THE RESULT OF WATER FLOW AND SETTLE ON FERROUS ION REMOVAL EFFICIENCY IN AQUEOUS SOLUTION

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ABSTRACT

Abstract---A survey to determine the amount of ferrous ion in groundwater that pump up for daily use in some area of Saraburi province, Thailand. It was found it up to 4.96 ± 0.03 mg/L. Therefore the ferrous concentration of 4.96 mg/L was prepared for the experiments. Ferrous ion removal apparatus was consisted of small glass column (diameter of 1.75 cm, height of 40 cm) connected with medium plastic column (diameter of 6.1 cm, height of 40.5 cm) line in vertical plane. The 10 g of calcium hydroxyapatite was filled into the glass column. The direction of solution was flow from the tip of glass column and up flow on the top to the plastic column. The average flow rate of the solution was 0.4 ml/s. The experiments were divided into 2 systems. The first was continuous flow of 5 L, 21 hours settle and the second was continuous flow of 20 L, 12 hours settle.

It was found that the maximum efficiency of the first system of ferrous ion removal up to 87.98 %, the minimum efficiency was 68.79 %, and the average efficiency was 81.07 %. It was found that the maximum efficiency of the second system of ferrous ion removal up to 96.21 %, the minimum efficiency was 75.80 %, and the average efficiency was 88.19 %. The removal efficiency of both system was differ statistically significant at the 0.05 level.

Keyword---Chemistry, Ferrous ion, Hydroxyapatite

INTRODUCTION

Cause of groundwater color was due to a compound of iron contamination. When the ferrous ion in water exposed to air, it was oxidized by oxygen to form insoluble substances, and was the cause of water turbidity and color. The domestic consumer complains of the brownish color which ferrous ion imparts to laundered goods. Ferrous ion appreciably affects the taste of beverages. The taste of ferrous ion may be readily detected at concentration of 1-2 mg/L. This concentration was suitable for iron bacteria, because the growth of it was fast. Drinking water standards of the U.S. Public Health Service, thus requiring less iron than 0.3 mg/L [1]. Current research has led to the calcium hydroxyapatite used in various branches of sciences. Calcium hydroxyapatite crystal structure was hexagonal, it was suitable for use as a sorbent because there was a large surface area, and was a good ability to exchange ions [2], such as Lead, Copper, Cadmium [3], Zinc [4], and Chromium [2].

However, there were not much in the adoption of the ferrous ion removal from groundwater. Therefore, the removal of it from the water supply comes from groundwater with calcium hydroxyapatite was something that should be studied as well.

OBJECTIVE

This article was aimed to investigate the ferrous ion removal efficiency using hydroxyapatite, and comparison of ferrous ion removal efficiency of 2 different treatments.

SCOPE OF THE STUDY

The experiments were divided into 2 systems. The first was continuous flow of 5 L, 21 hours settle and the second was continuous flow of 20 L, 12 hours settle. The experiments were stopped when the system efficiency was below 80 %.

METHODOLOGY

Calcium hydroxyapatite
It was obtained from my previous research [5].

Preparing a ferrous ion stock solution
The 10 mL of conc.H_2SO_4 was filled into 25 mL of distilled water, the acid solution was obtained, then 3.511 g of $Fe(NH_4)_2(SO_4)_2.6H_2O$ was dissolved into this solution. The iron solution was obtained, then 0.1 M $KMnO_4$ was filled to drop by drop until this solution was red, and adjust the volume with distilled water to a 500 mL. It was obtained a stock solution of ferrous ion concentration of 1000 mg/L.

Aqueous solution of ferrous ion
Pipette 5 mL of stock solution, and then adjusted to a 1 L with distilled water. The solution was triplicate analyzed of ferrous ion concentration. It was found that 4.94, 4.98, and 4.96 mg/L, respectively, and was equal to the average of 4.96 ± 0.02 mg/L. The average pH of the iron solution was 2.70.

Analysis of ferrous ion
Adaptation of the EPA Phenanthroline Method 315 B [6].

Operation system
Ferrous ion removal system was consisted of glass column (diameter of 1.75 cm, height of 40 cm) and connected with plastic column (diameter of 6.1 cm, height of 40.5 cm) in vertical plane. The 10 g of calcium hydroxyapatite was filled into the glass column. The direction of water was moved from the tip of glass column and up flow to plastic tube on the top. Fill in the solution of ferrous ion into the separating funnel. The flow rate of the water was adjusted to 0.45 – 0.35 mL/s. It was obtained an average flow rate of 0.40 mL/s. The velocity of the water in the glass column was 0.21-0.29 cm/s. It was obtained an average velocity of 0.25 cm/s. The pH of the system before the experiment was 7.50. The first system was continuous flow of 5 L, 21 hours settle. The second system was continuous flow of 20 L, 12 hours settle. The water out of the system were triplicate analyzed for pH and ferrous ion concentration.

RESULT

Ferrous ion removal
The pH of the water fill into the system was average of 2.70. The ferrous ion content of the water fill into the system was average of 4.96 mg/L. The first system work continuously 5 L, and settle. The second system work continuously 20 L, and settle. Water sample was collected and analyzed every 5 L. The ferrous ion removal was given in Table 1 and 2.

Table1: Ferrous ion removal efficiency of the first system

Items	Removal efficiency (%)	Volume of water flow through (L)	pH of water flow out
1	85.56	5	5.1
2	87.98	10	4.7
3	87.82	15	4.6
4	85.85	20	4.1
5	80.00	25	4.1
6	68.79	30	3.9
7	71.41	35	3.5
	Average 81.06	Total 35	Average 4.3

From the data in Table 1, it was found that the first 5 L of the system was effective in removing ferrous ion at 85.56 %, the second 5 L of the system was effective in removing ferrous ion up to 87.98 %, the third 5 L of the system was effective in removing ferrous ion at 87.82 %, the fourth 5 L of the system was effective

in removing ferrous ion at 85.85 %, the fifth 5 L of the system was effective in removing ferrous ion at 80.00 %. When the water flows through the system at 30 L, the system efficiency was reduce to 68.79 %. When the water flows through the system at 35 L, the system efficiency was reduce to 71.41 %, and average was 81.07 %. The pH of the water flowing out of the system is reduced from 5.1 to 3.5, and average was 4.3.

When water flows through the system 35 L. The amount of ferrous ion was flow into a system of 173.6 mg. By measuring the amount of ferrous ion that flows out of the system, it was found that all flow amount equal to 32.9 mg. So the amount of iron adsorbed by the system was equal to 140.7 mg.

Table 2: Ferrous ion removal efficiency of the second system

Items	Removal efficiency (%)	Volume of water flow in (L)	pH of water flow out
1	87.50	5	5.2
2	91.93	10	4.7
3	93.43	15	4.5
4	96.21	20	4.2
5	91.98	25	4.0
6	80.48	30	3.8
7	75.80	35	3.5
	Average 88.19	Total 35	Average 4.3

From the data in Table 2, it was found that the first 5 L of the system was effective in removing ferrous ion at 87.50 %, the second 5 L of the system was effective in removing ferrous ion at 91.93 %, the third 5 L of the system was effective in removing ferrous ion at 93.43 %, the fourth 5 L of the system was effective in removing ferrous ion up to 96.21 %, the fifth 5 L of the system was effective in removing ferrous ion at 91.88 %. When the water flows through the system at 30 L, the system efficiency was reduce to 80.48 %. When the water flows through the system at 35 L, the system efficiency was reduce to 75.80 %, and average was 88.19 %. The pH of the water flowing out of the system is reduced from 5.2 to 3.5, and average was 4.3.

When water flows through the system 35 L. The amount of ferrous ion was flow into a system of 173.6 mg. By measuring the amount of ferrous ion that flows out of the system, it was found that all flow amount equal to 20.3 mg. So the amount of iron adsorbed by the system was equal to 153.3 mg. The removal efficiency of both system was differ statistically significant at the 0.05 level.

DISSCUSSION

The flow rate of the water was adjusted to 0.35-0.45 mL/s, and it was obtained an average flow rate of 0.40 mL/s. The velocity of the water in the glass column was 0.21-0.29 cm/s, and it was obtained an average velocity of 0.25 cm/s. This velocity was a reasonable speed made calcium hydroxyapatite was in a fluid condition (fluidized bed) within a glass column, and it was not flow out of the system. Calcium hydroxyapatite crystal structure was hexagonal [7], it was suitable for use as a sorbent because there was a large surface area, and was a good ability to exchange ions. It was appropriate to be used as a remove contaminant such as iron in the water.

The pH of the water flow into the system was low. The slightly acidic or neutral pH of the iron solution should be studied in the future. Adsorption isotherm of calcium hydroxyapatite and iron should be also studied. Expansion of the system to a larger scale to be adopted in the design for the removal of water contaminated with iron should be further study. Besides, it should be study for pollutant adsorption in wastewater, and performance comparing with activated carbon [8].

CONCLUSION

The ferrous ion average concentration of 4.96 mg/L was prepared for the experiment. The 10 g of calcium hydroxyapatite was filled into the glass column. The experiments were divided into 2 systems. The first was continuous flow of 5 L, 21 hours settle and the second was continuous flow of 20 L, 12 hours settle. The experiments were stopped when the system efficiency was below 80 percent. The first system was average in removing ferrous ion at 81.07 %. The amount of ferrous ion adsorbed by the system was equal to 140.7 mg. The second system was average in removing ferrous ion at 88.19 %. The amount of ferrous ion adsorbed by the system was equal to 153.3 mg. Water flow and settle were affect ferrous ion removal efficiency. The system was the ability to remove ferrous ion in the water efficiently. The results of this

research can be applied to solve problems in the community that was affected by groundwater contaminated with ferrous ion.

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