



The Effectiveness of Sand Filters with Variations in Thickness and Sand Diameter in Reducing the Coliform Content of Dug Well Water

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ABSTRACT

Water filters are one of the efforts that can be made to reduce the content of contaminants and bacteria in water that do not meet the requirements. Sand and gravel are media that are widely used in filters, which can reduce coliform content levels. This research aims to see the effectiveness of sand filters with variations in the thickness and diameter of sand in reducing the coliform content of dug well water. This type of research is experimental, using pre-test and post-test methods. The population is a sample of dug well water containing Coliform bacteria in Wenang District, Telling Bawah Village. The sample is water that has passed the filtering process 12 times. The instruments in this research were sand filters with variations in diameter and thickness and biological examination of water samples. The research data was then tested using the t-test. The research showed that sand filters with a thickness of 70 cm and a diameter of 0.45 mm were ineffective in reducing coliform content. In comparison, sand filters with a thickness of 70 cm with a diameter of 0.3 mm and sand filters with a thickness of 90 cm with a diameter of 0.45 mm and a diameter of 0.3 mm effectively reduce the Coliform content in dug well water. The results of statistical tests using the t-test on a 70 cm thick sand filter with a diameter of 0.45 mm showed a value of 0.219 ($p > 0.05$). A sand filter with a thickness of 70 cm with a diameter of 0.3 mm shows an ap value of 0.001 ($p < 0.05$). A 90 cm thick sand filter with a diameter of 0.45 mm showed a value of 0.001 ($p < 0.05$). A 90 cm thick sand filter with a diameter of 0.3 mm shows an AP value of 0.000 ($p < 0.05$).

Keywords: Sieve, Sand, Thickness, Diameter, Coliform

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INTRODUCTION

Water is a natural resource necessary for many people's needs. According to Minister of Health Decree No. 907, 2002, clean water sources are used for washing food, cooking, washing clothes, bathing, washing toilets, and cooking for drinking. As a source of clean water, the family home must maintain good quality facet physics, chemistry, bacteriology, And radiology (Achmad et al., 2020).

Clean water and good sanitation are essential elements to support human health. Unfortunately, meeting the need for clean water and sanitation has not yet been fully implemented reasonably in some cleavage worlds (Limbongan, 2023). According to the United Nations Children's Fund and the World Health Organization, it is estimated that 1.1 billion people do not have access to a clean water supply, and 2.6 billion people lack adequate sanitation (Kusumawardhana & Auliya, 2019). Every day, almost 1,000 children die from diseases related to poor water quality and sanitation, based on Unity Nation Nation (Elysia, 2018).

Indonesia represents around 6% of the world's water resources. This shows that Indonesia has relatively abundant water resources. However, the reality shows that most regions in Indonesia, such as East Nusa Tenggara, Java, Bali, and Sulawesi, actually experience a shortage of clean water supply based on a report from the Directorate General of Pollution and Environmental Damage Control,

Ministry of Environment and Forestry (KLHK) in 2015, quoted by National Geographic Indonesia (2016).

Groundwater is relatively abundant and saturated when filled in layer geology spaces (Septiyah et al., 2023). By quality, As people live in big cities, the need for clean water is increasing. The fundamental problem with water resources is that there needs to be more water, both in quantity and quality, to meet ever-increasing human needs. According to a statement, the water quality requirements are clean and cover condition physical, chemical, and microbiology (Situmorang & Lubis, 2017).

Based on government regulations through the Health Service (Dinkes) and the environment, clean water requirements must be reasonable regarding physical, chemical, and microbiological parameters. nor radioactive (Gultom, 2016) . Pollution in water causes various health problems. Microbiology in water, one pollutant indicator used as a water quality parameter, can also reduce water quality. Pathogenic bacteria, such as Coliform, can cause microbiological pollution in pure water. Microbiological pollution in water can be the primary medium for transmitting skin, eye, and stomach diseases. Therefore, it is essential to utilize clean water in all daily activities to protect the body from contracting diseases by bacteria and pathogens (Kartika et al., 2021).

For this reason, efforts need to be made to reduce contaminants such as bacteria, color, taste, odor, and Fe so that clean water is obtained that meets standards, one of which is by using a standard water filter. Meeting the need for clean water services in the community requires innovation with appropriate technology by developing processing (filtering) of groundwater or healthy water with a high turbidity level so that clean water is obtained with a quality that meets health requirements. The water filtration processes widely known in the community are slow sand filters and fast (rapid sand filters) (Timpua & Watung, 2021).

Data from the Wenang Community Health Center shows that the number of diarrhea cases in 2021 was 53 cases of diarrhea and 16 of them were residents of Telling Bawah. In 2022, the data showed 111 cases of diarrhea, and 8 of them were residents of Telling Bawah. This shows that diarrhea cases will increase by 47% in 2022, but diarrhea cases in Lower Telling have decreased by 50%.

The initial survey was carried out in Wenang District, Telling Bawah Village. The community uses wells as a water source for daily needs and drinking water. However, the condition of the well used does not have a sound wall, and the location of the well is quite close to the livestock pen. For this reason, it is necessary to check the bacteriological quality of the water. It is also necessary to treat the healthy water using a slow sand filter For a lower contamination rate of Coliform bacteria (Mashadi et al., 2018).

Based on the background above, researchers are interested in further researching the effect of varying media thickness and finer diameter to reduce coliforms effectively. This research aims to determine the effectiveness of sand filters with sand thickness and diameter variations in reducing Coliform content in well water digs.

METHOD

This type of research is experimental research (Pre experimental design) measurements before treatment (pre-test) and measurements after treatment (post-test) so that the results of the treatment can be known more accurately because you can compare the results before and after treatment to determine the effectiveness of the sand filter with variations in thickness—and sand diameter in reducing the Coliform content of dug well water. The sample in this study used a purposive sampling method by determining sample criteria that were by the research objectives. The criteria in this research are dug well water used for daily needs that has been checked and contain 350 MPN/100 ml

Coliform bacteria. Biological Examination of Water Samples (Coliform Determination) According to SNI 01-2332-2006. Microbiological Test Method - Determination of Coliform and Escherichia coli, Confirmed Coliform Test. The analysis carried out in this research was to describe each independent variable as a sand filter with variations in sand thickness and diameter and the dependent variable in the form of the Coliform content of dug well water. The data obtained from examining water samples from each thickness and diameter of the sand filter are presented in tabular form and narrated.

RESULTS AND DISCUSSION

The effectiveness of sand filters with variations in thickness and diameter of sand in reducing the coliform content of dug well water, a laboratory examination was carried out on the sample water before and after passing through the filtration process. Sand filters with a thickness of 70 cm and 90 cm with a diameter of 0.45 mm and 0.3 mm. Based on the results of examinations carried out at the Environmental Microbiology Laboratory of the Manado Ministry of Health Polytechnic, it can be seen in the table below:

Water Sample Examination Results on Sand Filter (70cm/0.45mm)

Table 1. Coliform Content Before and After Filtration with Sand Filter (Thickness 70cm/Diameter 0.45mm)

Inspection	Before	<u>Content Colifo.</u>		Decline %
		After	Difference	
		(MPN/100ml)		
Sample 1	240	33	207	86.25
Sample 2	240	130	110	45.83
Sample 3	240	240	0	0
Average	240	134	106	44.02

The results of examining water samples on a sand filter with a thickness of 70 cm and a sand diameter of 0.45 mm in 3 examinations, the lowest Coliform content was in the first examination, namely from before the filtering process, the Coliform content was 240 MPN/100ml, decreasing to 33 MPN/100ml (86.25%).

Water Sample Examination Results on Sand Filter (70cm/0.3mm)

Table 2. Coliform Content Before and After Filtration with Sand Filter (Thickness 70cm/Diameter 0.3mm)

Inspection	Before	<u>Content Coliforr</u>		Decline %
		After	Difference	
		(MPN/100ml)		
Sample 1	240	23	217	90.41
Sample 2	240	13	227	94.58
Sample 3	240	33	207	86.25
Average	240	23	217	90.41

The results of examining water samples on a sand filter with a thickness of 70 cm and a sand diameter of 0.3 mm in 3 examinations, the Coliform content was lowest in the second examination, namely from before the filtering process, the Coliform content was 240 MPN/100ml, decreasing to 13 MPN/100ml (94.58%).

Water Sample Examination Results on Sand Filter (90cm/0.45mm)

Table 3. Coliform Content Before And After Filtration with Filter Sand (Thickness 90cm/Diameter 0.45mm)

Inspection	<u>Content Colif</u>			Decline %
	Before	After	Difference	
	(MPN/100ml)			
Sample 1	240	13	227	94.58
Sample 2	240	13	227	94.58
Sample 3	240	22	218	90.83
Average	240	16	224	93.33

The results of examining water samples on a sand filter with a thickness of 90 cm and a sand diameter of 0.45 mm in 3 examinations, the lowest Coliform content in the first and second examinations was from before process filtering content *Coliforms* 240 MPN/100ml, experience decline until 13MPN/100ml (94.58%).

Water Sample Examination Results on Sand Filter (90cm/0.3mm)

Table 4. Coliform Content Before and After Filtration with Sand Filter (Thickness 90cm/ Diameter 0.3mm)

Inspection	<u>Content Coliforms</u>			Decline %
	Before	After	Difference	
	(MPN/100ml)			
Sample 1	240	13	227	94.58
Sample 2	240	13	227	94.58
Sample 3	240	23	217	90.41
Average	240	20	224	93.19

The results of examining water samples on a sand filter with a thickness of 90 cm and a sand diameter of 0.3 mm in 3 examinations show the Coliform content was lowest in the first and second examinations, namely from before the filtering process the Coliform content was 240 MPN/100ml, decreasing to 13 MPN/ 100ml (94.58%).

Effectiveness Filter Sand With Variation Thickness and Sand Diameter In Lower Coliform Content.

Table 5. Effectiveness Filter Sand With Variation Thickness and Sand Diameter in Lower Coliform Content.

Thickness	Diameter	Mean	Q	Sig.
70cm	0.45mm	103,568	1,767	0.219
	0.3mm	10,000	37,586	0.001
90cm	0.45mm	5,196	74,667	0,000
	0.3mm	5,774	66,100	0,000

The results of statistical tests using the T-test for the effectiveness of sand filters with a thickness of 70 cm and diameter of 0.45 mm show a mean value of 103,568, and the calculated t-value = 1,767 < t table value = 2,919 and the p-value is 0.219 (p > 0.05), so H0 is accepted, and H1 is rejected. A sand filter with a thickness of 70 cm and a diameter of 0.45 mm is ineffective in reducing the dug well water's coliform content.

The results of statistical tests using the T-test for the effectiveness of sand filters with a thickness of 70 cm with a diameter of 0.3 mm show a mean value of 10,000, and the calculated t value = 37,586 > t table value = 2,919 and the p-value is 0.001 (p < 0.05), so H1 is accepted, and H0 is rejected. A sand filter with a thickness of 70 cm and a diameter of 0.3 mm effectively reduces the coliform content of dug well water.

The results of statistical tests using the T-test for the effectiveness of sand filters with a thickness of 90 cm with a diameter of 0.45 mm show a mean value of 5,774, and the calculated t -value = 74,667 > t table value = 2,919 and the p -value is 0.001 ($p < 0.05$), so H_1 is accepted, and H_0 is rejected. A sand filter with a thickness of 90 cm and a diameter of 0.45 mm effectively reduces the Coliform content of dug well water.

The results of statistical tests using the T-test for the effectiveness of sand filters with a thickness of 90 cm and a diameter of 0.3 mm show a mean value of 5,774. The calculated t -value = 66,100 > t table value = 2,919, and the p -value is 0.000 ($p < 0.05$), so H_1 is accepted, and H_0 is rejected. A sand filter with a thickness of 90 cm and a diameter of 0.3 mm effectively reduces the coliform content of dug well water.

They are determining fecal coliforms as an indicator of pollution because the number of colonies is positively correlated with the presence of pathogenic bacteria. In addition, detecting Coliforms is much cheaper, faster, and more straightforward than detecting other pathogenic bacteria. Examples of Coliform bacteria are *Escherichia coli* and *Enterobacter aerogenes*. So, Coliform is an indicator of water quality. The lower the Coliform content, the better the water quality (Timpua & Watung, 2021). The quality standard for total coliforms in clean water is based on Minister of Health Regulation 32 of 2017 <50 MPN/100ml.

The results of this research show that the MPN value for Coliform bacteria in dug well water from one of the Teling Bawah communities in Wenang District before going through the filtering process was 240 MPN/100ml, based on the quality standards for the total Coliform requirements for clean water, the dug well water does not meet the clean water quality requirements. Based on observations, the physical condition of the dug well does not meet the requirements because it does not have a sound wall, is not covered, and the location of the well is close to the livestock pen.

According to Tri Joko (2010), The height of the sound walls/bottom walls is a minimum of 300 cm from the surface of the healthy floor made of watertight concrete pipes and the rest made of perforated concrete pipes. A depth of 300 cm was taken because bacteria generally cannot live anymore at that depth.

This is in line with research conducted by Dema (2019), with the results of the chi-square statistical test showing a relationship between healthy walls and coliform content with a p -value of 0.023.

Sources of pollution, namely rubbish and animal waste, can contaminate dug well water because of the close distance to the dug well. This occurs because the absorption of bacteria in the soil from rubbish and feces contaminates groundwater, resulting in well water sources being digested by bacteria *E. coli* (Zulfikar et al., 2019).

This is to the research results of Hasnawi (2012) with statistical test results with an error level of α 5% (0.05). It turns out that the p -value obtained is 0.035, which means it is smaller than 0.05. The null hypothesis is rejected, meaning there is an influence on the construction of the dug well in terms of location (distance between the dug well and the pollutant source ≥ 10 m) and the content of *E. coli* bacteria in the dug well water.

The results of examining water samples on a sand filter with a thickness of 70 cm and a sand diameter of 0.45 mm in the third treatment showed no decrease before the filtering process. The Coliform content was 240 MPN/100ml, and there was no decrease. Examining water samples on a sand filter with a thickness of 70 cm and a sand diameter of 0.3 mm in the third treatment showed that the Coliform content was 240 MPN/100 before filtering. It decreased to 33 MPN/100ml. This is because the smaller the diameter of the sand, the better it can hold fine particles and microorganisms in the water.

According to SNI 3981:2008, the sand media size is tiny, and the pores between the media grains will also be tiny. Even though the pore size is tiny, it can still not hold the colloid particles and bacteria in raw water (ANGELA et al., 2021). However, with a meandering flow through the filter pores and the filter skin layer, the velocity gradient allows the fine particles to come into contact, forming larger clusters that can hold the particles until they reach their peak. Certain depth produces a filtrate that meets drinking water quality requirements (ROMY JUSAN RAMLI, 2021).

The results of examining water samples on a sand filter with a thickness of 90 cm and a sand diameter of 0.45 mm in the third treatment showed that the Coliform content was 240 MPN/100 before the filtering process. It decreased to 22 MPN/100ml. The results of examining water samples on a sand filter with a thickness of 90 cm and a sand diameter of 0.3 mm in the third treatment showed that the Coliform content was 240 MPN/100 before the filtering process. It decreased to 23 MPN/100ml. This is because the thickness of the media in the filtration process influences the results of the filtration process, where the thicker the filtration media, the longer it will flow, and the amount of filter power.

This is in line with research conducted by (Maryani et al., 2014), which shows that. Media in the 120 cm thick variation has a longer flow time and greater filter power. The contact between raw water containing bacteria and sand media is more prolonged, so removing Coliform bacteria is better.

The results of statistical tests using the Sand Filter Effectiveness T-test with a thickness of 70 cm with a diameter of 0.45 mm showed a mean value of 103,568, and the calculated t-value = 1,767 < t table value = 2,919 and p value 0.219 ($p > 0.05$). A sand filter with a thickness of 70 cm and a diameter of 0.45 mm is ineffective in reducing the dug well water's coliform content. The results of statistical tests using the Sand Filter Effectiveness T-test with a thickness of 70 cm and a diameter of 0.3 mm show a mean value of 10,000. The calculated t-value = 37,586 > t table value = 2,919, and the p-value is 0.001 ($p < 0.05$), so H1 is accepted, and H0 is rejected. A sand filter with a thickness of 70 cm and a diameter of 0.3 mm effectively reduces the coliform content of dug well water. The results of statistical tests using the Sand Filter Effectiveness T-test with a thickness of 90 cm with a diameter of 0.45 mm show a mean value of 5,774, and the calculated t-value = 74,667 > t table value = 2,919 and the p-value is 0.001 ($p < 0.05$), so H1 is accepted, and H0 is rejected.

A sand filter with a thickness of 90 cm and a diameter of 0.45 mm effectively reduces the Coliform content of dug well water. The results of statistical tests using the Sand Filter Effectiveness T-test with a thickness of 90 cm with a diameter of 0.3 mm show a mean value of 5,774, and the t-count value = 66,100 > t table value = 2,919, the t-count value which is higher than the t-table shows a significant difference towards reducing coliform levels. The p-value is 0.000 ($p < 0.05$), which means that a sand filter with a thickness of 90 cm and a diameter of 0.3 mm effectively reduces the coliform content of dug well water.

These results show that a thickness of 70 cm is sufficient to filter Coliform bacteria. However, grains of sand with a diameter of 0.45 mm are still not able to filter Coliform bacteria because the filter media grains are not refined enough, causing the pore size to be still large so that bacteria can still escape compared to 90 cm filter, the thicker the media used and the smaller the diameter of the sand media, the Coliform content in the water will decrease. Due to the media's thickness and the sand's diameter, raw water containing bacteria flow will take longer, so more bacteria will stick to the sand media (Nabilla Khoirunnisa, 2022).

This thing in line with study (Widyaningrum & Resi, 2019) Coliform MPN of Airnona River water before filtration using SPL = 710/100 ml, after filtration using SPL thickness of 60 cm = 28.33/100 ml, thickness of 80 cm = 25.33/100 ml, and thickness 100 cm = 22.33/100 ml; The average decrease in Coliform bacteria content after filtering using SPL thickness of 60 cm = 681.67, thickness of 80 cm = 684.67 and thickness of 100 cm = 687.67. The percentage reduction in Coliform bacteria

content after filtering using SPL with a thickness of 60 cm = 96.01%, a thickness of 80 cm = 96.43%, and a thickness of 100 cm = 96.85%, the lowest Coliform bacteria content is at a thickness of 100 cm = 22.33/100 ml. The thicker the media for filtering, the more significantly the Coliform bacteria content decreases.

One alternative technology for reducing the Coliform content in water is the filtering process using a sand filter with a thicker thickness and finer sand diameter. From the results of research on variations in the thickness and diameter of sand, it can be claimed that the Slow Sand Filter (SPL) is one of the practical, cheap, and simple water treatment processes. It is effective because it can reduce the Coliform content of dug well water. It does not require energy and chemicals, and its construction does not need to be extensive (Budiman et al., 2023).

CONCLUSION

Based on the research data and discussion, it can be concluded that a sand filter that is effective in reducing the coliform content of dug well water is a sand filter with a thickness of 70 cm a diameter of 0.3 mm, and a thickness of 90 cm with a diameter of 0.45 mm and a diameter of 0.3 mm. while a 70 cm sand filter with a diameter of 0.45 mm is not practical in reducing the Coliform content of dug well water. A sand filter with a thickness of 70 cm and a diameter of 0.45 mm is ineffective in reducing the dug well water's coliform content. A sand filter with a thickness of 70 cm and a diameter of 0.3 mm effectively reduces the coliform content of dug well water. A sand filter with a thickness of 90 cm and a diameter of 0.45 mm effectively reduces the Coliform content of dug well water. A sand filter with a thickness of 90 cm and a diameter of 0.3 mm effectively reduces the coliform content of dug well water.

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