The Utilization of Aluminum Sulfate Dosage with Jar Test at a Local Water Treatment Company in Jambi City

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ABSTRACT

Surface water before being used for certain purposes should be treated by special treatment. This process such kinds of procedure reducing the turbidity of the water. A kind of attention to the source water is cultivating the water by installing water treatment for the sake of the water that is produced is proper to be distributed to the society, and moreover safe for consumption. The local company that does this kind of treatment in Jambi City is the local drinking water company, Tirta Mayang. By using the coagulant, aluminum sulfate, at the treatment processing, this company cultivates the source water from the Batanghari River. Three factors determine the success of the coagulant that is used, listed various chemicals, doses of chemicals, and the mixture of chemicals that are used. By using the jar test, this research yielded that the utilization of aluminum sulfate significantly reduces the turbidity with the doses depending on the number of turbidities.

1. Introduction

The source of water that needs to be for humans is coming from rivers, wellsprings, rain, etc. Therefore the quality of water for society should be a concern in order for society to have clean water and satisfy the health condition of water to fulfill their needs [1]. Surface water should be treated by special treatment before being used for certain purposes. This process such kinds of procedure reducing the turbidity, color, and bacteria effect on the water. Technology applied from getting the source, the cultivating process, and the distribution of water by pipe from the station area to the people must be qualified for the standard quality of clean water. A kind of attention to the source water is cultivating the water by installing water treatment for the sake of the water that is produced is proper to be consumed and distributed to the society.

Jambi is a province on Sumatera island, Indonesia. This province has a river that is the longest also the widest in Sumatera, namely the Batanghari River. Batanghari river through Jambi city, and this river is the raw water for Jambi people to do some activities and moreover also for consuming in their life. In recent years, this source of water contaminated by several activities around the river, such the industrial waste, domestic waste, and fish cages around the river. These activities influence human health if the water used is not treated well. Several cultivating processes that can be held are coagulating, fluctuating, sedimenting, and filtrating. The quality of the water in the river determines by the condition of the circumstance listed as topography, land use, and activities around the river [2].

Raw water from the river can be cultivated by using filtrating–adsorbing technology. This uses layering with silica, activated charcoal, coconut, cotton, gravel, cellulose membrane, carbon granule, active carbon, reverse osmosis membrane, and ultraviolet (UV) lighting for disinfection [3]. Furthermore, the cultivation of raw water depends on the characteristics of the quality of the water itself. Surely, the cultivation method that was used, will be evolved the pollution in the water. The main factors that mention the water as polluted are the total of the bacteria as the pathogen, the turbidity, floating things, taste and smelt, and organic compounds [4]**.** The precise cultivation of raw water will decompose the turbidity, as well as the pure color of raw water, which exceeds the quality standards, namely coagulation, flocculation, and sedimentation units [5].

Tirta Mayang is the name of a local company in Jambi city that cultivation of the Batanghari river for the society in Jambi, especially for the people in Jambi city. The treatment is done in this company for the sake of can be distributed to all people in Jambi city in the line of setting off from the company. The cultivation of this company is using coagulating-fluctuating methods. The chemical processing in the step of treatment is a mixture of several compounds as coagulants with raw water from the Batanghari river such that homogenous substances formed.

Three factors determine the success of the used coagulant as follows, the various utilization of chemical compounds, the doses of chemical compounds, and the mixture of the used chemical compounds. Fitriyanti in [6] presents the earning of their research that the utilization of aluminum sulfate as the coagulant is effective for reducing the turbidity also the color of the liquid waste of coal by 99%.

Tirta Mayang company used aluminum sulfate ($Al_2(SO_4)_3$) as the coagulant in that company. $Al_2(SO_4)_3$ is a kind of coagulant that clears up the raw water and is mentioned as the derivative of such kind of the widest of aluminum that is available in commercial in powder-formed also liquid form.

The turbidity of raw water has many factors, such as the disposal of people's activities, depth of river, and is also caused by the season. This challenges the cultivation company to do the treatment on the water for the sake of the water that can be drunk by the people. When the raw water quality is not proper to be consumed, the company should be doing the preparation for clean water also qualified. Therefore, the company doing the cultivation also operates the water treatment plant (WTP). There are several processes at the WTP in the company. One of them is water purification. The solid particle that is suspended in the water, and the colloid or pseudocoloid in the raw water are difficult to precipitate. It will be chaged into a bigger particle, which is called a floc, also with the higher density so that it can be separated easily in the sedimentation processing [7].

The coagulation process binds the water colloid particles by using the coagulant which will run into the bottom of the shelter. It can be done either automatically or manually. The mixing process in the coagulating by sure dose influences the purification of water. Certainly, the dose that mixes with the raw water need to be set for the sake of the doses can be fixed. The determining dose of coagulant doing every several hours by using jar-test. The abnormal situation of the measuring of $Al_2(SO_4)_3$ is not good for the quality of water so the efficiency of the coagulating-fluctuating process depends on the utilization of $Al_2(SO_4)_3$ doses.

Oktaviasari in [8] in the previous research found that the involving parameter in the jar-test that is significantly effective for the purification of turbidity in the water is the doses of coagulant, the timing of the fast mixture, and the timing of the slow mixture at the coagulant, with contribution value 62.00%, 10.39%, and 16.03% respectively. Previous research, Nisa in [9] yields that as high as the dose level of PAC as the coagulant used for at-water cultivation gives the effect that the value of pH, turbidity, and total hardness value were decaying smoothly. However, Coagulant aluminum sulfate is believed to be better than poly–aluminum–chloride (PAC). It is effective also economically [10]. Moreover, Aluminum sulfate as the coagulant declined iron standard in the water until 0.74 mg/L. The amount of 30 ppm used has effectively reached 96.10 percent [11].

Further, sampling in the water treatment processing needs to be ensured for the sake of the real activity that can be applied in the company. The values of turbidity, bacteria, taste, smelt, pH, and

organics compound need to be checked. However, because the analysis in this paper concern to use jar – test only, certain factors only will proceed.

Factors that influence the optimum doses of Aluminum Sulfate are the turbidity values and pH of raw water, only. The optimum coagulant dose values are obtained by sampling the water treatment in the jar – test [12].

The various doses of the raw water in the treatment are following the initial quality of water. Corresponding to the conditions needs to do jar tests frequently in order to control dosing in the treatment processing. The low concentration of alkali in the water becomes an acid condition. In effect, it needs to control the pH of water as long as the water is cultivated. Jar test has been set on for determining the quality of water to be proper for consumption based on coagulating – fluctuating processing [13].

Yield to hold the dose of $Al_2(SO_4)_3$ as the coagulant in the purification processing, the cultivation of raw water from the local company is using jar test in the installation of water cultivation in a specific area called Broni, Jambi City. This treatment is concerned with solving the turbidity, pH, and suspension of chemicals in the raw water, of the Batanghari river.

2. Research Methodology

2.1. Materials

Raw water used in this research is the water from the Batanghari river. Moreover, the material used in this research is aluminum sulfate ($Al_2(SO_4)_3$). This compound is acidic and influences the pH of raw water. The decaying of pH depends on the content of the raw water that impacts coagulating-fluctuating processing. For checking the purifying condition in the water used the implementation of jar test arrangements by four goblets with a capacity of 1000 ml per glass, also besides stirring use the electric stirrer. The liquid of $Al_2(SO_4)_3$ that is used is 1%. The additional chemical compounds used are Brom Cresol Purple (BCP), and Brom Thymol Blue (BTB).

2.2. Procedures

First, the raw water is collected in the shelter at the main station in the company. Every cubic of raw water should have the raw data, especially for this research listed as pH, and the values of turbidity. Further, the coagulant put on the water station, and the raw water should be mixed well with that coagulant. Based on the pursuit of this method, is to find the sure value of $Al_2(SO_4)_3$ dose. With the addition of the coagulant, the doses will be fixed based on the testing results by jar test. This test should be done until the standard value hold.

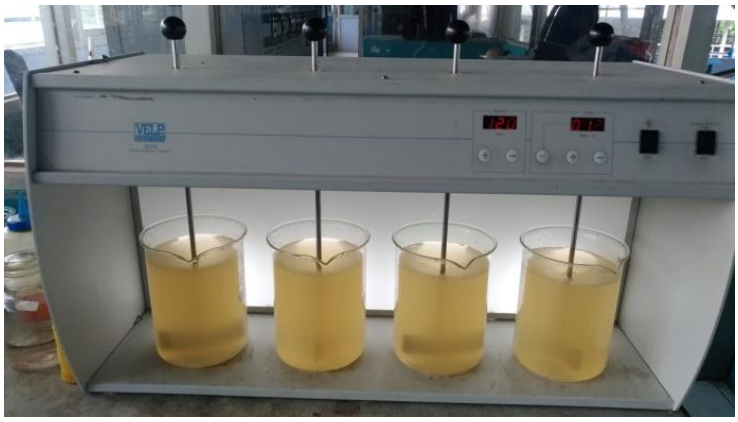

Fig.1. Jar-test implementation

2.2.1 Jar test

The jar test is a method for knowing the coagulants' capacity and clarifying the optimum doses in purification processing in water treatment [14].

The cultivating water processing should be through a jar test for the finishing parameter of the water treatment procedure. A jar test is done at every distinguishing process from the water

treatment, and based on the conditions face in the laboratory. This information will be used for the future step of coagulant additional or several actions for uncontrolled the occurring in the treatment of water. The utilization in the coagulation, fluctuation, also purification will be carried out from the result of this kind of test.

Several parameters should be noted in every procedure in the test written as the coagulant doses also the second coagulant, pH, methods of coagulant augmentation, the velocity of chemical solvent, times, and representation of the water for the purification.

The doses of coagulant in the cultivation processing calculate by using the following formula

$$q = \frac{Q \times X \times 60}{C \times 1000} \qquad \ldots\ldots(1)$$

where q, Q, X, and C are representations of doses of coagulant (ml/minute), debit intake (L/s), optimum dose (ppm or mg/L), and the concentration of aluminum solution respectively. The efficient cultivation processing made several observations that needed to be applied. At the jar test, an initial step of fluctuation processing as usual only needs around 1 minute after the addition of the chemical compound. The best result will be shown at 3,5 until 5 minutes after the experiment. The uncontrolled result indicated that the affixing of chemical compounds is out of the notes. It means that the experiment needs to be justified. Be careful about the disturbance in the jar, it will make chaotic of the result in the tube experiment.

2.2.2 Turbidity value

Turbidity represents the properties of the optical from the water that determining from the lighting adsorption and shining from the materials in the water, unity by Nephelometric Turbidity Unit (NTU). The measuring process will be handled by a turbidimeter. By connecting the tool to electricity, the sample of the water will be calculated on a turbidimeter, and the result will appear on the screen of the tool.

2.2.3 pH of water treatment

The common value of acidity in the water namely by pH. By a certain interval, the water will be classified as acid or alkali as well. The value of water pH shows us the negativity logarithm from hydrogen activities in the water. This measuring will be held on the raw water from Batanghari river, also to the product as the result after the mixture of water and chemical compound as the experiment procedure above.

3. Results and Discussion

Raw water from the Batanghari river simulated the test in the jar. This kind of jar test is a procedure for cultivation processing as mentioned above. Further, the treatment to the jar is set off the treatment of the dose on the raw water for a certain time, and data from raw water, and the data after treatment by the coagulation process can be shown in Table 1.

Table 1. Observation data and treatment data

Day	1st month					2nd month				
	Raw water		Clarify		Doses of coagulant (mg/L)	Raw water		Clarify		Doses of coagulant (mg/L)
	pH	Tb (NTU)	pH	Tb (NTU)		pH	Tb (NTU)	pH	Tb (NTU)	
1	6.6	141	5.8	7.64	45	6.9	155	6.0	7.54	50
2	6.6	183	5.8	7.98	45	7.0	145	6.1	7.25	48
3	6.6	138	5.8	7.65	45	7.0	139	6.1	7.61	48
4	6.6	122	5.8	7.32	45	7.0	123	6.1	7.64	48
5	6.5	141	5.7	7.44	42	7.0	126	6.1	7.32	48

6	6.5	174	5.8	7.37	42	7.0	122	6.2	7.44	50
7	6.5	226	5.8	7.52	42	7.0	126	6.2	7.68	53
8	6.4	251	5.8	7.92	42	7.1	133	6.2	7.83	53
9	6.4	256	5.7	7.83	42	7.0	277	6.0	7.51	61
10	6.4	236	5.7	7.92	42	7.0	221	6.1	7.49	58
11	6.4	228	5.7	8.64	45	7.0	324	6.1	7.51	58
12	6.4	208	5.7	8.32	45	7.0	312	6.1	7.56	58
13	6.4	194	5.7	7.71	45	7.0	265	6.1	7.31	58
14	6.4	186	5.7	7.63	45	7.0	383	6.0	7.63	61
15	6.4	181	5.7	7.56	45	7.0	187	6.0	7.84	58
16	6.4	164	5.7	7.64	45	7.0	181	6.0	7.56	58
17	6.4	169	5.7	7.82	45	7.0	204	6.0	7.81	61
18	6.4	210	5.7	7.76	48	7.0	235	6.0	7.68	61
19	6.4	182	5.7	7.53	48	7.0	252	6.1	7.94	61
20	6.4	184	5.7	7.49	48	6.9	197	6.1	7.62	58
21	6.4	178	5.7	7.88	45	6.8	388	6.0	7.53	56
22	6.4	174	5.7	7.94	45	6.8	222	6.0	7.52	56
23	6.4	173	5.7	7.65	45	6.8	166	6.0	7.34	53
24	6.4	177	5.7	7.87	45	6.8	196	6.0	7.22	53
25	6.4	176	5.7	7.93	42	6.8	169	6.0	7.62	53
26	6.4	182	5.7	7.86	42	6.8	173	6.0	7.56	53
27	6.5	175	5.7	8.21	42	6.8	183	6.0	7.72	56
28	6.5	164	5.8	8.34	42	7.0	181	6.1	7.54	58
29	6.5	158	5.8	8.12	40	7.0	163	6.1	7.58	58
30	6.5	153	5.8	7.39	40	7.0	156	6.1	7.43	58
31	6.5	160	5.8	7.44	40	7.0	148	6.1	7.33	58

Data collected by split months, mention as 1st month and 2nd month, given the different values of pH, and turbidity. By figuring out data into several graphs, it can be shown that the distinct values of 1st month, and 2nd month that have significant differences. Both values of pH and turbidity from raw water dominate in 2nd month that having higher values than the condition in 1st month. Most of the days in the 2nd month have high turbidity values, and moreover, all days in the 1st month have more acid than the whole day in the 2nd month. The detail can be shown in Figure 2, that is presenting the value of pH and turbidity of raw water at both of 1st month and 2nd month.

Raw water that is not qualifying for society's needs will be treated by adding the coagulant into the water with certain doses needed. The $Al_2(SO_4)_3$ as the coagulant in this treatment has the pursuit

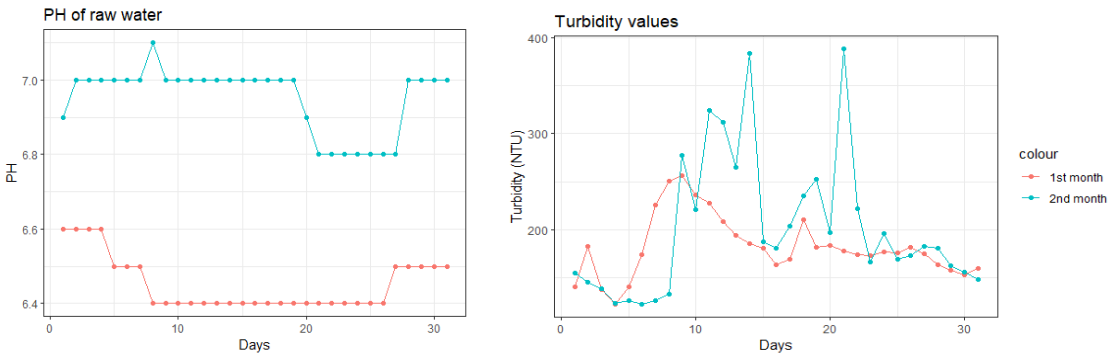

Fig.2. Graphs of raw water by months of observation

as the remover of the mud in the water so that the water got its purify, or at least the number of turbidity decaying. Obviously, by Table 1 we can see that the turbidity (Tb) value before and after treatment has a significant difference, also the pH condition in both months. However, the opposite wishing is yielded to this position, that additional coagulant also decays the value of pH, meaning that the water needs to be cultivated for the sake of the standard value of pH allowed. So many values reducing and running out of great value for the standard value of consuming water. By Figure 3, it can be seen that the pH of more acid than before treatment, that is around 0.8 for every treatment processing.

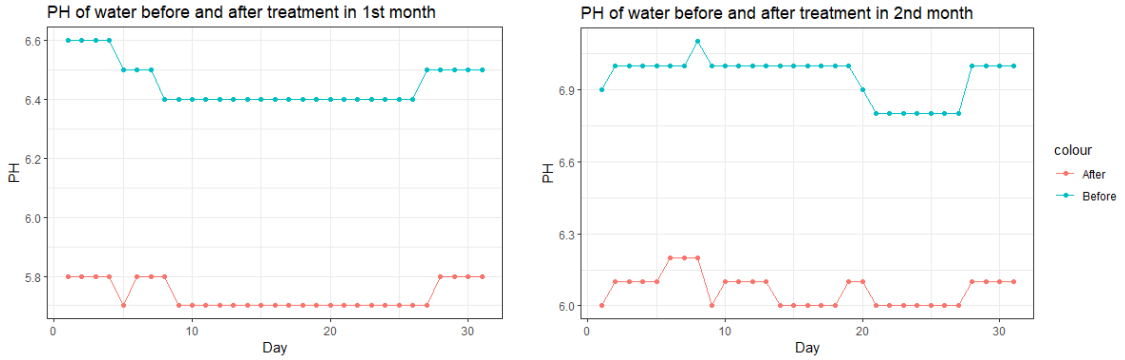

Fig.3. Decreasing value of pH after treatment at 1st and 2nd months

Surely this coagulation process decays the value of pH in both months because the coagulator of the treatment is acid form. So, before water distribution, its need to be control by next process in the company in order to satisfy the standard of pure water from the company, such as filtration, disinfectan, etc.

High values of turbidity in the water will affect the doses of coagulants that are used in the treatment. The comparing doses of $Al_2(SO_4)_3$ based on months of observation are presented in Figure 4. By using equation (1), it yields that the doses of coagulant in 2nd month is greater than utilization in the 1st month.

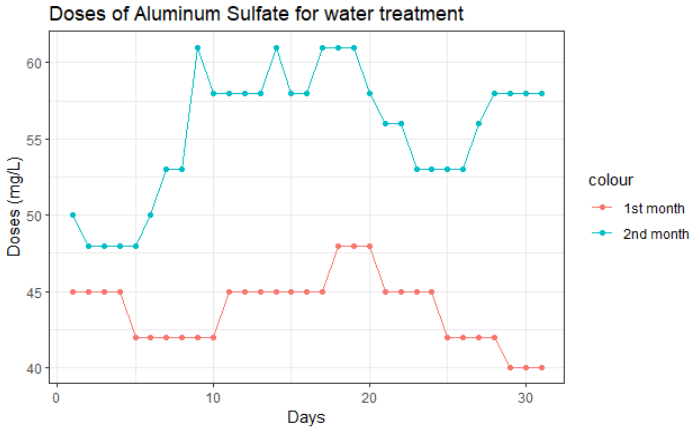

Fig.4. Doses of coagulant in the treatment

The turbidity values are split by months and the treating process are presented in Figure 5. Even though the shapes of the turbidity of raw water and clarify are not equal, however, $Al_2(SO_4)_3$ processing has been taking place as a good coagulant because the value of turbidity after treatment decaying significantly, and the values are in the interval of turbidity threshold, that is between 5 – 10 NTU.

It's clear that the utilization of $Al_2(SO_4)_3$ as the coagulant in the water treatment at the water treatment company in Jambi City yields the purification of water, and it's only needed next step for ready distribution.

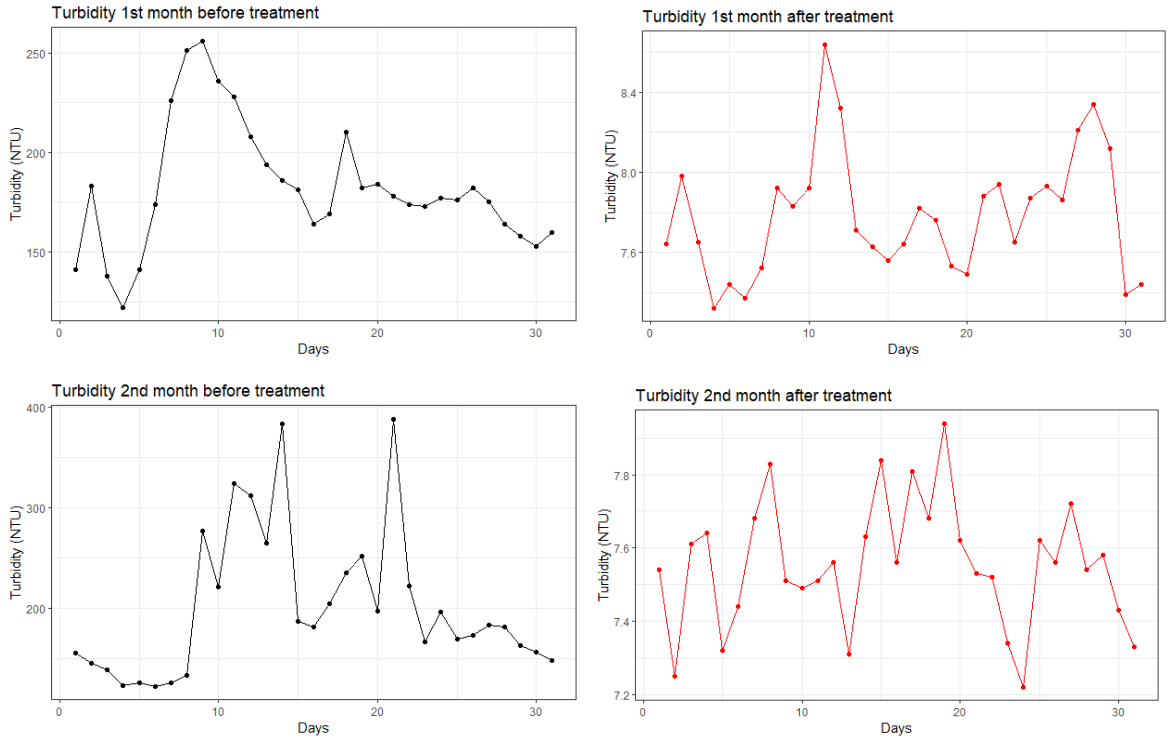

Fig.5. Turbidity shapes before and after treatment

4. Conclusion

The doses of coagulant in water treatment company yield great result. It show that the number of turbidity in both months of observation is in turbidity threshold, that is between 7 – 9 comparing to the standard value 5 - 10. The utilization of coagulation, especially $Al_2(SO_4)_3$ is depend on the value of turbidity.

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