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Effect of Filter Media Thickness on Reducing Lime Levels in Groundwater

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Abstract

Water is a necessity that cannot be separated from the lives of living things. According to the Regulation of the Minister of Health of the Republic of Indonesia, the maximum permissible level of hardness is 500 mg/l. The condition of the clean water in Kedungwaru Village, Sugio District, Lamongan Regency has lime contamination because it is located near limestone mountains, so it needs to be filtered. The purpose of this study was to determine the effect of the thickness of the filtration media of ginger coral and pumice on reducing the levels of lime in groundwater. As well as providing recommendations for filer designs based on experimental data. This research is experimental using a filtration process with ginger coral and pumice stone by varying the thickness of the filter. Based on the results of the study, there is an effect of the thickness of the filter media on the decrease in the levels of lime in groundwater. The value of the effectiveness of each filter is a decrease in lime levels. In filter 1, the reduction effectiveness was 31.88%; in filter 2, it was 36.23%; in filter 3, it was 34.78%; in filter 4, it was 39.13%; and in filter 5, it was 26.08%. The most effective result for reducing total hardness is filter 4.

Keywords*: Filtration, ginger coral, groundwater, lime level, pumice stone*

1. Introduction

Clean water is very important to meet people's needs in all activities. Therefore, it is necessary to know how the water quality is clean and can be used adequately for people's daily activities [1]. According to Regulation No. 492 of the Minister of Health of the Republic of Indonesia concerning Drinking Water Quality Requirements, the maximum permitted hardness level is 500 mg/l. The water to be consumed must not contain organic or inorganic substances that exceed the specified quality standards, have a pH in the range of 6.5–8.5, and not contain toxic chemicals that are detrimental to health. Drinking water must be tasteless, odorless, colorless, and not cloudy [2].

Clean water containing lime if used in households or industry can cause several problems, for example household use causes more soap consumption. This is because the molecules in soap are bound by the Ca element. In industry, the use of hard water can cause scale deposits on equipment and cause damage. In addition, water that has a high level of hardness can cause health effects that can cause blockage of the heart's blood vessels. (cardiovascular disease) and kidney stones (urolithiasis) [3]. Therefore, processing is needed so that groundwater can meet drinking water requirements.

The condition of clean water in Kedungwaru Hamlet, Sugio District, Lamongan Regency is experiencing contamination by lime because it is located around the limestone mountains. In hilly areas or limestone mountain areas the condition of clean water is polluted by lime, especially in dug wells around these mountains, causing the water to become hard. Measuring the low quality of groundwater caused by rock structure and soil type uses hardness parameters.

Based on the problems above, efforts can be made to reduce the levels of lime contained in ground water. One method that can be used to remove lime is filtration. In filtration, water is filtered through a porous medium to remove suspended solids from the water. The media usually used in filtration are sand, palm fiber, charcoal and zeolite [4].

In this study of the reduction of lime in groundwater, the media used were ginger coral and pumice.

Pumice is a light, porous, volcanic stone with a large surface area. It is easily and cheaply found in nature or some kinds of waste. Pumice is composed of highly micro vesicular glass pyroclastic with very thin, translucent bubble walls of extrusive igneous rock. Pumice is commonly pale in color, ranging from white, cream, blue, or grey, to green-brown or black. Pumice has an average porosity of 90%, and initially floats on water. Pumice has been widely tested and used in water treatment as an adsorbent, filter bed and support media, thus pumice stone would be a suitable candidate as an adsorbent [5].

Filtration using ginger coral and pumice as media is more effective for the water purification process, because the cavities on the surface of ginger coral have sufficient porosity for decomposing bacteria to purify the water [6]. As in the research of Alaydrus [7], the condition of the water treated using a purifier with pumice stone filter media, becomes clearer, odorless, and suitable for use. This research aims to determine the effect of the thickness of the ginger coral and pumice filter media on reducing lime levels in ground water.

2. Materials and Methods

The research used is experimental, with conditions determined and controlled by the researcher, references to literature related to the study and the existence of controls to determine whether there is a causal relationship and the magnitude of the causal relationship through certain treatments to several experimental groups and testing them as controls as a comparison.

This research uses a filtration process using ginger coral and pumice as media. The sample used was groundwater in Kedungwaru Hamlet, Karang Sambigalih Village, Sugio District, Lamongan Regency. This research was carried out by varying the filter thickness to determine the effect of filter thickness on the performance of the filtration process using ginger coral and pumice as media in reducing lime levels in ground water. An image of the research prototype can be seen in Figure 1.

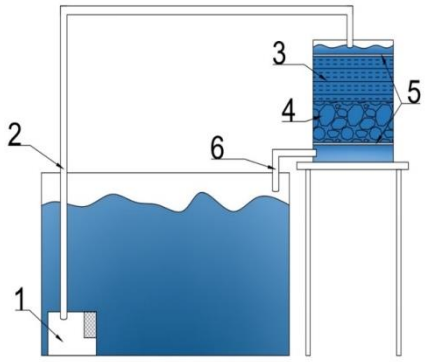

Figure 1. Prototype of the filter

The first stage in this research was to flow the groundwater samples by pump (1) through inlet pipe (2), into a filter reactor (5) containing ginger coral (3) and pumice (4) filter media with different thicknesses, and the clean water back to storage through outlet pipe (6).

There are five types of filters used, namely:

a. Filter 1 (100:0): Layer consisting of ginger coral 20 cm thick and pumice layer 0 cm thick.
b. Filter 2 (75:25): Consists of a 15 cm thick layer of ginger coral and a 5 cm thick layer of pumice.
c. Filter 3 (50:50): Consists of a 10 cm thick layer of ginger coral and a 10 cm thick layer of pumice.
d. Filter 4 (25:75): Consists of a layer of ginger coral 5 cm thick and a layer of pumice stone 15 cm thick
e. Filter 5 (0:100): Consists of a 20 cm thick layer of ginger coral and a 0 cm thick layer of pumice.

After the water was circulated for 6 hours in the reactor, samples were taken to be tested for lime content in the laboratory.

3. Results and Discussion

3.1. Research result

The results of measuring water samples with total hardness parameters can be seen in Table 1, while the percentage of effectiveness after processing can be seen in Table 2. The total hardness of well water from Kedungwaru Hamlet, Karangsambigalih Village, Sugio District, Lamongan Regency, East Java Province, before processing is e 276 mg/l and still meets the quality standards in accordance with the Regulation of the Minister of Health of the Republic of Indonesia No. 492 of 2010 concerning Drinking Water Quality Requirements [8].

Table 1. Results of the analysis of total hardness parameters

No	Research variable				Data Results
	Treatment Stages	Thickness Comparison	Thickness Variations (Ginger Coral : Pumice Stone)	Dwell Time (Hours)	Total Hardness (mg/L)
1	Before	-	-	-	276
2	Filter 1	100:0	20 cm:0 cm	6	188
3	Filter 2	75:25	15 cm:5 cm	6	176
4	Filter 3	50:50	10 cm:10 cm	6	180
5	Filter 4	25:75	5 cm:15 cm	6	168
6	Filter 5	0:100	0 cm:20 cm	6	207
Quality Standards [6]					500

Table 2. Effectiveness of Total Hardness Parameters

No	Total Hardness (mg/l)	
	Treatment Stages	Effectiveness (%)
1.	Filter 1 (100:0)	31,88
2.	Filter 2 (75:25)	36,23
3.	Filter 3 (50:50)	34,78
4.	Filter 4 (25:75)	39,13
5.	Filter 5 (0:100)	26,08

3.2. Filter Media Thickness Variation Test

In this research, media changes were made according to the planned media variants, namely 5 filter variations. The aim of processing is so that the test water meets the requirements for drinking water quality standards so that it is safe for consumption. Based on the experimental results of well water processing using filters to reduce total hardness, it has the ability to reduce with varying levels of reduction. The final concentration data can be seen in Figure 2, graph of the decrease in total hardness value with variations in filter thickness.

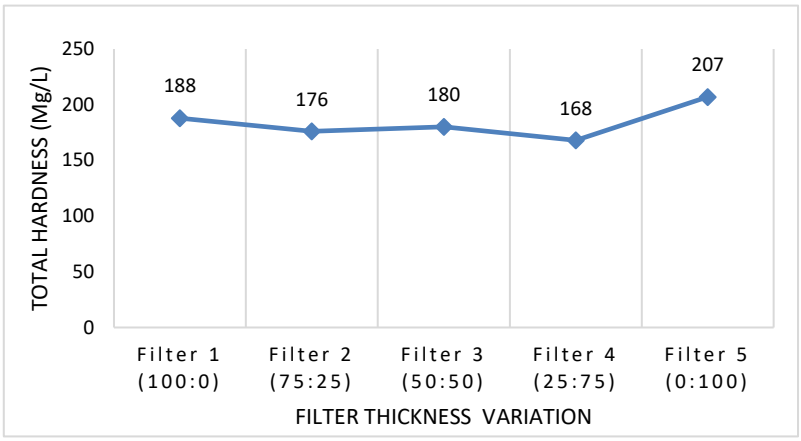

Figure 2. Graph of decreasing total hardness value with variations in filter thickness

Based on Figure 2, it shows that ginger coral and pumice as filtration media have the ability to reduce hardness with varying degrees of reduction. After processing filter 1 with a ratio of 20 cm thickness of ginger coral layer and 0 cm thickness of pumice stone, the hardness value was 188 mg/l. In filter 2 with a ratio of 15 cm thickness of ginger coral layer and 5 cm thickness of pumice stone, a total hardness value of 176 mg/l was obtained. Then on filter 3 with a layer of ginger coral 10 cm thick and pumice stone 10 cm thick, the total hardness value was 180 mg/l. On filter 4 with a layer of ginger coral 5 cm thick and pumice stone 15 cm thick, the total hardness value was 168 mg/l. Meanwhile, on filter 5 with a layer of ginger coral 20 cm thick and pumice stone 0 cm thick, the total hardness value was 207 mg/l.

The decrease in well water hardness concentration with the lowest value was found in filter 5, namely 207 mg/l. Meanwhile, the highest decrease in total hardness values occurred in filter 4, with a variation in the thickness of ginger coral of 5 cm and pumice stone of 15 cm compared to the variations in the thickness of the other filters. This is because the composition of pumice stone is greater, and the combination with ginger coral is what makes the filtering power of Filter 4 better. Apart from that, pumice has high pores, and its porosity reaches 85%. Porosity is the level of the number of holes (porous) cavities or pores in rock. Rocks are said to have high porosity if they have many holes (vesicles) or pores [9].

Meanwhile, ginger coral has the main function of stabilizing the pH of the water. The water processed through this filter enters the cavity of the pumice stone and ginger coral so that lime is trapped and the hardness of the water decreases [10]. The contents of lime water are calcium chloride ($CaCl_2$), calcium nitrate ($Ca(NO_3)_2$), calcium sulfate ($CaSO_4$), and magnesium chloride ($MgCl_2$). In filter 5, the decrease in hardness levels is not significant due to the calcium content of the lime water filtered by the pumice stone, so ginger coral is needed to stabilize the pH.

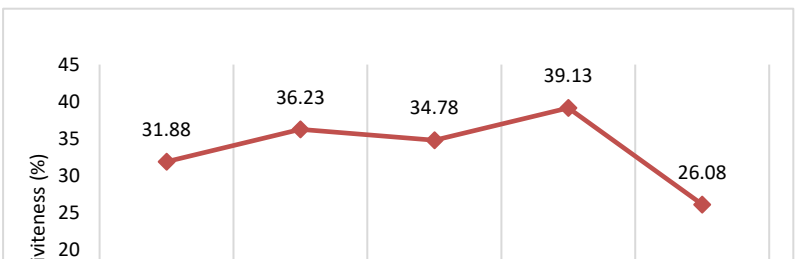

Figure 3. Graph of the effectiveness of reducing total hardness against variations in filter thickness

Figure 3 shows a graph of the percentage effectiveness of reducing total hardness values with variations in filter thickness. In filter 1, the effectiveness reduction was 31.88%, and in filter 2, it was 36.23%. Then, in filter 3, the effectiveness decreases by 34.78%. In filter 4, the effectiveness of reducing total hardness is 39.13%. Meanwhile, for filter 5, the effectiveness reduction was 26.08%; thus, the most effective result in reducing total hardness was filter 4, with higher effectiveness compared to the other filters.

4. Conclusion

Based on the research conducted, it can be concluded that filter thickness influences reducing lime levels in groundwater. The effectiveness value of each filter shows a decrease in lime content. In filter 1, the effectiveness reduction was 31.88%; in filter 2, it was 36.23%; in filter 3, it was 34.78%; in filter 4, it was 39.13%; and in filter 5, it was 26.08%. The most effective result in reducing total hardness is filter 4.

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