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The Use of Various Filtaritaion Media in Lowering the Level of Water Hardness

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Abstract: Hard water is common in areas with thick topsoil and limestone formations. Because the topography of Kupang City is in the form of limestone, in the rainy season rainwater passes through the limestone soil layer so that the raw water becomes hard or very hard. Identification and analysis of field parameters and levels of raw water hardness before and after treatment to calculate the effectiveness of decreasing hardness of various types of filter media. This research is an experimental study. The object of inspection is raw water from Oenesu springs that have undergone filter media treatment. The filter media consists of activated carbon, silica sand, quartz sand, and zeolite with a residence time of 60 minutes. The results of laboratory tests are displayed in the form of tables and graphs and analyzed. The field parameters tested are smell, taste, color, temperature, turbidity, TDS and pH to meet water quality standards. The level of hardness before and after treatment obtained raw water hardness of 365.33 mg/L, activated carbon media 362.85 mg/L, silica sand media 236.53 mg/L, quartz sand media 239.01 mg/L and zeolite media 296.59 mg/L. The field parameters tested meet water quality standards according to Permenkes 32 of 2017. The level of water hardness treated by the filtration process with quartz sand media is more effective in reducing the level of raw water hardness, with a decrease efficiency of 35.26%.

Keywords: Effectiveness; Filtration media; Hardness Water Level

Introduction

Hardness is a common problem in groundwater management. This can happen because when it is harvested from the soil, it penetrates different layers of soil, including limestone soils which contain Ca and Mg, making the water hard. Hard water is common in areas with thick topsoil and limestone formations (Shakerkhatibi et al., 2019; Sutrisno & I., 2006; Wang et al., 2022). As a result of the topography of Kupang City which is limestone, during the rainy season rainwater comes in contact with the calcareous soil layers, causing the raw water to become hard or very hard.

Hard water can cause losses in the form of disruption and or damage both technically and to human health (Mofijur et al., 2021; Jansen van Rensburg et al., 2019). Water hardness can reduce the efficiency of using soap (Verbyla et al., 2019). causes stains on glassware and flats, causes linen to turn pale, clogs flush nozzles and drains, residual water hardness can coat heating elements and reduce heat efficiency and can create metal scum in bathroom showers and bathtubs.

Various attempts have been made by residents or drinking water suppliers to reduce total hardness or calcareous water, including by heating water, processing alternative water reservoirs, and processing various drinking water products (Saravanan et al., 2021; Syafrudin et al., 2021). Another effort made to reduce the level of hardness is to use a filtration process (Beyene & Ambaye, 2019; Enfrin et al., 2019). Filtration process is the process of cleaning solid particles from a fluid by passing it through the filter media. Filtration media that are generally used in this process include zeolite, silica sand, activated carbon, anthracite, gravel and so on. The media used will be able to remove chemical and organic substances in the water which causes the water to become smelly, cloudy, and has a high hardness content to make it suitable for consumption.

Drinking water consumed for the body is in the soft category, which has a total hardness number of 60-120

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mg/lt. The impact of drinking water hardness on content above 60-120 mg/l can cause health problems in the form of kidney stones, while below 60-120 mg/l can cause minerals and cause calcium deficiency. The aims of this study were to identify and analyze the parameters of mold and raw water hardness before and after treatment, and to calculate the effect of reducing hardness by different types of filter media.

Method

This research is actual experimental research. The target of the survey is filtered raw water from the Oenesu spring. The filtration media used were activated charcoal, silica sand, quartz sand, and zeolite with a retention time of 60 minutes used as filter media. The raw water is checked for field parameters and the water produced by the filter media is tested for its hardness.

Laboratory test results are presented in the form of tables and graphs for descriptive analysis to obtain the effect of reducing hardness due to the filtration process using different types of media. The research was conducted in stages as shown in Figure 1.

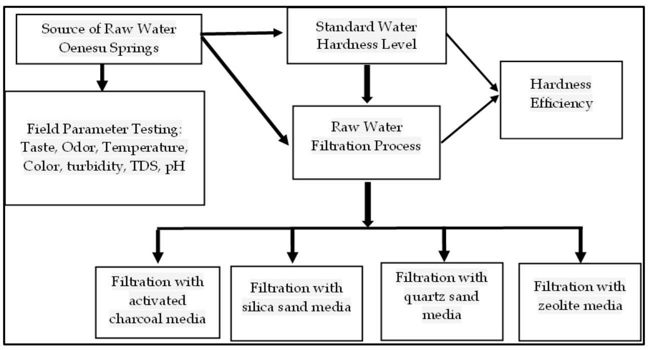

Figure 1. Stages of the Research Process

Result and Discussion

An overview of the sample before examination, when adding buffer solution and EBT and after titration is shown in the following figure.

Figure 2. The Overview of Sample

The results of examining the values of physical properties and hardness before and after treatment with filter media are show in figure 3.

Examination of the parameters of the water area of the Oenesu spring area.

The results of the study of the water parameters from the Oenesu well are shown in the table below.

Table 1. Parameter Examination Results Field on Yang Water Sourced from Oenesu Springs.

Parameter	Unit	Result
Odor	-	No Odor
Taste	-	No Taste
Temperature	^{0}C	28.3
Color	TCU	1
Turbidity	NTU	0.03
TDS	mg/L	282
pH	-	7.02

Based on the table above, it is known that all the parameters studied met the water quality standards required by Permenkes 32 of 2017.

Decreasing hardness by filtration

The graph below shows the hardness of the Oenesu spring before and after filtering.

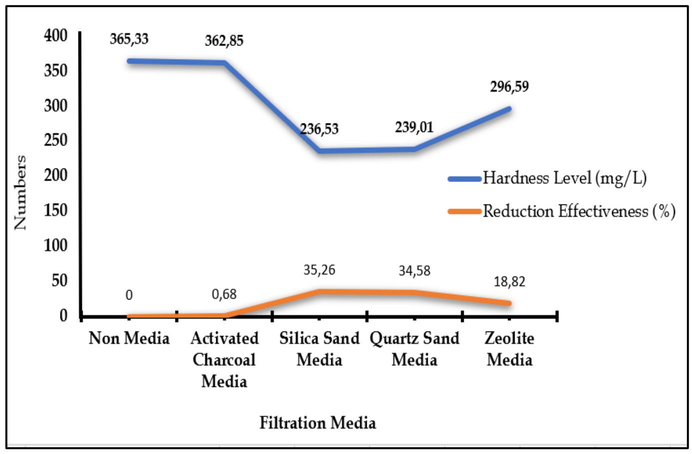

Figure 3. Average Hardness Level (mg/L) Before and After Treatment Using Filtration Media

The geological structure of Kupang City and Kupang Regency mostly consists of limestone and coral, especially terraced corals due to the lifting process. This formation usually has natural cavities caused by dissolving parts of the limestone by rainwater. The soils found in this area are usually of two soil types, Rhodustalf and Pellustert, which react with weak acids to neutral. Both types of soil are derived from limestone and coral as the parent material. The geological structure of the area affects the condition and quality of the water found in the clean springs used by the community.

According to the findings of Theodolfi & Waangsir (2014), the water sources commonly used for clean water in Kupang City come from several local springs, flow at a certain height, and are distributed to the community by gravity. Another water source that has the potential to become one of the main sources of water demand in Kupang City is artesian wells (Theodolfi & Waangsir, 2014). The quality of clean water consumed by the people of Kupang City is usually not polluted by heavy metals and other chemical contaminants. A study conducted by Arnawa et al. (2022) shows that E. coli is still found in one of Kupang's surface springs, among other types of contaminants (Arnawa et al., 2022).

Various attempts have been made by local governments or drinking water suppliers to reduce total hardness or calcification of water, including heating the water and treating it in additional drinking water reservoirs. In one attempt, people usually heat water before consumption (Waangsir et al., 2018). Drinking water consumed by the body is included in the soft water category, with a total hardness value between 60 and 120 mg/lt.

Basically, hardness is caused by water containing cationic elements such as Na, Ca, Mg. The concentration of Ca and Mg in surface water is usually high (>200ppm) CaCo3, so that the water flowing through the limestone area becomes hard. A hardness level of 100 mg/L affects household appliances, and more than 300 mg/L can have long-term effects on people with weak kidneys, causing kidney problems (Astuti et al., 2016; Bobihu, 2012; Kusumawardani & Astuti, 2018).

As a result of the investigation the average hardness content of Oenesu raw spring water is 365.33 mg/l. The hardness level of the Oenesu water source in this study was found to be 84.07 compared to the water source used by PDAM Wainitu in Ambon City and the water source used at several different sampling locations remained high between ~98.09 mg/l (Latupeirissa & Manuhutu, 2020).

In this study, the decrease in hardness when using activated carbon filter media, silica sand, silica sand, and zeolite filter media showed a lower change in direction than raw water. Filtration is the first step in the physical treatment process and its purpose is to remove particles present in water. This filtration process separates solids from solution and removes very fine suspended particles by passing the solution through a medium or porous material. This process is used to maintain good water quality in drinking water treatment plants (Hartono, 2010; Nurhayati, 2010). Water hardness can be divided into calcium hardness and magnesium hardness, whereas carbonate hardness is very sensitive to heat and is easily reduced at high temperatures. The hardness of groundwater, like that of well water, is usually higher than that of surface water. Water hardness affects the ability of water to form bubbles. The higher the water hardness, the more difficult it is for soap to form foam through precipitation (Effendi, 2003; Surbakti, 2019).

Among all the media used, silica sand media was the most effective in reducing raw water hardness, with a reduction efficiency of 35.26%, and the lowest media was activated carbon with 0.68%. Silica sand is generally extracted from areas with relatively high SiO2 or quartz content. The results of this study are in line with research conducted by Utari et al. (2022) which showed that the use of zeolite media, quartz sand, and activated carbon can reduce hardness concentrations (Utari et al., 2022). Another study conducted by Ningrum (2020) showed that after a filtration process using different silica sand and zeolite media, the hardness level decreased significantly and the composition of the silica sand filtration media - 96.63% activated carbon was also shown to decrease to water.

Raw water increased from 281mg/L to 15.1mg/L, but with the composition of activated carbon-quartz sand filter media, raw water decreased further to reach 94.95%, raw water decreased with a value of 281mg/L, water hardness was 14, 2 mg/l (Ningrum, 2020). In this study, zeolite media reduced hardness because zeolite is an aluminosilicate chemical compound that hydrates with sodium, potassium and barium cations. Zeolite has a three-dimensional structure with small holes through which water can pass. Ca2+ and Mg2+ ions will be replaced by Na+ and K+ ions from the zeolite, so the water is not hard. The volume and composition of the medium have a strong influence on the adsorption and filtration of suspended solids, colloidal particles and ions that cause hardness (Hapsari, 2015).

The use of filter media such as activated carbon, sand and zeolite to reduce hardness has been proven to be effective. For this reason, further analysis is needed on blending media filters with longer retention times to increase the efficiency of reducing hardness in raw water. The longer the exposure during filtration and adsorption, the more effective the effect of reducing the hardness of well water (Husaini et al., 2020).

Conclusion

Field test results, water parameters from the Oenesu source including smell, taste, temperature, color, turbidity, TDS and pH still meet the water quality standard requirements according to Minister of Health Regulation Number 32 of 2017. The hardness of raw water from the clean water source of the Oenesu spring is 365.33 mg/l; 3. Water hardness after being treated in the filtration process using a silica sand substrate is more effective in reducing raw water hardness with a reduction efficiency of 35.26% and the bottom is an activated carbon substrate of zero 68%. Additional studies need to be carried out regarding the media used in the reactor or filter and the specific contact time variation to achieve a more diverse hardness reduction effect.

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