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Removing of Fe and Mn in Groundwater by Adsorption Process

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Abstract. Clean water and healthy drinking water are sources of need for humans in daily activities. One of the sources of drinking water is groundwater. Nowadays, a lot of groundwater is polluted. The method used to reduce Fe and Mn content in groundwater is the Adsorption process using kepok banana peel. The process of making kepok banana peel adsorbents by drying in the sun, carbonized at a temperature of 300°C to become charcoal then sieved with a size of 100 mesh and then activated using 20% H_2SO_4 for 24 hours. The adsorption process was carried out on a batch scale using a jartest, variations in stirring speed of 100 and 150 rpm, variations in contact time of 15, 30, 45, 60, 75, 90 minutes. The optimum stirring speed of 150 rpm with an optimum contact time of 60 minutes was able to remove Fe metal with an effluent concentration of 0.2726 mg/L of 83.9% and Mn metal obtained an optimum time of 30 minutes with an effluent concentration of 0.368 mg/L with a removal of 81.27 %.

INTRODUCTION

Every year the population in Indonesia increases. The increasing population causes the need for public service facilities and infrastructure, especially for clean water. Clean water and healthy drinking water are the main sources of daily needs. One source of drinking water is groundwater. A lot of groundwater was found to be polluted. Polluted groundwater is often found in heavy metals such as Fe and Mn.

The color of the water changes to yellow-brown after some time in contact with the air, due to the presence of Fe and Mn in the water [1]. If left exposed to air, water containing Fe and Mn metals forms a precipitate from the oxidation reaction. The presence of a small amount of iron (Fe) in drinking water will cause abdominal pain in the form of nausea and support the growth of iron bacteria and will cause a fishy odor in the water [2]. According to the Regulation of the Minister of Health No. 492/MENKES/PER/IV/2010, the maximum permissible levels in drinking water are iron (Fe) 0.3 mg/l and manganese (Mn) 0.4 mg/l [3].

Based on the existing problems, if not addressed immediately, the heavy metal (Fe) and (Mn) content that pollutes groundwater has an impact on human health and can also pollute the environment. One of the methods for reducing iron (Fe) and manganese (Mn) content is adsorption because it has low operating costs and easy equipment maintenance. Adsorption is the process of absorbing molecules and ions on the surface of the adsorbent [4]. One of the methods that can be used to reduce the concentration of pollution by heavy metals is adsorption. Adsorption is a mass transfer process on the surface of the pores in the adsorbent granules and occurs because of the surface attraction force. In the adsorption process, natural materials can be used as adsorbents including kepok banana peels, corn cobs, coconut shells, coconut fibers and so on. In this case, it can be seen the removal of various natural adsorbents by the adsorption process. Banana peel contains high enough cellulose so that it can be used as an adsorbent [5]. The galacturonic acid contained in cellulose causes banana peels to absorb metal ions. Another content of cellulose is pectin substance, the pectin substance itself is a source of absorption media where the pectin substance contains carboxylic groups which form complex compounds when reacting with metal ions.

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METHOD

This research was conducted from February to July 2021. This research was conducted at the Environmental Laboratory, Environmental Engineering Department, Building K, Trisakti University, West Jakarta. The groundwater sample used in this study came from the well of one of the residents' houses in the Sindang Barang Loji area, Bogor City.

This study was used the tools: Spectrophotometer, heating oven, jartest, funnel, heater, 10 mL and 100 mL measuring pipettes, 125 mL and 250 mL Erlenmeyer, 50 mL and 100 mL volumetric flasks, and 500 mL beakers. The materials used in this study were: 250 ml of groundwater, 10 grams of kepok banana peel adsorbent, 20% H_2SO_4, 2 ml of HCL, and 1 ml of $NH_2OH.HCL$, 10 ml of ammonium acetate buffer, 4 ml of 1,10-phenanthroline, 5 mL of special reagent, 1 drop of H_2O_2, 35 mL of distilled water, and 1 gr $(NH_4)_2S_2O_8$.

Kepok banana peel waste was obtained from fried banana traders in the Bogor city area. Kepok banana peels that have been obtained are washed with running water and dried in the sun for seven days. After drying, the kepok banana peel was carbonized at 300°C until charcoal was formed, then blended and sieved with a size of 100 mesh. The carbonized banana peel is then chemically activated. It aims to open the closed pores when carbonized by combustion residues so that the adsorption power increases [6]. Activation can also function to remove hydrocarbons and water trapped in the carbon pores [7]. Solution for activation using 20% H_2SO_4 for 24 hours. The ratio of adsorbate and adsorbent is 2 mL : 1 gram. After that, the activated carbon was washed with distilled water and dried in an oven at 110°C for 2 hours and then the adsorbent was ready for use.

Variations used in determining the stirring speed are 100 and 150 rpm. The beaker glass was filled with 250 ml of groundwater sample and then 10 grams of kepok banana peel adsorbent was added. The mixture was stirred using a jartest with variations in the speed of 100, 150 rpm for 15, 30, 45, 60, 75, 90 minutes obtained previously. Then the solution was filtered with Whattman No. 42 filter paper to separate the residue from the filtrate. The obtained filtrate was measured using a spectrophotometer with a wavelength of 510 nm for Fe metal and 525 for Mn metal.

In determining the optimum stirring speed, it can be seen from the highest removal results. The adsorption capacity or the number of copper ions that can be absorbed by the adsorbent is calculated using the following equation (1):

$$q = [(Co-C).V] / W \qquad (1)$$

q is the number of copper ions absorbed by the adsorbent (mg/g), the initial effluent Co contains the copper ion concentration (mg/L), C the final effluent contains the copper ion concentration after adsorption (mg/L), V is the initial volume of the effluent containing the solution of copper ions (L), and W is the weight of the adsorbent (gr) [8]. The removal efficiency can also be determined using the following equation (2):

$$RE = [(Co-C) / Co] \times 100\% \qquad (2)$$

RESULT AND DISCUSSION

The adsorption process in absorbing iron and manganese in groundwater with variations in stirring speed and contact time obtained optimum results using a kepok banana peel adsorbent. **Figure 1**, show that in the removal of Fe, the optimum stirring speed of 150 rpm with a contact time of 60 minutes was able to control the concentration of influent iron from 2.13 mg/L to 0.272 mg/L which had met the water quality standard of at least 0.3 mg/L. The speed of stirring can affect the absorption of more adsorbate due to the movement of particles that spread. Contact time can affect the amount of adsorbate that is absorbed. Contact time is required to reach an equilibrium state (adsorption equilibrium). Variation of contact times obtained for the adsorption equilibrium is reached and determines the adsorption ability of activated carbon [8].

Figure 2, show that the percentage of adsorption removal increases, this can be seen from the stirring speed of 150 rpm with a time of 60 minutes the highest removal percentage is 83.9%. So, it can be seen from the removal results that the adsorbent of kepok banana peel is very effective in reducing Fe heavy metal, this is due to the long contact time between the adsorbate and the adsorbent which is evenly distributed so that the ability to reduce Fe heavy metal levels in groundwater becomes more effective.

Figure 3, show that in the removal of Mn, the optimum stirring speed of 150 rpm with a contact time of 30 minutes was able to eliminate the influent manganese concentration of 1.26 mg/L to 0.368 mg/L which met the drinking water quality standard of 0.4 mg/L. Figure 4, show that the percentage of adsorption removal increases, this can be seen from the stirring speed of 150 rpm with a time of 30 minutes the highest removal percentage is 81, 27%.

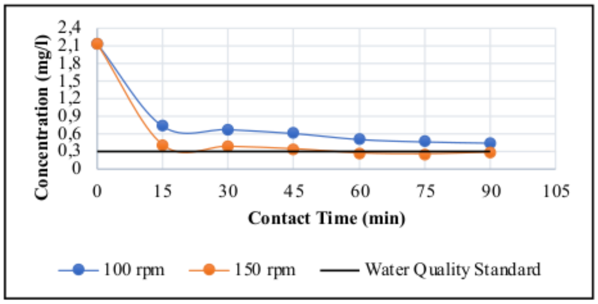

FIGURE 1. Effect of Stirring Speed and Contact Time to Concentration Removal of Heavy Metal Fe

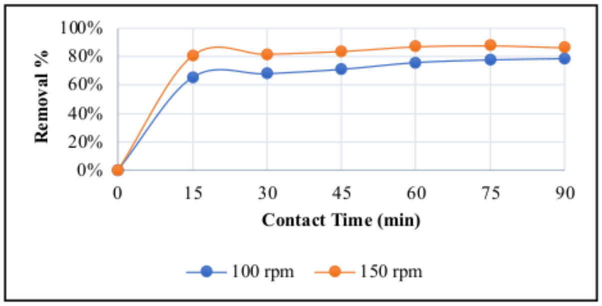

FIGURE 2. Effect of Stirring Speed and Contact Time to Percent Removal of Heavy Metal Fe

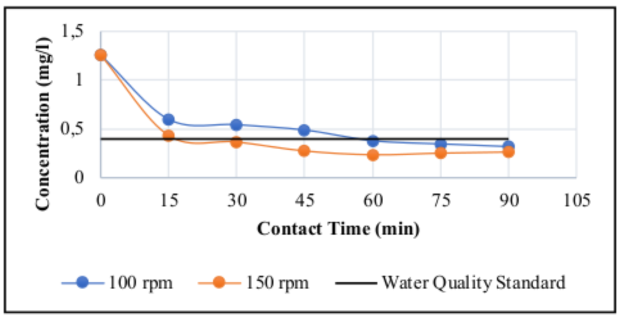

FIGURE 3. Effect of Stirring Speed and Contact Time to Concentration Removal of Heavy Metal Mn

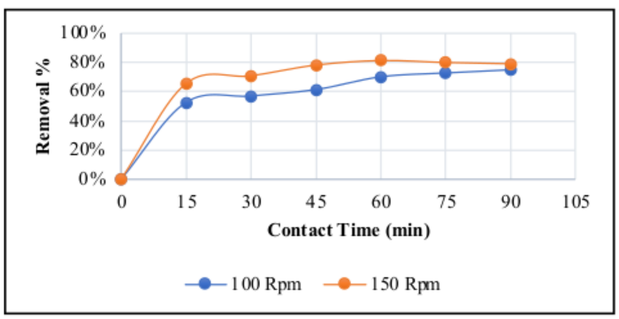

FIGURE 4. Effect of Stirring Speed and Contact Time to Percent Removal of Heavy Metal Mn

CONCLUSION

Based on the research result, removing of Fe and Mn with adsorption process using kepok banana peel, the efficiency of removing heavy metal levels of Fe 83.9% and Mn 81.27% . The concentration of heavy metal levels of Fe in groundwater obtained with an optimum stirring speed of 150 rpm with a contact time of 60 minutes was able to reduce the concentration of Fe from 2.13 mg/L to 0.272 mg/L. The concentration of heavy metal levels of Mn in groundwater obtained with an optimum stirring speed of 150 rpm with a contact time of 30 minutes was able to reduce the concentration of Mn from 1.26 mg/L to 0.368 mg/L.The effluent concentrations of Fe and Mn meet the standards of PERMENKES No. 492. In 2010 for metal, the maximum Fe in drinking water is 0.3 mg/L and Mn is 0.4 mg/L.

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