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Separation of Manganese Metal Ions with Natural Zeolite Adsorbents and Activated Charcoal of Shall Water use Column Adsorption Method

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ABSTRACT

The purpose of this study is to determine the effectiveness of natural zeolite and activated charcoal to reduce levels of manganese in shall water, determine the effect of contact time with the effectiveness of separation of manganese metal in a shallow well water and know the condition before-after the adsorption process. Method that used was column adsorption with a flow system in which sample is applied to the filtration tube containing zeolite and active carbon. The tests carried out included testing of drinking water parameters namely pH and TDS, testing of manganese content in a shallow well water using Atomic Absorption Spectrophotometer (AAS). The results showed the effectiveness value of natural zeolite adsorbent and activated charcoal using an adsorption column to reduce manganese content in a shallow well water of 90.404%. The longer the use of natural zeolite and activated charcoal, the effectiveness of reducing the manganese content in a shallow well water tends to decrease. A shallow well water samples before the adsorption process have safe conditions for pH and TDS parameters, for manganese metal parameters are also still below the appropriate threshold (SNI) number 01-0220-1987 and RI Permenkes No.492 / MENKES / PER / IV / 2010, after the process of adsorption of f a shallow well water is safe for consumption.

Keyword: *: Column adsorption, zaolite effectiveness, water quality*

1. INTRODUCTION

Water is a source of life that humans need to meet all their needs such as cooking, bathing, washing and other needs. Water sources can be classified into several types namely rainwater, surface water, ground water, and sea water. The water source most used by humans is groundwater such as in the shallow well water, because it is relatively better than other water sources in terms of quality, especially its turbidity. One of them is the use of a shallow well water for the community in Tegalyoso Village, Klaten. Ground water as a source of clean water can generally be used directly for daily life. However, without realizing it, groundwater contains many metal elements dissolved in water, one of which is manganese, which can interfere with the body's health if it is continuously consumed in high quantities (Santropie, 1984).

High concentrations of Mn in a shallow well water can cause health problems. According to Widowati, et al. (2008) the exposure to manganese (Mn) causes obesity, glucose intolerance, blood clots, skin disorders, skeleton disorders, decreased cholesterol levels, resulting in birth defects, hair

discoloration, nervous system disorders, heart problems, liver problems, and vascular vessels, a decrease in blood pressure, resulting in defects in the fetus, brain damage, and irritation of the digestive organs. Therefore, according to Health Ministry of Republic Indonesia Regulation No. 492/MENKES/PER/IV/2010, the permissible level of Mn in drinking water is 0.4 mg/l.

The metal content of manganese pollutants in groundwater can be reduced in various ways, one of which is the adsorption column method which is considered easier and more applicable. The adsorption method is easier in terms of equipment and material search, does not require a large area, and in operation does not require special expertise, so it is suitable for the community and has been widely proven to separate metals (Rahman, 2004). Adsorption is the process of adsorbate accumulation on the adsorbent surface caused by the attractive forces between the adsorbate molecules and the adsorbent surface. The interactions that occur in the adsorbate molecule with the surface may be followed by more than one interaction, depending on the chemical structure of each component (Pehlivan et al, 2013). Adsorption is considered an economical and effective method for removing metal content because it is relatively inexpensive, regenerable, and relatively simple (Al-ayubi et al, 2010).

There are many materials can be used as adsorbent, such as silica (Liu, et al, 2009; Saputri & Priyambodo, 2019), activated carbon (Tran, Chao & You, 2018; Santi, et al, 2019), clay (Auta & Hameed, 2012; Chay, et al, 2020), etc. Natural zeolite and activated carbon have the potential to be used as adsorbents (Khanday, et al, 2017). This research uses natural zeolite and activated charcoal as adsorbent or adsorbent. Natural zeolites are abundant in nature, have a high ion exchange capacity, cheap, have high selectivity, and stable (Erdem and Donat, 2004). According to Abdur Rahman and Budi Hartono that water Soil is passed through a glass column filled with zeolite, Fe content can be reduced to 55%, while Mn content can be reduced to 100%. Analysis of manganese metal content can be done using Atomic Absorption Spectroscopy (AAS) method. The choice of the atomic absorption spectrophotometer method is because it has high sensitivity, is easy, cheap, simple, fast, and requires little samples and does not require preliminary separation (Suyanta, et.al, 2015).

Based on this background, it is necessary to conduct a study on the separation of manganese metal ions in shallow a shallow well water in the village of Tegalyoso Klaten using an adsorption column with natural zeolite adsorbent and activated charcoal. This research was conducted on a field scale which aims to determine the effectiveness of natural zeolite and activated charcoal to reduce levels of Mn in a shallow well water water using the adsorption column method, to determine the effect of contact time on the effectiveness of separation of manganese metal in shallow a shallow well water using the adsorption column method. Analysis of manganese metal ion levels can be done using the Atomic Absorption Spectrophotometer (AAS) method.

2. RESEARCH METHOD

The research was conducted in Tegalyoso Village, Klaten Regency on a field scale. The independent variables in this study were the usage period of natural zeolite and activated charcoal, namely the usage period of the 1st day, 7th day, 14th day, 21st day, 28th day and 35th day of using natural zeolite and activated charcoal. The materials used are natural zeolite, activated charcoal, and distilled water. The natural zeolite used is not activated unless it is washed with clean water. Activation is not carried out because the amount of adsorbent used is large so it will be ineffective if the activation process is carried out. The process of a shallow well water adsorption by natural zeolite and activated charcoal is carried out in a resident's well in Tegalyoso Village, Klaten. The tools used are 2 sets of adsorption columns made of PVC material with a height of 150 cm and a diameter of 80 cm for a column containing natural zeolite and a height of 120 cm and a diameter of 50 cm for a column containing activated charcoal. The complete form of the tool can be seen in Figure 1. Other tools used in this study are pH meters, TDS meters, buckets, water pump machines, and atomic absorption spectrophotometry.

Figure 1. Series of Column Adsorption Method Water Treatment Equipment using Natural Zeolite Adsorbent and Activated Charcoal

The adsorption process in a shallow well water begins with flowing using a water pump. The a shallow well water sample containing manganese ions is passed into the first column containing natural zeolite. Water that has passed through the column containing natural zeolite is then flowed to the second column which contains activated charcoal. It then flows through a new fertilator and then exits through the faucet and is ready to be removed for analysis. The water from the adsorption results is then analyzed using an Atomic Absorption Spectrometer (AAS) which is used to determine the concentration of manganese contained in the well. Analysis of a shallow well water samples with AAS was carried out at the Water Chemistry Physics Laboratory of the Center for Environmental Health Engineering and Disease Control BBTKLPP Yogyakarta.

3. RESULTS AND DISCUSSION

Before separating and testing manganese in a shallow well water, a number of drinking water parameters were tested. The parameters tested were pH and TDS (*Total Dissolve Solid*). This drinking water parameter test was carried out to determine the extent to which natural zeolite adsorbent and activated charcoal can improve water quality

Table 1. Data of pH Parameter Test Results

Day (duration of use)	pH Result*	
	A	B
1st	7,1	7,4
7th	7,1	7,4
14th	7,1	7,5
21st	7,1	7,5
28th	7,1	7,5
35th	7,1	7,6

*A: before adsorption

B: after adsorption

In this study, the measurement of water pH was carried out before the a shallow well water passed through the adsorption column and after pass through the adsorption column. The degree of acidity (pH) in this study before passing through the adsorption column was 7.1. After passing through the adsorption column the resulting pH was 7.5. This shows that the treatment of natural zeolite and activated charcoal does not significantly affect the pH of a shallow well water. If the results are compared with the Health Ministry of Republic Indonesia Regulation No. 492/MENKES/PER/IV/2010 regarding drinking water requirements, the permissible pH ranges from 6.5-8.6 so that the water treated with natural zeolite and activated charcoal is still within the permissible standards.

Table 2. Parameters Test Result Data TDS

Day (duration of use)	Results of TDS (ppm)	
	A	B
1st	171	162
7th	171	157
14th	171	152
21st	171	152
28th	171	148
35th	171	146

*A = Before adsorption
B = After adsorption

TDS (*Total Dissolved Solids*) in the a shallow well water sample before passing through the adsorption column treated with natural zeolite and activated charcoal at 171 mg/L, after passing through the adsorption column the of TDS result was 153 mg/L. This indicates an insignificant decrease in TDS. The decrease in TDS can improve water quality because the large number of dissolved substances will determine whether the water is fit for consumption or not. The smaller the TDS content, the better the water is for consumption. Drinking water quality standards for TDS parameters according to Health Ministry of Republic Indonesia Regulation No. 492/MENKES/PER/IV/2010 is 500 mg/L, so the treated water is still safe for consumption because it is still within the predetermined threshold.

Table 3. Test results of Manganese concentration in a shallow well water sample

Day (duration of use)	Manganese concentration (mg/L)		Efficiency (%)
	A	B	
1st	0.297	0.012	95.960
7th	0.297	0.020	93.266
14th	0.297	0.028	90.572
21st	0.297	0.030	89.899
28th	0.297	0.033	88.889
35th	0.297	0.048	83.838

*A = Before adsorption
B = After adsorption

Based on the table above decreased levels of manganese determined by the difference between the levels of manganese ions after passing through the adsorption grading manganese ion prior to passing through the adsorption column. In general, the manganese content after passing through the adsorption column which has been treated with natural zeolite and activated charcoal has not decreased significantly.

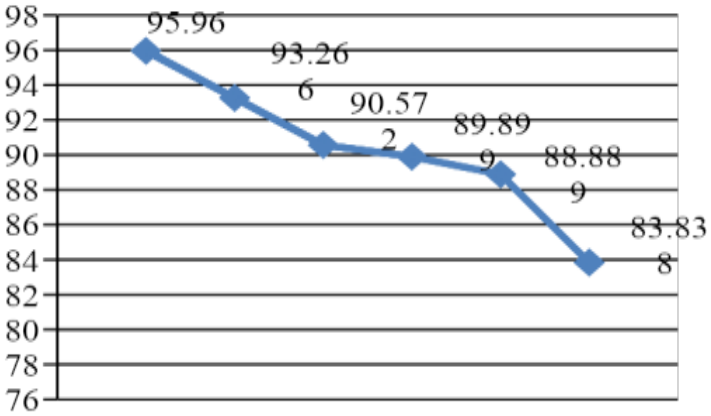

Figure 2. Graph of Manganese Reduction Efficiency in the n-Day Use

Based on the graph above, the efficiency of the adsorption power of the tool with natural zeolite adsorbent and activated charcoal against manganese metal from the first day to the 35th day of use. As the usage period increases, the efficiency of manganese metal decreases from week to week tends to decrease. The highest decrease in manganese levels occurred at the first day of use which was able to reduce manganese levels by 95.960%, while the lowest decrease was at the time of use on the 35th day of 83.838%. From the research results, the adsorption power of natural zeolite and activated charcoal in the adsorption column to decrease manganese levels in a shallow well waterwas very good with an average reduction efficiency of 90.404%. The results of the above study are in accordance with Widodo's research (2012) which shows that zeolites become saturated after being used for 42 days continuously and there is a decrease in efficiency along with the increasing usage period of the adsorbent.

4. CONCLUSION

From the research that has been done it can be concluded that the effectiveness of natural zeolite and activated charcoal can reduce manganese levels by 90.404%. The longer the adsorbent usage period, the lower the effectiveness of manganese content. A shallow well water before and after passing through the adsorption column for pH and TDS parameters is still in a safe condition for consumption. The manganese parameter is still below the threshold so that it is safe for consumption according to (SNI) and RI Health Minister Regulation No.492/MENKES/PER/IV/2010, after passing through the shallow well water column has better water quality.

It is necessary to do research with other parameters such as Pb in a shallow well water. Further research needs to be done using different sizes of natural zeolites. The adsorption efficiency graph shows that it is necessary to wash the zeolite once in 42 days to produce adsorbents that remain effective in water treatment.

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