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APPLICATION OF ULTRASONIC TECHNOLOGY ON THE ADSORPTION OF Fe (II) AND Mg (II) METAL IONS USING KAOLIN AS ADSORBENTS

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ABSTRACT

Kaolin is a mineral found in sedimentary rocks known as claystone. Ultrasonic is used to accelerate the adsorption of metal ions on the adsorbent. This study aims to see the effect of the optimal temperature and time needed by the ultrasonic device to absorb metal ions in wastewater. Choline was activated using HCl, then modified with CTAB and ABS surfactants. Organokaolin modified with ABS was used to adsorb Fe (II) metal ions at 50□, and those modified with CTAB were used to adsorb Mg (II) metal at 70□, and each time varied 10,20,30,40,50 minutes. From this study, the highest value of efficiency in absorbing Fe metal ions was 92.97% at 50 minutes of irradiation, and for the absorption of Mg metal ions was 95.69% at 50 minutes of irradiation. This shows that the longer the irradiation time used, the better the absorption efficiency obtained. FTIR test results showed the presence of groups, O-H, C-H, and O=C=O. The results of the SEM test showed that the voids that were empty before adsorption were filled with metal ions during the conditions after adsorption.

Keywords: Kaolin, Ultrasonic, Surfactant, Adsorption, Adsorbent

INTRODUCTION

Water is an important element needed by humans, but in conditions that have been polluted water can cause health problems. Heavy metals are a source of environmental pollution. The Lhokseumawe city reservoir was built to collect water from the area around the city of Lhokseumawe to prevent flooding and is also used as a tourist attraction destination. The change in the color of the reservoir water is thought to be due to the high content of organic matter[1]. Conducted research on the removal of Fe metal in the Lhokseumawe city reservoir water, the results of an initial analysis of the concentration of Fe metal in

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Lhokseumawe city reservoir waste were 3.932 ppm. Magnesium is an essential heavy metal which is a pollutant in water systems. Mg (II) in the human body is not biodegradable, so it can accumulate in the organs of the human body[2].

Adsorption is a method commonly used to remove heavy metals because it is more efficient, cheaper and more efficient[3]. The adsorption process is usually carried out by contacting a solution/gas with a solid in such a way that some components of the solution/gas are adsorbed on the surface of the solid, thereby changing the composition of the solution. One of the adsorbents used comes from natural materials such as kaolin, which is also widely available in Aceh Province[4].

Kaolin is a mineral found in sedimentary rocks known as claystone. Kaolinite is the main mineral component of kaolin, which has attracted widespread attention as an adsorbent due to its high adsorption capacity, large specific surface area and good physical and chemical stability[5].

One of the efforts to increase the absorption of kaolin as an adsorbent can be done by modifying it using surfactants. Surfactants are active compounds that have the ability to lower surface tension (surfactants) and have a bipolar structure. The heads are hydrophilic and the tails are hydrophobic, so surfactants tend to act at the interface between two different polarities and hydrogen bonds, much like how oil and water occur. The uses of surfactants include reducing surface tension, interfacial tension, increasing the stability of dispersed particles and controlling the type of emulsion formation[6]. Modification of kaolin with surfactants aims to bind surfactants to the hydrophobic surface of kaolin

Ultrasonic is defined as various types of sound with a frequency above the average that can be responded to by the human ear or above 20 kHz[7]. The use of ultrasonic has been shown to be a very useful tool for accelerating the adsorption of metal ions and dyes on adsorbents by increasing the affinity between the adsorbate and the adsorbent. In the study[8], metal Pb (II) which was adsorbed by ultrasonic wave irradiation was greater than without irradiation as the contact time increased.

In this research, a study was conducted on the utilization of ultrasonic irradiation technology in the absorption of Fe (II) and Mg (II) metals by utilizing kaolin as an adsorbent by modification with alkyl benzene sulfonate (ABS) and CTAB surfactants. It is hoped that the ultrasonic technology and the utilization of these surfactants can be an environmentally friendly alternative in an effort to increase the absorption capacity of absorbents, especially kaolin[8].

EXPERIMENTAL

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2.1 Material

The materials used in this research are kaolin, Cetyl Trimethyl Ammonium Bromide (CTAB), Alkyl Benzene Sulfonate (ABS), Mg2SO4 Artificial Waste, 1 N HCl Solution, Aquades.

2.2 Methodology

2.2.1 Kaolin activation

Kaolin measuring 100 mesh was mixed with 1.0 N HCl and allowed to stand for 1 hour. Then neutralized using distilled water and then removing the water content using an oven at 105 □.

2.2.2 Modification of Kaolin with Surfactants

Modification of kaolin is done by mixing kaolin with a surfactant (organokaolin). The total weight of kaolin is 400 g. Modifications were made with a ratio of 45% of the total weight. The mixture was stirred and left to stand for 2 hours, after which the kaolin precipitate was filtered and neutralized with distilled water and then dried using an oven at 105□. ABS-modified kaolin was used to adsorb Fe (II) metal ions and CTAB-modified kaolin was used to adsorb Mg (II) metal ions. The characteristics of the organokaolins were tested using SEM and FTIR[9].

2.2.3 Adsorption process on samples using ultrasonic

Adsorption was carried out using 5 g of organokaolin put into an erlenmeyer and mixed with 100 ml of wastewater (artificial waste and Lhokseumawe reservoir waste water), then put into ultrasonic with variations: temperature 70□, and time 10,20,30,40,50 minutes for kaolin which has been modified with CTAB surfactant and absorbs Mg (II) metal ions, temperature 50□, and time 10,20,30,40, 50 minutes for kaolin which has been modified with ABS surfactant and absorbs Fe (II) metal ions, then the solution is filtered, the filtered kaolin is put in the oven and then analyzed using SEM and FTIR, while samples of artificial waste and reservoir water in Lhokseumawe City are tested using AAS[10].

2.3 Characterization Techniques

2.4.1 Analysis of functional groups with Fourier Transform Infra Red (FTIR)

FTIR is used to analyze the characterization of polymer materials and functional group analysis. The sample will be crushed with KBr using Shimadzu FTIR spectrophotometer.

2.4.2 Scanning Electron Microscope (SEM)

In principle, this method measures the mass loss of a material when it is heated from room temperature to a high temperature of about 900□ with a heating rate of 20□.

2.4.3 Atomic Adsorption Spectrofotometers (AAS)

AAS is a tool used in analytical methods for the determination of metal and metalloid elements based on the absorption of radiation adsorption by free atoms.

RESULTS AND DISCUSSION

3.1 Effect of Ultrasonic Temperature and Time

After the sample is adsorbed using ultrasonic, the wastewater after adsorption is tested with AAS, then the following equation is used to determine the percentage of absorption of metal ions:

% Absorption efficiency = (co-ct)/co x 100%

Where co is the initial concentration (mg/L), and ct is the final concentration (mg/L).

The absorption efficiency in adsorbing Fe and Mg metal ions is shown in Figure 1. At 50□ the percentage of absorption continued to increase, until the highest absorption percentage at 50 minutes of irradiation reached 92.97%. At a temperature of 70 □ the percentage of absorption also continued to increase until at the 50th minute irradiation, the absorption percentage reached 95.69%. The irradiation time affects the absorption percentage, the longer the irradiation time used the higher the absorption percentage, this is also directly proportional to the temperature used, the higher the temperature used the higher the absorption percentage value used[11-12]. The maximum removal value of metal ions in water using surfactant-modified kaolin and ultrasonic irradiation occurs maximally because the surfactant sticks to the surface of the kaolin, resulting in contact between the molecules of the kaolin and surfactant which causes the formation of a layer which causes metal ions in the water to be absorbed. Where as in research conducted [13-14], adsorption using kaolin modified anionic surfactants resulted in the maximum removal of Pb metal in 90 minutes with a removal efficiency of 78%. According to [15] the difference in the maximum allowance for absorption of metal ions is due to the use of ultrasonic technology in the adsorption process to increase the surface area and accelerate the movement of molecules so that the adsorption process occurs faster.

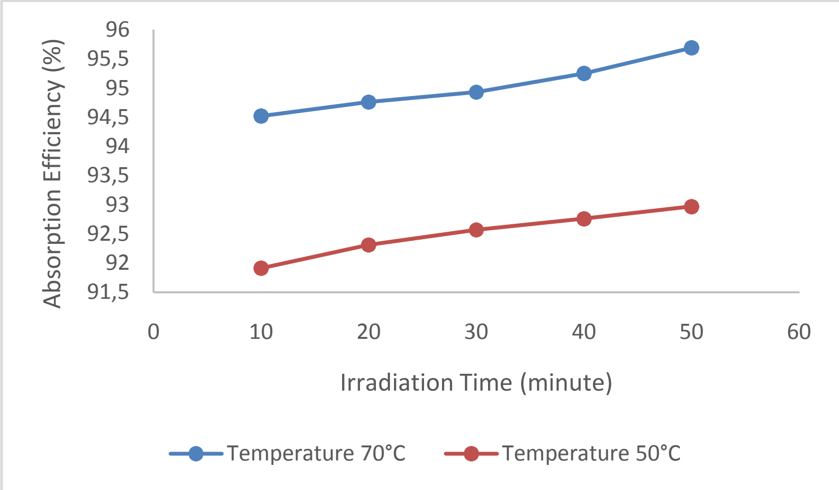

Figure 1. Absorption efficiency of Fe and Mg metal ions

3.2 Results of FTIR test analysis on conditions before and after absorption

The first spectral peak of kaolin before adsorption and after adsorption is at a value of 3666.7 cm-1 indicating the presence of O-H stretching vibrations caused by O-H stretching vibrations of the adsorbed water. The peaks of the second spectrum in the conditions after and before adsorption ranged at 2914.4 and 2933.7 which indicated the presence of C-H stretching vibrations which indicated the presence of CTAB content in them[16].

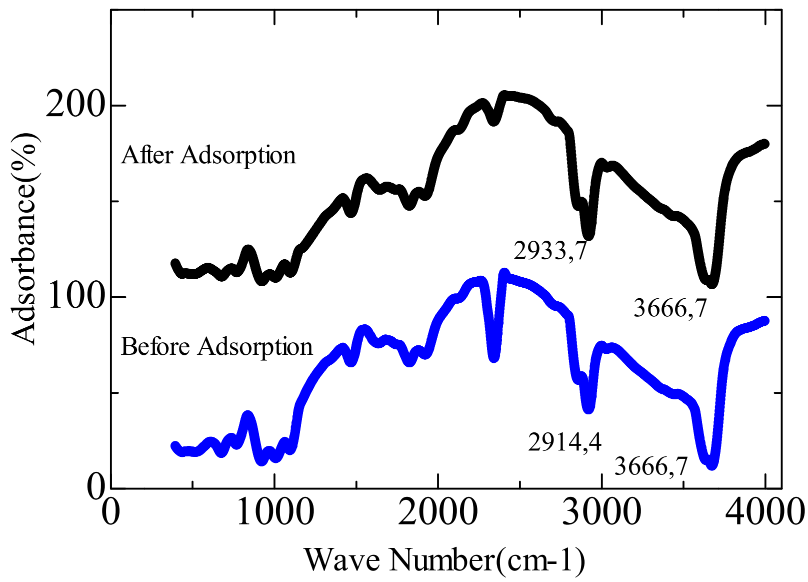

Figure 2. IR Spectrum of Kaolin and CTAB in Absorbing Mg Metal Ions

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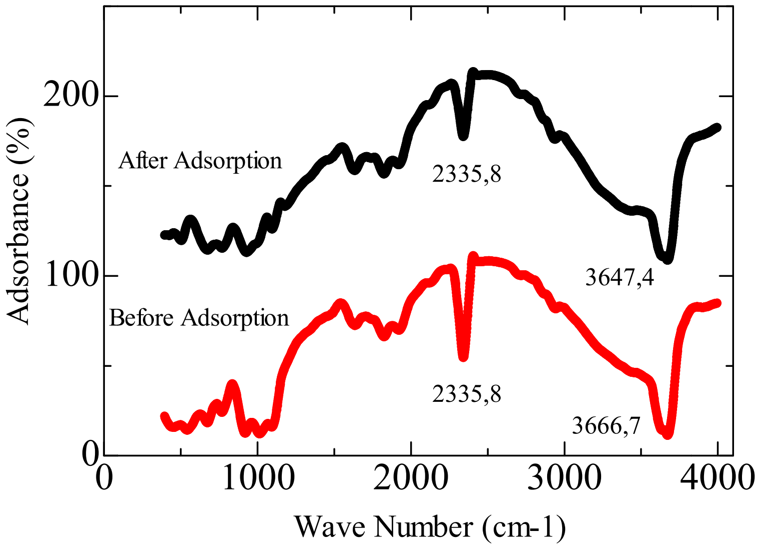

Figure 3. IR Spectrum of Kaolin and ABS in Adsorbing Fe Metal Ions

The first spectral peaks of kaolin before adsorption and after adsorption are at 3666.7 and 3647.4 cm-1 indicating the presence of O-H stretching vibrations caused by O-H stretching vibrations of the adsorbed water. The peak of the second spectrum in the conditions after and before adsorption is at a value of 2335.8 cm-1 which indicates the presence of an O=C=O stretching vibration indicating the presence of adsorbed Fe content in it.

Table 1. Wavenumbers and predictions of functional groups present in the FTIR spectra of kaolin

Wave Number (cm-1)	**Functional Group Prediction**
3666,77	O-H Stretching
2914,4 & 2914,4	C-H Stretching
2335,8	O=C=O Stretching

3.3 SEM Test Result Data for the morphology of the adsorbent before and after SEM absorption

Based on the results of the SEM test on the surfactant modified kaolin adsorbent before the Fe metal adsorption process, there were still several large pores and empty cavities on the organokaolin surface (figure 4a). Whereas in the observation of the surfactant modified kaolin adsorbent after the adsorption

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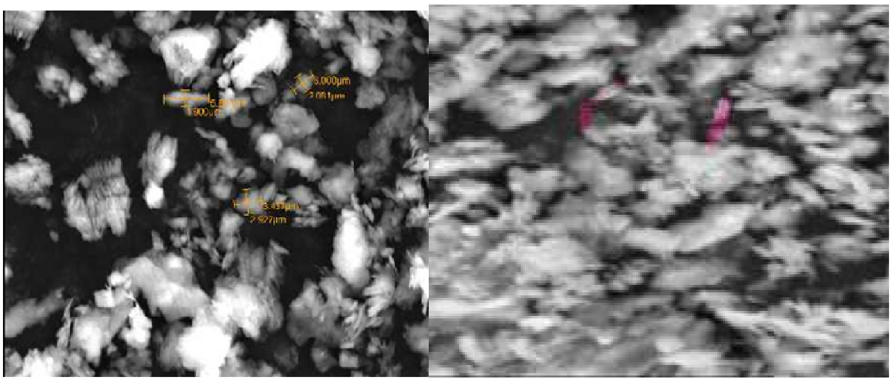
process of Fe metal (figure 4b), it can be seen that the cavity that was previously empty has been filled and flat and has small pores. This is due to the absorption process of Fe metal.



(a) (b)

CONCLUSION

Based on the results of the research that has been done, it can be concluded that the use of ultrasonic technology greatly affects the absorption of metal ions in water. The irradiation time affects the percentage of absorption, the longer the irradiation time used, the higher the percentage of absorption. This is also directly proportional to the temperature used. The higher the temperature used, the higher the percentage absorption value used. At 50□, the highest absorption efficiency occurred at 50 minutes of irradiation reaching 92.97%. At a temperature of 70 □ the percentage of absorption also continued to increase until at the 50th minute irradiation, the absorption percentage reached 95.69%. The FTIR test results showed the presence of O-H functional groups indicating the presence of kaolin, C-H groups indicating the presence of CTAB, and also the O=C=O group indicating the presence of adsorbed Fe metal ions. From the results of the SEM test it can be seen that the voids that were empty before adsorption have been filled, this happens because metal ions in water are adsorbed.

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