorine solution to calculate the amount of chlorine that is used in the processing of raw water at the Giri Menang Mataram Regional Drinking Water Company

Equipment Preparation

Always wear appropriate personal protective equipment (PPE) before handling chlorine powder, including chemical-resistant rubber gloves to protect the skin, safety goggles or a face shield to prevent eye irritation or injury, and a lab coat or protective clothing to avoid contact with hazardous substances. Ensure that all handling and preparation activities are conducted in a well-ventilated area, preferably under a chemical fume hood, to prevent the accumulation of harmful vapors or dust. When measuring the chlorine powder, use a calibrated digital scale or an analytical balance with high precision to ensure accurate dosing, which is essential for both the effectiveness of the solution and the safety of the procedure [11].

Calculation

Calculate how much chlorine powder is needed to achieve the desired concentration (0.4464%). For example, if you want to make 10 liters of solution, you will need 0.04464 liters or about 44.64 ml of pure chlorine.

Dilution

Take a suitable container, usually plastic or glass that is resistant to chlorine. If you want to make 10 liters of solution, add water to the container until it reaches about 9.95536 liters (9,955.36 ml). Make sure the water is clean, free from contaminants.

Chlorine Addition

Add chlorine powder to the water while stirring continuously. Mix thoroughly so that the chlorine dissolves in the water. Make sure not to inhale the vapor produced during the stirring process.

Stirring

After adding the chlorine powder, stir the solution gently to ensure that the chlorine is completely dissolved in the water. You can use a stirring tool or stir by hand if necessary.

Storage

After preparing the chlorine solution, transfer it carefully into a clean, dry, and chemically compatible storage container, preferably one made of high-density polyethene (HDPE) or another chlorine-resistant plastic material. Ensure that the container has a tight-fitting, leak-proof lid to prevent the escape of chlorine gas, reduce the risk of contamination, and minimize exposure to light and air, which can accelerate the degradation of the solution. Label the container clearly with the contents, concentration, and date of preparation, and store it in a cool, dry, and well-ventilated area away from direct sunlight, heat sources, and incompatible chemicals..

Study Stages

The Study Stages are a series of study processes. The study stages that will be carried out include preparing materials and equipment for surveys and documentation of the raw water source. Next, collect field data, observe the amount of chlorine powder usage and the location of chlorine solution waste disposal. Once completed, the survey and observation data will be processed and analyzed to obtain an overview of chlorine powder usage every day according to the required regulations. Furthermore, from the analysis results, recommendations will be given on the use of chlorine powder according to calculations and the handling of chlorine solution waste.

Data used for the study

Data on the use of chlorine powder in each raw water source, Data on the use of chlorine solution in each

raw water source and Data on water requirements in making chlorine solution.

Data Analysis Techniques

Data obtained from all measurements are analyzed thoroughly to determine whether each test result for each parameter has experienced significant changes or not, so that it can be used as a consideration in making management and monitoring policies.

Results and Discussion

Description of Water Source Points of PDAM Giri Menang that uses Chlorine

In general, the number of raw water sources managed by PDAM Giri Menang is more than 25 points, which are spread across the West Lombok Regency. As an illustration of chlorine use, samples were taken from 10 raw water sources (Springs and drilled wells), more details can be seen in Table 1.

Table 1. Location and Coordinate Point

No	Location Name	Coordinate Point
1	Royal madinah housing driling well	-8038’4”S and 11605’5”E
2	WTP Sembung	-8037’3”S and 11609’53”E
3	Reservoar Telagasari	-8035’39”S and 116011’45”E
4	Water Springs Montong	-8034’33”S and 116013’8”E
5	Water Springs Orong Petung	-8032’55”S and 116014’37”E
6	Water Springs Saraswaka	-8034’12”S and 116010’43”E
7	Reservoar Langko	-8033’6”S and 11609’49”E
8	SPL Penimbung	-8032’43”S and 11608’45”E
9	Graha Permata City Drilling Well	-8034’56”S and 11609’5”E
10	Reservoar Sekotong	-

Use of Chlorine Solution in Clean Water Treatment at the Giri Menang Mataram Regional Drinking Water Company

In the clean water treatment process conducted by the Giri Menang Regional Drinking Water Company in Mataram, varying doses of chlorine are applied at different stages and locations within the treatment system. This variation is based on several factors, including the quality and source of the raw water, the specific treatment objectives at each unit, and the need to maintain optimal residual chlorine levels throughout the distribution network. By adjusting the chlorine dosage accordingly, the company aims to ensure effective disinfection while minimizing the formation of harmful disinfection by-products and maintaining compliance with national drinking water quality standards. The chlorine requirements used in the processing of clean water can be seen in Table 2.

Table 2. Chlorine requirements used in the processing of clean water

No	Water Source	Daily use of Chlorine (Kg)
1	Royal madinah housing driling well	1
2	WTP Sembung	45
3	Reservoar Telagsari	90
4	Water Springs Montong	2
5	Water Springs Orong Petung	1
6	Water Springs Saraswaka	1
7	Reservoar Langko	10
8	SPL Penimbung	0.5
9	Graha Permata City Drilling Well	0.5
10	Reservoar Sekotong	0.5

The table above shows that of the 10 (ten) raw water sources managed by PDAM Giri Menang, the levels of chlorine use vary from the lowest 0.5 kg to the highest 90 kg, with the tank size used being between 550-1050 liters.

Chlorine is the most widely used disinfectant because it is effective at low concentrations, inexpensive, and forms a residual when used at the right dose [12]. Chlorine's disinfection ability comes from its properties as a strong oxidizer. Chlorine oxidizes enzymes that function as metabolic processes in microorganisms [13].

The amount of residual chlorine used at each water treatment plant

In the manufacture of chlorine solutions carried out by field officers, there is residual chlorine solution that cannot dissolve in water when the solution is made; this becomes a problem when it is disposed of in the soil or water bodies. The amount of residual chlorine used at each water treatment plant can be seen in Table 3.

Table 3. Residual chlorine solution in every water source

No	Water Source	Daily residual chlorine amount (Grams)
1	Royal madinah housing driling well	982
2	WTP Sembung	44.190
3	Reservoar Telagasari	88.380
4	Water Springs Montong	1.964
5	Water Springs Orong Petung	982
6	Water Springs Saraswaka	982
7	Reservoar Langko	9.820
8	SPL Penimbung	491
9	Graha Permata City Drilling Well	491
10	Reservoar Sekotong	491

The table above shows that the remaining chlorine solution, assuming a calculation of 80% of the chlorine powder used, is mostly dregs, with the largest remaining chlorine solution being in the Telagasari reservoir.

Chlorine is a strong oxidizing compound that is dangerous if it enters the human body. Chlorine, even at low concentrations, can affect the taste and odor of drinking water, causing consumers to complain or use alternative sources [14].

Based on research conducted on the distribution of the Lulut River IPA, Bandarmasih Regional Drinking Water Company, the results of field sampling of the clean water distribution network system of the Lulut River IPA, Bandarmasih Regional Drinking Water Company, showed that chlorine residue in customers was in the range of 0.2-0.7 mg/l [15].

Calculation of Chlorine Requirements for Clean Water Treatment at the Giri Menang Matarm Regional Drinking Water Company

Based on the calculations that have been carried out, the chlorine requirements for water treatment in each water source can be seen in Table 4.

Table 4. Chlorine Requirements in Each Raw Water Source

No	Water Source	Daily Chlorine Requirements	
		Grams	Kg
1	Royal Madinah housing driling well	111.6	0.1116
2	WTP Sembung	1339.2	1.3392
3	Reservoar Telagasari	2578.4	2.6784
4	Water Springs Montong	223.2	0.2232
5	Water Springs Orong Petung	111.6	0.1116
6	Water Springs Saraswaka	111.6	0.1116
7	Reservoar Langko	334.8	0.3348
8	SPL Penimbung	55.8	0.0558
9	Graha Permata City Drilling Well	55.8	0.0558
10	Reservoar Sekotong	55.8	0.0558

The table above provides an overview of the chlorine needs in each different raw water source, according to the provisions of the amount of chlorine powder needed to make a chlorine solution, if the need for chlorine powder for 1 liter of water is 4.464 grams. So, the table above shows the highest daily chlorine powder needs in the Telagasari reservoir of 2.7 kg (2,678.4 grams). While the lowest chlorine use is SP Sembung, GPK, Sekotong, 0.06 kg (0.0558 grams).

To calculate how much chlorine solution is needed, we first need to calculate how much chlorine powder is needed per day, then calculate how much volume of water will be chlorinated in 2,016 m³. Daily chlorine powder requirement: The expected level is 60% of 15 kg of chlorine powder per day. To calculate how much chlorine powder is needed, we use the following formula: Daily requirement (kg) = 60% x 15 kg = 0.60 x 15 kg = 9 kg. The volume of water to be chlorinated in 2,016 m³: We know that we want to chlorinate 2,016 m³ of water. The concentration of chlorine solution required: To calculate the concentration of chlorine solution needed, we can use the formula:

Concentration (%) = (Daily requirement(kg)/Water volume(m³)) x 100%

Concentration (%) = (9 kg / 2,016 m³) x 100% ≈ 0.4464%

Chlorine is a hazardous and toxic chemical. Always wear appropriate personal protective equipment (PPE) when handling chlorine and follow safety guidelines set forth by local authorities. Be sure to avoid direct contact with chlorine and avoid mixing chlorine with other chemicals that can produce hazardous gases [16]. To make a chlorine solution with a concentration of approximately 0.4464%, it is necessary to calculate how much chlorine and water are needed. This concentration can be expressed as the ratio of the weight of chlorine to the total weight of the solution [17].

In the case of making a chlorine solution, the chlorine requirement per litre/day must be considered. So that the provision of chlorine does not leave dangerous sediment. The solution is made by inserting chlorine powder into a 25 liter bucket, taking a measurement of 1 kg from a total of 15 kg of chlorine powder is taken based on the assumption of not using scales, even from 45 kg of chlorine powder divided into 12 buckets of 25 liters in a day [18]. The manufacture of chlorine that has been carried out so far does not comply with the calculation of making chlorine solution, resulting in sediment or residual chlorine solution [19].

If the manufacture of chlorine solution is in accordance with the correct stages and calculations in each source of raw water of the Giri Menang Regional Drinking Water Company, the chlorine powder will decompose by itself in the water and will not leave any residue or sediment of chlorine solution [20]. The emergence of dregs or residue of chlorine solutions in the field is basically caused by the calculation and dosage of making the chlorine solution that is not yet correct [21].

Conclusion

Chlorine production carried out so far does not comply with the calculations for making chlorine solutions, resulting in sediment and residual chlorine solutions. The use and production of chlorine solutions currently carried out need to be reviewed in accordance with the calculations for making chlorine solution doses. Chlorine with a dose exceeding the specified value can have a significant impact on humans and the environment. Exposure to chlorine can cause irritation to the eyes, skin and respiratory tract, as well as digestive disorders. At high doses, chlorine can cause poisoning and even death. In the environment, chlorine can disrupt aquatic ecosystems, reduce the number of plankton and small organisms, and affect water

temperatures, which can disrupt migration patterns and reproduction of living things.

Author's Contribution

Azwaruddin: Manage Permitss and Collect Data. Taufik Abdullah: Searching for supporting literature for compiling research results and compiling research result. Sri Wahyuningsih: Compiling research results and publication in scientific journals

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