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Discharge Variation Effect for Iron and Manganese Concentration Reduction Efficiency in Dug Well Water By The Sand Filter Technique at Mulyorejo Utara Surabaya

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Abstract:- Ground water quality problems that used the public was less qualified as drinking water. Ground water usually contains iron (Fe) and manganese (Mn) on high level. They were caused the yellow color of the water into the tub wall and yellow spots on clothes. This research purposed to determine the influenced of flowrate variance in removal of Fe and Mn from groundwater used activated sand filtration technique. Variance of flowrate as independent variable and removal of Fe and Mn as dependent variable. This research used three variance of flowrate, they were 15 ml/minute, 30 ml/minute, and 60 ml/minute by activated sand thickness was 110 cm. Three of flowrate variance and $KMnO_4$ was used for activating the sand media. Data was analyze by descriptive analysis used Canberra Matrix and Group Average Clustering Methods. This research result was the decreasing of flowrate would eliminated Fe and Mn. Efficiency removal of Fe with the variance of flowrate 15 ml/minute, 30 ml/minute, and 60 ml/minute, respectively were 53.98%; 53.48%; 45.39%. Removal of Mn efficiency with the variance of flowrate 15 ml/minute, 30 ml/minute, and 60 ml/minute respectively were 97.29%; 96.91%; 88.96%. The best effect to remove Mn was on flowrate 15 ml/minute.

Keywords:- activated sand filtration, flowrate, removal of Fe and Mn

I. INTRODUCTION

Ground water quality problems that used the public was commonly less qualified as drinking water. Ground water usually contains iron (Fe) and manganese (Mn) on high level. The content of Fe and Mn caused the yellow color of the water into the tub wall and yellow spots on clothes (Primary, 2010)[1]. Therefore, using groundwater as a source of drinking water have to fullfill drinking water quality standards. According to the Regulation of the Minister of Health No.492/Menkes/PER/IV/2010 about drinking water quality requirements, the concentration of Fe maximum for drinking water was 0.3 mg/l and the concentration of Mn maximum for drinking water was 0.4 mg/l (Anonymous, 2010)[2].

One of the processing systems tool that could be used was an aerator then forwarded to the active sand filter. Rakhman research (2001)[3] showed that the most effective combination to reduced the Fe concentration was the process of aeration and active sand filter using a filter height variation. The most effective combination that could reduce Fe was at a height of 110 cm, the reduction reached 98.8% (with aeration process preceded). This study used a household scale drinking water treatment equipment by using a combination of aeration and active sand filter process (silica sand which had been activated by KMnO4). The aims of this research was found the most effective discharge for reducing Fe and Mn. The result of this research would be recommended to public.

II. MATERIALS AND METHODS

This study starts from the preparation stage to assemble active sand filter reactor and make active sand media. Activation of filter media could be done by washing the silica sand (measuring 0.4-0.8 mm) with water, and then to activate the sand, sand soaked for 24 hours in a solution of KMnO4, then drained and dried in the sun. Silica sand that had been dried were put into the furnace with ± 500^0C for 1 hour and then put in to oven with a temperature of 105^0C for ± 1 hour. When the sand was not in hot condition, put it in the filter column.

Actively sand incorporated into the filter column had been prepared as high as 110 cm, previously it had been filled as high as 20 cm of gravel that served as a buffer to the active sand media did not qualify for the faucet effluent. Charging filters column to create a water column height of 10 cm above the surface of the active sand media, then turn the aerator influent and effluent discharge setting in accordance with a predetermined discharge was 15ml/min. Figure 1 was a schematic of the reactor active sand filter.

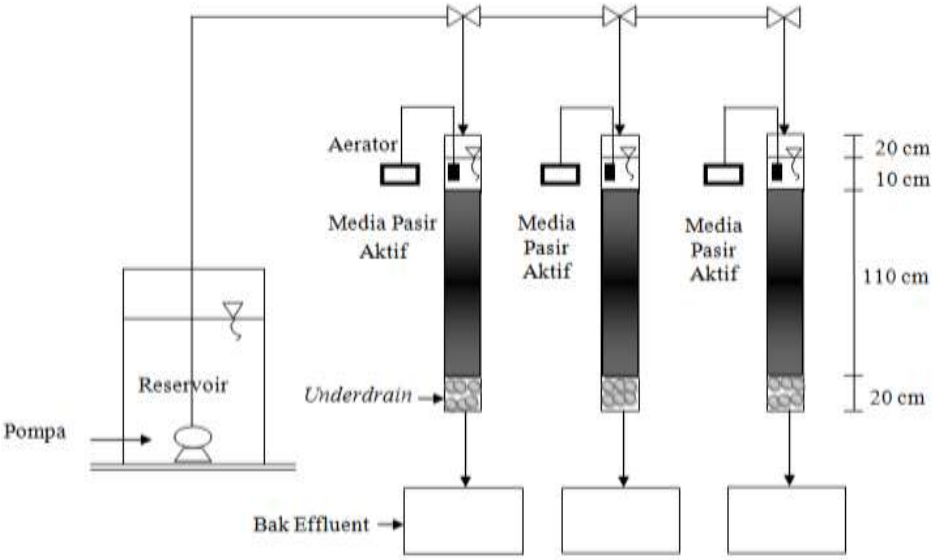

Figure 1 schematic active sand filter reactor

Continuous mechanism in this study started from the raw water was continuously pumped from the reservoir to the reactor and then a process of preliminary aeration and filtration processes. Parameters measurement (pH and temperature test) of discharge arrangements made every day in the influent and effluent point of each reactor. Discharge measurements performed with a measuring cup, where the water was collected in a measuring cup and note several time it took to fullfill the specified volume. Faucet openings arranged to obtain the appropriate flow 15 ml/min, 30 ml/min, and 60 ml/min. Water sampling for the testing was the influent and effluent of the reactor, sampling was performed at 0, 16, 24, and 40, then analyzed concurrently after the 40th hour. It was took at 4 points, ie points in the influent (in the reservoir), the point on the active sand filter reactor effluent with flow rate 15 ml/min, a point on the active sand filter effluent flow rate of 30 ml/min and a point on the effluent active sand filter reactor with a flow rate of 60 ml/min.

Data were analyzed by descriptive analysis and efficiency analysis. efficiency Analysis was in order to illustrate the efficiency of Fe and Mn concentration decrease at discharge various with active sand filter.The value can be obtained from the equation:
The percentage decrease (%)

$$\% = \frac{(Co - C1)}{Co} \text{ x } 100\% \quad (1)$$

Descriptive analysis was performed using Canberra index by the following formula:

$$Ic = 1 - \frac{1}{n} + \sum \left\{ \left(\left| \frac{Ya - Yb}{Ya + Yb} \right| \right) \right\} \quad (2)$$

Once the canberra index was calculated then proceed with Group Average Clustering Methods analysis.The final results were expressed in the form of a dendogram level of similarity or dissimilarity in all variations of discharge.

III. RESULTS AND DISCUSSION

1. Fe concentration Efficiency Decreased in the Active Sand Filter reactor

The results of Fe concentration measurements after being subjected to the active sand filter that each column filter based on discharge variations could be seen in Figure 2.

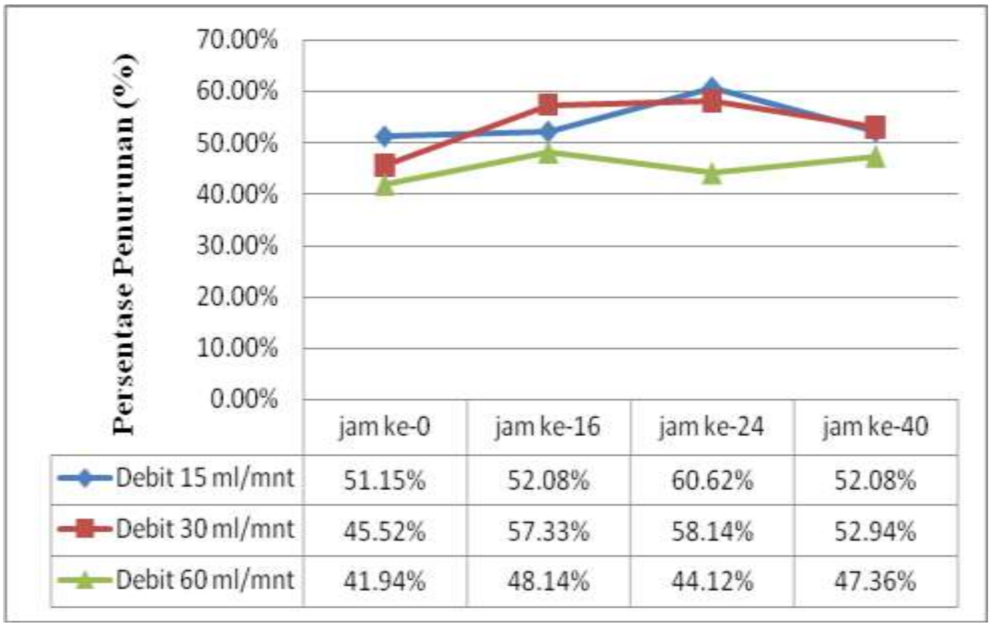

Figure 2 Efficiency Decreased of Fe concentration

The ability of each column in the Fe concentrations lower was different. The average reduction efficiency in the Fe concentration in each column of the filter after 40 hours of continuous research amounted to 53.98% for the discharge of 15 ml/min, 53.49% for the discharge of 30 ml/min, and 45.39% for the discharge of 60 ml/min.

The test results showed that the active sand filters can only decrease the concentration of Fe on average by 50%. This was due to several factors such as lack of control over the water pH as well as preliminary aeration process less effective. Based on the results of pH value measurements was known that the average pH of the influent (before treatment) of 6.23. While the average pH value in the effluent (after treatment) of each column was a sieve with 6.30 for debit column 15 ml / min, 6.37 to discharge the filter column with 30 ml / min and 6.39 for the filter column with discharge of 60 ml / min. The pH value should be equal to or more than 7 on the oxidation process to reduce the concentration of Fe from the water wells (Barlokova and Ilavsky, 2010)[4].

According to Joko (2010)[5] that at neutral pH and the presence of dissolved sufficient oxygen, then the ferrous ion (Fe^{2+}) were dissolved can be oxidized to ferric (Fe^{3+}) ions and subsequently formed a precipitate. Important factors in addition to the pH value and Fe concentration in the influent that was noted a decrease in the efficiency of Fe concentration was the contact time between the water with filter media (HRT), the thickness of the medium, the chemicals composition in the medium, the KMnO4concentration, and the backwashing process and regeneration of filter media (Barlokova and Ilavsky, 2010)[4].

2. Fe Parameter Data Analysis

Descriptive analysis was used to determine removal efficiency differences in Fe concentration of discharge different variations. This analysis was used Canberra Index followed by Group Average Clustering Methods. The results of analysis showed that the discharge variation did not make a difference to the decrease efficiency of Fe concentration by using active sand filter.

3. Efficiency Decrease of Mn concentration in Active Sand Filter Reactor

This study was to determine the efficiency of Mn concentration decrease based on the operating time of the reactor, then made a graph illustrating the relationship. Efficiency decrease in the Mn concentration in each filter column based on variations in discharge could be seen in Figure 3.

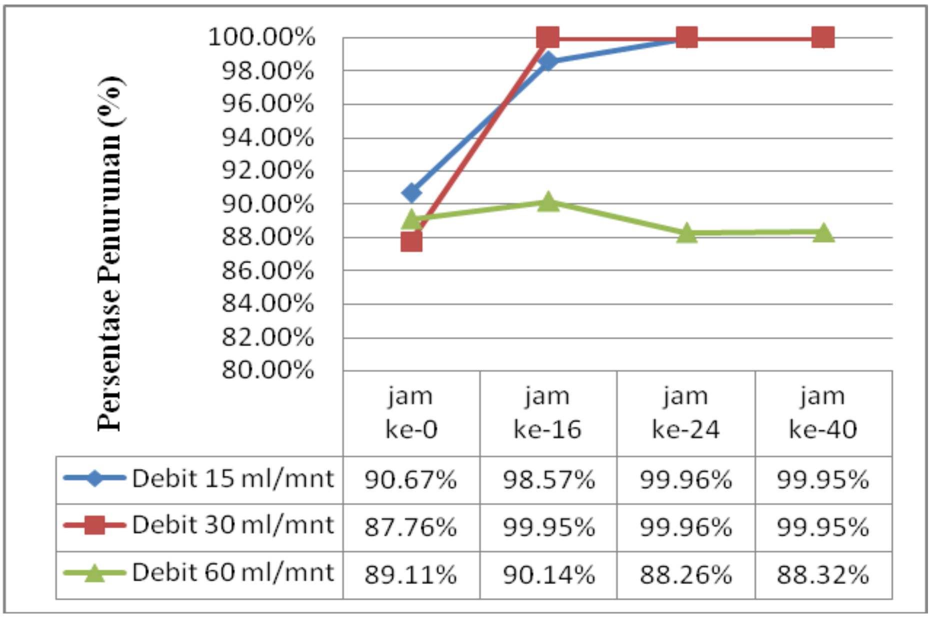

Figure 3 Efficiency Decreased concentration of Mn

Figure 3 showed the relationship between the efficiency of Mn concentrations decrease with time of reactor operation. There were 3 treatment, 2 of them experienced a decrease in the concentration of Mn increased efficiency. This showed that every column of filter had different capabilities in reducing the concentration of Mn. The ability of active sand filter in reducing the Mn concentration had a similar pattern with Fe, where the shorter the contact time and the discharge greater, it could reduced the ability of the filter to the decreased levels of Mn.

Based on it, an active sand filter reactor could decreased the concentration of Mn in the water wells. Overall efficiency of each column filters would increased along the length of operating time, but would decreased if the media had reached a saturation point. The average efficiency of the resulting decreased in concentration after active sand filter was 97.29% for debit sieve column 15 ml / min, 96.91% for the filter column 30 ml / min, and 88.96% for debit column with 60 sieve ml / min.

The measurements of the Mn concentration after active sand filter were known that the average concentration of Mn removal efficiency was 94%. This suggested that the processes took place in the column filters work well. According to Joko (2010)[5] iron and manganese removal efficiency of one of them depends on the type of oxidant used. Type of oxidant used in accordance with the order of the strength of oxidation from largest to smallest was KMnO4 →Chlorine → O2. Based on Roccaro et.al research (2007) in Zogo et al. (2011)[6] found that after experiencing the process of oxidation with KMnO4 obtained efficiency decreased by 95% of the Mn concentration in the well water.

When compared with the percentage decreased in the Fe concentration results, so decreased concentrations of Mn to obtain better results, it was due to differences in the characteristics of Mn atoms. Mn atom had a radius greater than Fe. This leads to an opportunity Mn filtered in the media pores more. While Fe (because it had an atomic radii smaller), so had opportunity to escape from the larger pores. So that Fe would be adsorbed unoptimal.

4. Data Analysis of Mn Parameters

The descriptive analyzes was used to determine differences of Fe concentration decreased efficiency in different variations of discharge. This analysis was done by using Canberra Index followed by Group Average Clustering Methods analysis. It showed that the variation of the discharge treatment made a difference to the efficiency of Mn concentration decrease. This was supported by the results of the efficiency decrease of Mn concentration on several discharge variations. It found that on 15 ml / min was gave the best results in lowering the concentration of Mn.

IV. CONCLUSION

The most effective discharge for reducing Fe was the discharge of 60 ml/min and the most effective discharge for reducing Mn concentration was discharge of 15ml/min. The Canberra index and Group Average Clustering Methods analysis showed the variation of the discharge did not provide a Fe concentration decrease, however the best result was gave different efficiency decrease of Mn concentrations with flow 15 ml/min. So it was suggested for next research to use another experiment or use another variation of discharge for reducing Fe and Mn concentration in dug well water, so the best research would be recommended to public.

ACKNOWLEDGEMENTS

An Based on the results of this research and discussion, it could be concluded as follows:

1. Decrease Efficiency in Fe concentration that could be achieved by active sand filters based on variations of the discharge was 53.98% for the discharge of 15 ml/min; 53.48% for the discharge of 30 ml/min; and 45.39% for the discharge of 60 ml/min and a decrease of Mn concentration efficiency could be achieved by active sand filters based on variations of the discharge was 97.29% for the discharge of 15ml/min; 96.91% for the discharge of 30 ml/min; and 88.96% for the discharge of 60 ml/min.

2. Descriptive analysis of the Canberra index followed by Group Average Clustering Methods showed the variation of the discharge did not provide a Fe concentration decrease, however the best result was gave different Mn concentrations efficiency decrease with flow 15 ml / min.

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