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Effect of coagulation and filtration in slow sand filters on iron absorption in groundwater

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ABSTRACT

The study was done to analyze the results of the filtration system of deep pearl housing groundwater using slow sand filtration methods. The analysis is based on the physical and chemical parameters of color/frequency, pH, iron and *Escherichia coli* with variations in coagulant, clay and alloy. The color/frequency of frequency before filtration has a value of 16.9 NTU, after value filtration declines 0.6%. The phasing of water before filtration was acid 6, having done filtration the pH of water down to 5.8 but had not reached a normal limit (6.5 – 8.5), so slow sand filters had not been effective in curbing the pH of water. The content of iron metals (Fe) before filtration was 0.1867 mg/l, after being made filtrating the content of iron metals (Fe) on the water was down to 0.021 mg/l. The content of *Escherichia coli* before filtration was 7 CFU / 100 ml, after exfiltration of the *Escherichia coli* content was reduced to zero CFU / 100 ml. The study suggests that slow sand filters use variations in coagulating and clay materials are effective in improving the quality of the groundwater in the high-yield housing projects.

Keywords: Clay; coagulation; groundwater; slow sand filter; soil water

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INTRODUCTION

Water as a component of the environment will affect and be affected by other components. Poor quality water will result in a bad environment that will affect the health and safety of humans and other living things. Decreased water quality will reduce the utility, efficiency, productivity, carrying capacity and holding capacity of water resources which will ultimately reduce the wealth of natural resources [1].

The presence of iron (Fe) in water is available in dissolved conditions, ferrous (Fe^{2+}) and suspended, ferric (Fe^{3+}). This depends on the pH and dissolved oxygen conditions in the water. The presence of sufficient dissolved oxygen and neutral pH in water will oxidize Fe^{2+} to ($Fe(OH)_3$), where ($Fe(OH)_3$) is difficult to dissolve at neutral pH. Ferrous ions are often found in water sources that contain low dissolved oxygen such as groundwater and the bottom layer of lakes. The concentration of Fe in groundwater can reach around 1 – 10mg/1, while in surface water Fe levels exceeding 1 mg/1 are rarely found [2].

Acidity level (pH) is a physical parameter used to indicate the intensity of the acidic or basic state of a solution. Water is acidic if the pH is < 7, water with a pH value 7 is neutral, while pH > 7 is said to be basic [3]. The high or low pH of water does not affect health, but if water with a pH < 6.5 will cause corrosion of metals that dissolve toxic lead, copper, cadmium elements. Likewise, if the pH > 8.5 which is basic can form deposits (scale) on water pipes made of metal [4].

The pH of water will affect the iron content in the water, if the pH of the water is low it will cause corrosion which causes the dissolution of iron and other metals in the water and can result in the color of the water, causing the water to become colored, smelly and tasteless [2]. A pH meter is a tool for measuring pH, in addition to a pH meter, pH can also be measured using litmus paper [5].

Filtration is a water treatment process in which water is separated from colloids and impurities, the number of bacteria is reduced and the chemical characteristics of the water change by passing it through a porous medium. Filtration is a water treatment process by flowing raw water through a filter media (porous layer) composed of granular materials with a certain diameter and thickness [6].

The Mentangor sub-district area is precisely in the Mutiara Tenayan Raya Housing (MTRH) complex, the community gets water resources from drilled wells managed by the housing complex. The water in the community's drilled wells is suspected of containing iron which has a negative impact when the community uses the water for a long period of time. As a result, the community is very disturbed by the negative impact on the water they use every day. The MTRH complex has oily and sedimentary water conditions, and the water is still used for daily needs. To find out whether the water meets the health requirements and clean water standards, an analysis is needed to determine the quality of groundwater in order to determine the exact cause of damage to the groundwater.

RESEARCH METHODS

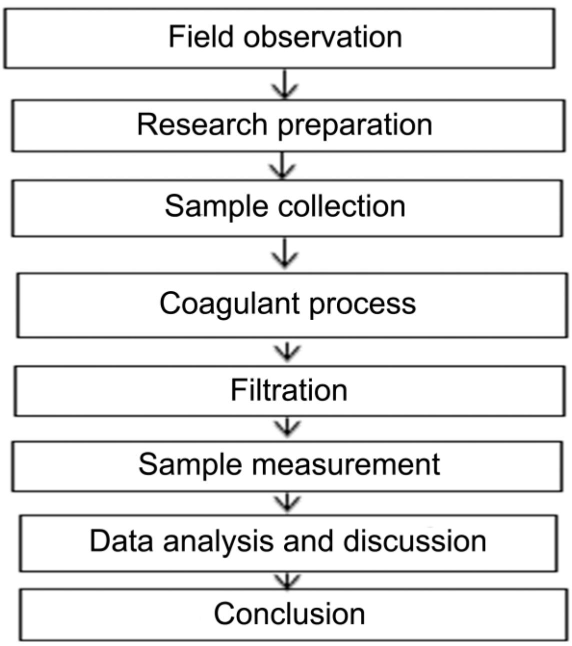

Figure 1. Research flow.

This research method (see Figure 1) begins with field observation to understand the context of the object being studied, followed by research preparation which includes planning the methodology and measuring instruments. Next, sampling is carried out from the target population to obtain representative data. The next process is coagulation, which may involve separating particles in the sample, followed by filtration to separate solid components from liquids or gases. After that, sample measurements are taken using measuring instruments according to research parameters. The measurement data are then analyzed in the data analysis and discussion stages, finally presenting a summary of the results and their implications in the conclusion stage, providing a comprehensive overview of important findings related to the initial hypothesis.

The samples used in this study were taken from the groundwater of MTRH which consisted of 4 sample points using GPS points. The first sample was taken in the south, the second sample was taken in the east, the third sample was taken in the north and the last sample was taken in the west with a distance of 100 m from the center point.

Then given treatment using a coagulation process with 3 variations of coagulants, namely alum, clay and a mixture of alum and clay using the slow sand filter method. The quality of water in this study was seen based on physical and chemical parameters, namely color/turbidity level, pH, heavy metal content of iron (Fe) and *Escherichia coli*.

RESULTS AND DISCUSSION

Color/Turbidity Level of Groundwater of MTRH Residents with Slow Sand Filter Filtration

The groundwater of MTRH is located on clay soil and has a clear color/turbidity level but will change color to yellowish if left for several hours. One of the requirements for good water quality is that the water is colorless. The results of the study on the turbidity of groundwater in MTRH through the coagulation process and using the slow sand filter method before and after filtration are shown in Figure 2.

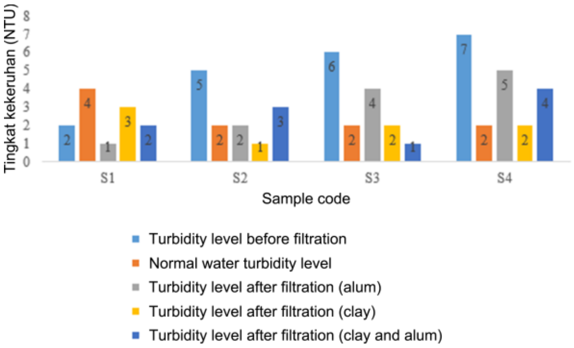

Figure 2. Graph of the color/turbidity level of well water in MTRH before and after filtration using slow sand filters.

Figure 2 shows the color/turbidity level of water before and after filtration using slow sand filters and variations in coagulation of alum, clay and mixtures. The highest value before filtration is in the fourth sample, which is 7 NTU which has a more yellow color because the fourth sample is located very close to the cliff land where there are no residential areas, the lowest value is in the first sample, which is 2 NTU. The decrease in color parameters is due to the addition of coagulants which produce chemical reactions where the negative charges that repel each other around the colloidal dissolved particles will be neutralized by the positive ions from the coagulant and the colloidal particles will attract each other and clump together to form flocs.

Groundwater pH Value of MTRH with Slow Sand Filter Filtration

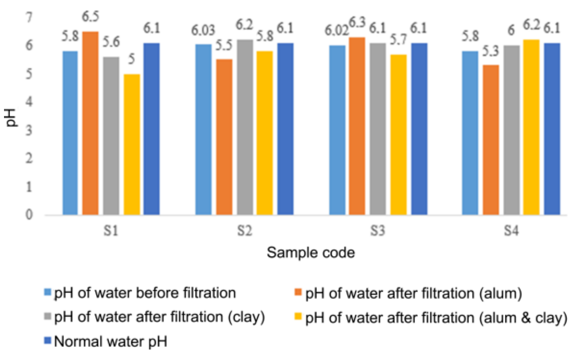

Figure 3. Graph of pH values before and after filtration using variations of alum, clay and mixed coagulants.

Figure 3 shows the pH values before and after filtration using alum, clay and mixed coagulants. The pH value before filtration in sample S1 was 5.8, S2 was 6.03, S3 was 6.02 and S4 was 5.8. The results of the values after filtration using alum coagulant increased and decreased in each sample. The first and third samples increased by 6.5 and 6.3 while the second and fourth samples decreased by 5.5 and 5.3. The results of the values after filtration using clay coagulant increased in the fourth sample by 6 while the first, second and third samples decreased by 5.6, 6.2, and 6.1. The results of the values after filtration using a mixture of alum and clay coagulants have decreased values in the first, second and third samples, namely 5, 5.58, and 5.7, while in the fourth sample there was an increase of 6.2.

Heavy Metal Concentration Content of Iron (Fe) in Groundwater of MTRH with Slow Sand Filter Filtration

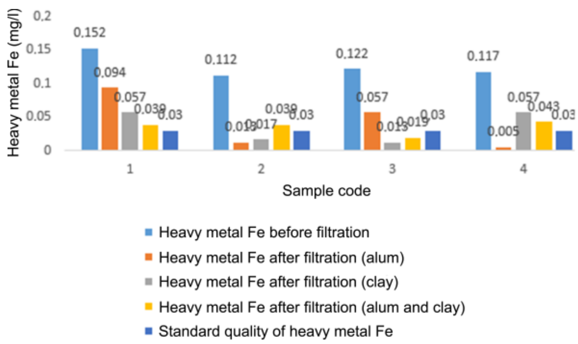

Figure 4. Graph of heavy metal content of Fe in groundwater of MTRH before and after filtration using a variety of coagulants.

Figure 4 shows the concentration value of iron metal (Fe) before and after filtration using a slow sand filter along with variations in alum, clay and mixed coagulants. Before filtration in sample S1 it was 0.152 mg/l, S2 was 0.112 mg/l, S3 was 0.122 mg/l, and S4 was 0.117 mg/l. Sample S1 before filtration has the highest iron (Fe) content of 0.152 mg/l because sample S1 before filtration was very new so that the iron content in the water was very high. After being filtered using a variety of coagulants, the value of each sample decreased by 0.094 mg/l to 0.005 mg/l.

Escherichia coli Content of Groundwater in MTRH with Slow Sand Filter Filtration

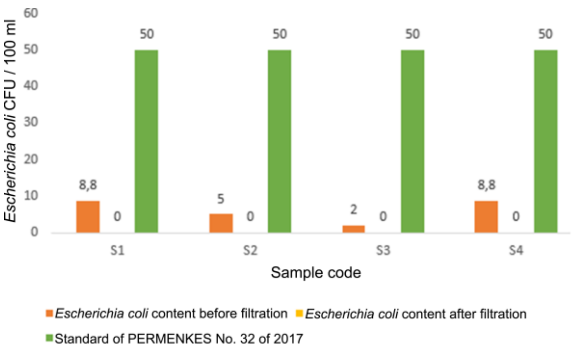

Figure 5. Graph of *Escherichia coli* content of groundwater in MTRH with slow sand filter filtration.

Figure 5 shows the *Escherichia coli* content before and after filtration using a slow sand filter. The *Escherichia coli* content before filtration had values of 8.8, 5, 2, and 8.8 CFU/100ml respectively and were still below the threshold set by PERMENKES, No. 32 of 2017 amounting to 50 CFU / 100 ml. After filtration using the slow sand filter method, the E-Coli content value decreased by 0 CFU / 100 ml.

CONCLUSION

Groundwater of MTRH when filtered using slow sand filter on alum coagulant, clay and mixture has different treatment so that different results are obtained. In each sample, alum coagulant is inserted for 3 to 10 minutes until sediment is seen at the bottom of the water tank used as a filter or catcher of fine particles in the water and replaces it with sediment that helps the groundwater filtration process. While clay functions to reduce toxins in the water.

The parameter value of heavy metal (Fe) sample S1 is 0.152 mg/l, sample S2 is 0.112 mg/l, sample S3 is 122 mg/l and sample S4 is 117 mg/l. Sample S1 before filtration has the highest iron metal (Fe) content of 0.152 mg/l because sample S1 before filtration the water condition is very new so that the iron content in the water is very high. The results of this study indicate that the *Escherichia coli* parameter value and the heavy metal parameter value of iron (Fe) decreased after slow sand filter filtration with variations of alum and clay coagulants, compared to the pH value which only increased and decreased in each sample due to the addition of high levels of alum, if dissolved it will reduce the pH level in water.

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