International Journal of Health, Economics, and Social Sciences (IJHESS)
Vol. 5, No. 3, July 2023, pp. 210~215
DOI: 10.56338/ijhess.v5i3.3788
Website: https://jurnal.unismuhpalu.ac.id/index.php/IJHESS

OPEN ACCESS JOURNALS

Research Article

The Effectiveness of Slow Sand Filtration on Reduction of Iron (Fe) and Calcium (CaCO3) Levels in Water

Moh. Andri[1]*, Budiman[1] , Fabotin Taib[1]
[1] Faculty of Public Health, Universitas Muhammadiyah Palu Palu, Indonesia

Articles Info

Articles history:

Received May 29, 2023
Revised june 30, 2023
Accepted July 02, 2023

Keywords:

Slow Sand Filtration;
Iron (Fe);
Calcium (CaCO3)

ABSTRACT

Ground water or well water is the largest source of clean water used. The most common obstacle in using groundwater is the problem of iron (Fe) and calcium (CaC03) content in raw water. This research aims to determine the effectiveness of slow sand filtration to reduce Fe and CaCO3 levels in water. This type of research is a pure experimental study in a re-treatment design (One Group Pretest Posttest). The samples of raw water were taken from water pump wells owned by residents on JI. Datu Adam, Lere Village. Sample testing after slow sand filtering was carried out at the UPTD Laboratory of the Office of Environment, Donggala. The filter was carried out with a medium thickness of 45 cm sand, 5 cm gravel sand, 7 cm gravel and 5 cm high puddle water. Before filtering the test results Fe 0.4mg/L and CaCO3 546.37mg/L. Based on the effectiveness test of slow sand filtration with 3 treatments, it was found that the levels of substances after filtering were iron (Fe) 0.29, 0.21 and 0.I2 mg/L respectively, while calcium (CaCO3) was 273.41, 241.35 and 210.11 mg/L respectively. From these results, slow sand filtration is effective in reducing Fe and CaCO3 levels in water. The community is expected to be able to use simple filtering media such as slow sand filters to reduce iron (Fe) and calcium (CaCO3) levels in water. It is also expected to provide additional knowledge studies in the field of public health, especially environmental health.

Corresponding Author:

Moh. Andri
Faculty of Public Health, Universitas Muhammadiyah Palu, Indonesia
E-mail: mohamadandri4747@gmail.com

1. INTRODUCTION

Health is a necessity and right of life for every human being in order to lead a productive and happy life. In order for everyone anywhere and anytime to obtain a healthy life, health must be an inherent ability in every human being. To achieve a healthy life, various activity programs have been developed by the government and the community. One of them is the clean water supply program (1).

In the regulation of the Minister of Health No. 32 of 2017 states that what is meant by water is the Environmental Health Quality Standard for water media for Sanitation Hygiene purposes including physical, biological and chemical parameters which can be in the form of mandatory parameters and additional parameters. Water for hygiene and sanitation purposes is used to maintain personal hygiene such as bathing and brushing teeth, as well as for washing food, cutlery and clothing. In addition, for sanitary hygiene purposes, it can be used as raw water for drinking water (2).

Water quality including physical, chemical and biological parameters must be in accordance with the limits listed in the supervision and water quality requirements set forth in Regulation of the Minister of Health of the Republic of Indonesia No. 32 of 2017. The water needed by the community is clean water that can be

consumed directly or indirectly (3). Groundwater or well water is the largest source of clean water used. The most common obstacle encountered in using groundwater is the problem of the content of iron (Fe) and lime (CaCO3) contained in raw water. Iron and lime in water are usually dissolved in the form of compounds or bicarbonate, gram sulfate, hydroxide and also in colloidal form or in a state combined with organic compounds (4).

Lime is a substance that can damage the environment, one of which is water pollution (5) . Based on preliminary observations made by researchers in several communities, one of which is Mr. Hermanto said that clothes washed with well water left yellow stains, also caused a brownish color on the bathroom and tub floors, it was found that groundwater in the Jalan Datu Adam area Lere Village , West Palu District, Palu City, residents who complain about their water source. Based on this phenomenon, it is suspected that the groundwater contains high levels of iron (Fe).

Is one of the water processes, which is the process of removing fine particles or flocs that escape from the sedimentation unit, where the particles or flocs will be retained in the filter media as long as the water passes through the media . Filtration is needed to improve the reduction of contaminants such as bacteria, color, odor and taste, so that clean water that meets drinking water quality standards is obtained (6).

Hermanto 's well water field above, it is necessary to make efforts to overcome this, namely to make a well water purification process tool that is cheap, simple, has good technology and the ingredients are easy to get on the market to use to minimize the problem of bad well water quality by using sand and gravel clarification media.

Based on the description above, the authors are interested in conducting research on slow sand filtration in reducing levels of iron (Fe) and Lime (CaCO3) in water, with the title Effectiveness of Slow Sand Filtration on Decreased Levels of Iron (Fe) and Substances Lime (CaCO3) In Water.

2. RESEARCH METHODS

This type of research is a pure experiment in a re-treatment design called One Group Pretest – Posttest. The location of the water sample in this study was taken from a resident's pumping well on Jalan Datu Adam , Lere Village , West Palu District. Samples that had been given treatment were then analyzed at the UPTD Laboratory of the Donggala Regency Environmental Service . This research was conducted in June 2022.

3. RESULTS

The slow sand filtration system in this study was carried out by making a water filtration tank dominated by sand as a filtration medium which is expected to be able to reduce levels of Iron (Fe) and Lime (CaCO3). The arrangement in slow sand filtering used is as follows:

Table 1. Filter Media Composition Components

No.	Filter Media	Size	Thickness On Media
1	Gravel	5mm	7cm
2	Gravel Sand	1mm	5cm
3	Sand	0.3mm	45cm
4	Stagnant water	-	5cm

Source: Primary Data, 2022

Figure 1. Appearance of the screening tank and slow sand filtering process

Table 2 . Physical Characteristics of Water Before and After Slow Sand Filtration

Sample	Treatment	Color	Flavor	Smell
Raw water pump well samples I, II and II	Before Screening	Clear/not cloudy	Taste	Smells like iron
	After Screening	Clear/not cloudy	Tasteless	No smell
Conclusion		No changes	There was a change in taste	There is a change in smell

Source: Primary Data, 2022

Based on the results of the research on the effectiveness of slow sand filtering on reduced levels of iron (Fe) and levels of lime (CaCO3) in water conducted at the UPT Laboratory for the Environmental Service of Donggala Regency, the results obtained after the screening process are as follows:

Table 4 . Results of Water Filtration with the Slow Sand Method for Reducing Iron Levels (Fe)

Treatment	Treatment Time	Levels of Iron (Fe) mg/L		Quality Standard Value*
		Before Screening	After Screening	
I	May 23, 2022	0.4	0.29	**0.3mg/L**
II	May 27, 2022	0.4	0.21	
III	May 30, 2022	0.4	0.12	

Source: Primary Data, 2022

Table 5. Results of Water Filtration with the Slow Sand Method for Reducing Lime Content (CaCO3)

Treatment	Treatment Time	Content of Lime (CaCO3) mg/L		Quality Standard Value*
		Before Screening	After Screening	
I	May 23, 2022	546,37	273,41	**500 mg/l**
II	May 27, 2022	546,37	241.35	
III	May 30, 2022	546,37	210,11	

Source: Primary Data, 2022

4. DISCUSSION

Based on the Indonesian National Standard (2008), Slow Sand Filtration or slow sand filter is a filter box that uses sand as a filtering medium with very small grain sizes but has a high quartz content. The filtering process takes place by gravity, very slowly, and simultaneously on the entire surface of the media. The filtering process is a combination of physical processes (filtration, sedimentation and adsorption), biochemical processes and biological processes (7).

In this study the filter media used were gravel, gravel sand, sand, and water to make puddles. All tools and materials in this slow sand filtering method are tools and materials that are easy to find in everyday life. As with its main objective, it is hoped that this method can be used continuously without any problems in terms of its provision. As Said explained in Febrina & Amdani (2015) that the slow sand filter system is a very simple water treatment technology with good quality clean water. This slow sand filter system has advantages, including not requiring chemical coagulants, which chemicals are often encountered in water treatment processes (8). According to Artidarma (2021) the filtering method with a slow sand filter system is the right system for treating clean water. This system was chosen with consideration of processing effectiveness, cost and ease of operation (9).

The results of the filtration process using the slow sand filtering method in this study affected changes in the physical characteristics of the water, namely the water sample before filtering had a taste and smell like iron but after the filtering process the water became tasteless and odorless. As explained in Quddus' research

(2014) that the water filtering method by separating the solid components contained in the water by passing it through porous media or other porous materials to separate the solids in the water both in the form of suspensions and colloids can reduce the content of bacteria, smell, taste, manganese, and iron (10).

4.1 Reducing Iron (Fe) Levels through Slow Sand Filtration

Iron (Fe) is a natural element that can be found in soil and rocks. The element iron can be associated with the weathering of rocks and minerals (11). In general, water in nature contains iron due to direct contact between the water and soil layers containing iron. The presence of excessive amounts of iron in water can cause various problems including the unpleasant taste of drinking water, can cause sediment and increase turbidity.

Based on the results of the study, before carrying out the filtering process using sand, gravel, sand gravel and water media for stagnation of iron (Fe) levels in the community dug well water on Jl. Datu Adam, Lere Village, which is 0.4 mg/L. The dug well water used by the community has an iron (Fe) level that exceeds the standard for clean water quality, namely 0.3 mg/L, so if the water is used continuously it is very dangerous to health.

Based on the results of testing the water sample after the filtering process was carried out using the slow sand method, it was found that the results of a significant decrease in the levels of iron (Fe) in the sample, namely in treatment I obtained a value of 0.29 mg/L, in treatment II obtained a value of 0.21 mg/L L and in treatment III a value of 0.12 mg/L was obtained with an iron (Fe) level before filtering the water of 0.4 mg/L. The results obtained in the sample testing after going through the filtering process using the slow sand filtering method are in accordance with drinking water quality standards based on the Minister of Health of the Republic of Indonesia Number 492/Menkes/Per/IV/2010, which is 0.3 mg/L.

From this description it can be concluded that the filtering process with the slow sand filtering method is effective in reducing iron (Fe) levels in water. This research is in accordance with research conducted by Artidarma (2021) which found a decrease in iron (Fe) levels after filtering using the slow sand filtering method, namely the iron (Fe) level before filtering was 0.77 mg/L after filtering, a value of 0.11mg/L. The decrease in iron (Fe) content in slow sand filtering is caused by the filtering activity of the sand, the higher the media thickness, the higher the filtering power. As explained in Akbar, et al (2014) the activity of microorganisms occurs in layers up to 30-40 cm below the surface. These microorganisms function to eat by destroying organic matter when water flows through the sand. The thickness of the media underneath again functions as a filter for chemical substances, because chemical processes occur here. Sand diameter ranges from 0.2–0.3 mm.

This method can be a solution for health agencies and the government in an effort to obtain clean water that is healthy and in accordance with quality standards considering that water is the most important component as a basic human need.

Excessive levels of iron (Fe) in water can cause health problems. In addition to being harmful to health, Fe levels that exceed a predetermined maximum also cause an unpleasant odor and cause a yellow color on the tub walls and yellow spots on clothes (12).

4.2 Reducing Lime Content (CaCO3) through Slow Sand Filtration

Calcium carbonate or lime is a chemical compound with the chemical formula CaCO3, a common substance that is easily found in rocks in all parts of the world, and is the main component of the shells of marine organisms such as snails, pearls and eggshells. This material is very useful for everyday life but within certain limits and quantities.

Based on the results of the study, prior to carrying out the filtering process using sand, gravel, sand gravel and water for puddles of lime content (CaCO3) in the community's dug well water on Jl. Datu Adam, Lere Village, namely 546.37 mg/L. The water from the dug wells used by the community has a calcium content (CaCO3) that exceeds the standard for clean water quality, namely 500 mg/L. This condition is an indication that the soil in the Lere Village area has a high lime content.

Based on the results of testing the water sample after the filtering process was carried out using the slow sand method, it was found that the results of a significant decrease in the levels of lime (CaCO3) in the sample, namely in treatment I obtained a value of 273.41 mg/L, in treatment II obtained a value of 241.35 mg/L L and in treatment III a value of 210.11 mg/L was obtained with a lime content (CaCO3) before water filtration of 546.37 mg/L. The results obtained in the sample testing after going through the filtering process using the slow sand filtering method are in accordance with drinking water quality standards based on the Regulation of the Minister of Health of the Republic of Indonesia Number 492/Menkes/Per/IV/2010, namely 500 mg/L.

From this description it can be concluded that the filtering process with the slow sand screening method is effective in reducing lime content (CaCO3). In this study the total thickness of the sand and gravel filter media used was 57cm. The way sand works is as a fine bearing filter that can hold/filter bacteria and suspended particles, with a strength of nearly 100% (13). Meanwhile, gravel has a way of working as an adsorbent or absorbs the lime content in water, and as an ion exchanger (14).

This study is in accordance with research conducted by Istiqomah (2014) with the results of research on the initial hardness or lime level (CaCO3) of 562 mg/L after filtering using the slow sand filtering method

using sand and gravel media of zeolite type, the results showed a decrease in lime levels. (CaCO3) of 196 mg/L at a thickness of 50cm filtration media, 145 mg/L at a thickness of 55 cm, and 116 mg/L at a thickness of 60 cm.

This processing method is a water filtering effort that is very suitable as a solution to reduce levels of lime (CaCO3) in water. This treatment is an effort to obtain clean water quality and suitable for consumption in accordance with standards.

Levels of hardness or lime (CaCO3) that exceed the standard can cause various health problems, namely can damage the human kidney, can damage cooking utensils by forming scale on the kettle, it is difficult to foam soap so that it increases the use of soap and can cause blockages in paralon pipes.

5. CONCLUSION

This study concludes that the slow sand filtering method using a combination of sand media with a thickness of 45cm, sand gravel 5cm, gravel 7cm and added with a 5cm high puddle is effective in reducing levels of iron (Fe) in water with an initial level before filtering of 0.4 mg/L and after slow sand filtering with 3 treatments it decreased, namely each obtained results of 0.29 mg/L, 0.21 mg/L and 0.12 mg/L. Then the slow sand filtering method using a combination of sand media with a thickness of 45cm, sand gravel 5cm, gravel 7cm and added with a pool of water as high as 5cm is effective in reducing levels of lime (CaCO3) in water with initial levels before filtering of 546.37 mg/L and after slow sand filtering with 3 treatments it decreased, namely each obtained results of 273.41 mg/L, 241.35 mg/L and 210.11 mg/L

6. SUGGESTION

A special ongoing program is needed to improve health promotion regarding clean water management in accordance with environmental quality standards and can utilize simple filter media to obtain quality clean water such as slow sand filtering.

7. REFERENCES

1. AQUA SPER. PERATURAN MENTERI KESEHATAN REPUBLIK INDONESIA NOMOR 32 TAHUN 2017 TENTANG STANDAR BAKU MUTU KESEHATAN LINGKUNGAN DAN PERSYARATAN KESEHATAN AIR UNTUK KEPERLUAN HIGIENE SANITASI, KOLAM RENANG. 2017;
2. Depkes RI. Peraturan Menteri Kesehatan Nomor 32 Tahun 2017 Tentang Standar Baku Mutu Kesehatan Lingkungan dan Persyaratan Kesehatan Air untuk Keperluan Higiene Sanitasi, Kolam Renang, Solus Per Aqua, Dan Pemandian Umum. Depkes RI, Jakarta. 2017;
3. Febrina L, Ayuna A. Studi penurunan kadar besi (Fe) dan mangan (Mn) dalam air tanah menggunakan saringan keramik. J Teknol. 2015;7(1):35–44.
4. Budiman B, Hamidah H, Hasria H. Limbah kulit pisang kepok (Musa acuminate) sebagai biofilter zat besi (Fe) dan zat kapur (CaCO3). Promot J Kesehat Masy. 2018;8(2):152–8.
5. Noor MM, Bungawati A, Andri M. Analisis Kandungan Zat Kapur (Caco3) Dan Escherichia Coli Air Minum Di Wilayah Pengungsian Desa Lolu Kabupaten Sigi. J Kolaboratif Sains. 2019;2(1).
6. Fitriyana S. Efektivitas Aerasi dan Filtrasi terhadap Penurunan Kadar Mangan (Mn) pada Air Sumur Bor berdasarkan Lama Kontak dan Ketebalan Media. Universitas Muhammadiyah Semarang; 2018.
7. CHANDRA C. Pengolahan Air Sumur di Diploma Teknik Universitas Diponegoro menjadi Air Aquades dengan Menggunakan Teknologi Sand Filter dan Reverse Osmosis (Well Water Treatment in Diploma Engineering of Diponegoro university into distilled water using Sand Filter and Reverse Osmosis Technology). undip; 2016.
8. Febrina R, Amdani K. PENGARUH UKURAN BUTIRAN DAN KETEBALAN LAPISAN PASIR TERHADAP KUALITAS AIR SUNGAI DELI DAN DEBIT OUTLET PADA SARINGAN PASIR LAMBAT SEDERHANA. EINSTEIN (e-Journal). 2(3).
9. Artidarma BS, Fitria L, Sutrisno H. Pengolahan air bersih dengan saringan pasir lambat menggunakan pasir pantai dan pasir kuarsa. J Teknol Lingkung Lahan Basah. 2021;9(2):71–81.
10. Quddus R. Teknik pengolahan air bersih dengan sistem saringan pasir lambat (downflow) yang bersumber dari Sungai Musi. J Tek sipil dan Lingkung. 2014;2(4):669–75.
11. Timpua TK, Watung AT. Efektivitas Berbagai Media Pasir Lokal Sebagai Media Filtrasi Air Baku Menjadi Air untuk Kebutuhan Higiene Sanitasi. J Kesehat Lingkung. 2021;11(1):40–7.
12. Purba MFD, Hartini E. Penurunan Kandungan Zat Besi (Fe) Dalam Air Sumur Gali Dengan Metode Aerasi. VISIKES J Kesehat Masy. 2013;12(1).
13. Istiqomah A, Dwi Astuti SKM, Ambarwati SP. Pengaruh Kombinasi Ketebalan Media Filter Pasir Dan Zeolit Terhadap Penurunan Kadar Kesadahan Pada Air Sumur Di Desa Kismoyoso Ngemplak Boyolali.

Universitas Muhammadiyah Surakarta; 2014.
14. Fazil M, Adhar S, Ezraneti R. Efektivitas penggunaan ijuk, jerami padi dan ampas tebu sebagai filter air pada pemeliharaan ikan mas koki (Carassius auratus). Acta Aquat Aquat Sci J. 2017;4(1):37–43.