Increased Absorption Capacity Of Organokaolin Adsorbents In Absorb Metals Using Microwave Technology

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Abstract. This study about the absorption of iron and magnesium as metal ions in water solutions and kaolin were used as adsorbents. The power of Kaolin as adsorbent still very low so it is necessary to modify kaolin using acyl sulfonate (ABS) surfactant which is an organic compound. The aim is to increase the absorption capacity of kaolin in absorbing metal ions contained in water using modified kaolin to get effective absorption results in absorbing metal ions, especially iron, this research was carried out by varying microwave irradiation time 5, 15, 30, 50 and 80 minutes using surfactant kaolin modification and without surfactant modification, the waste used was artificial waste with an initial concentration of 100 mg/l. The samples were analyzed using Atomic Absorption Spectrophotometers (AAS), while the characteristics used were Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscope (SEM). Kaolin modification with microwave use in the adsorption process results in a decrease in artificial Fe waste at 3 minutes irradiation time on modification of efficiency reduction of 72% and Mg waste at 30 minutes decreased by 61%.

Keywords: adsorption, adsorbent, metal ion, kaolin, microwave, surfactant.

1. Introduction
One of the environmental problems that occur in many areas is the occurrence of water pollution caused by the presence of metal ions in the water such as iron and magnesium, metal ions in the water if consumed continuously will adversely affect human health. Recent efforts to control metal ion waste are increasingly developing, leading to efforts to find new methods that are cheap, effective, and efficient. One method for removing metal ions in water using the adsorption process [1]. The adsorption process is more widely used in industry because it has several advantages, which are more economical and also do not cause toxic side effects and are able to remove organic and inorganic materials. Adsorption is a process of waste absorption that occurs above the surface of the adsorbent due to the attraction between the adsorbate molecule and the adsorbent surface [2].

The use of conventional adsorbents requires relatively more expensive operational and regeneration costs. Conventional adsorbents that are often used in the adsorption process are alumina, activated carbon, silica gel, these adsorbents have good adsorption ability but are not economical. In this study using alternative adsorbents derived from nature, in the form of kaolin because in addition to having good adsorption capability, these adsorbents are also more economical [3].
using pure kaolin for the adsorption of lead, zinc and cadmium. From the results of the research it turns out that the adsorption capacity of pure kaolin is still low, when compared to activated carbon, zeolite and bentonite [4].

One of the efforts to improve the absorption capability of kaolin, trying to modify kaolin using acyl sulfonate surfactant (ABS). [5]. Although the absorption of heavy metals in kaolin that has been modified by surfactants has been better than using pure kaolin, the absorption rate of the metal is only 78%. The absorption capacity of kaolin is thought to still be increased by modifying the process using microwave technology. The use of microwaves in the adsorption process will increase electromagnetic energy in the process, the energy can penetrate the particles and interact between the molecular so that the reaction will occur better and the process will be more homogeneous faster than the conventional absorption process [6]. Microwaves can heat the reaction mixture very quickly, uniformly and directly without obstructing the problem of heat transfer through walls as is the case with conventional heating [7]. In addition, the use of microwaves can save energy [8].

Even so, until now information about the use of microwave technology in the adsorption process is still very limited. Therefore, this research will try to apply microwave technology to increase kaolin absorption of Fe and Mg metal ions in water. The results of this study are expected to provide new information as an alternative in increasing the absorption capacity of kaolin adsorbents

2. Method
The materials used in the form of kaolin contained in nature, acyl sulfonate surfactants (ABS) which are positively and negatively charged, are used for the modification process of activating kaolin as an adsorbent. Aquadest, HCl is used in the activation process using acid to remove metal content and organic compounds found in kaolin to increase its absorption [9].

Size of 100 mesh kaolin particles. The equipment used included oven, pH meter, microwave, desiccator, glass beaker, stirring rod, filter paper, Determination of initial and final concentrations for Fe and Mg components using Shimadzu UV-1800 Atomic Absorption Spectrophotometer (AAS), while determining the characteristics for length wave before and after treatment using Fourier Transform Infra Red (FTIR) -IR spectrophotometer and Scanning Electron Microscope (SEM).

2.1. Activation Kaolin
Activation is done using 100 mesh kaolin. Kaolin is heated using an oven at 105 ° C for 3 hours. After being cool mixed with 1N HCL then allowed to stand for 1 hour, then washed with aquadest until neutral (pH = 7) [5]. Drying again using an oven with a temperature of 105 ° C for 2 hours.

2.2. Modification of Kaolin with Anionic Surfactant
Modification is carried out by mixing solid kaolin and anionic surfactants (organocalin). Modification is carried out with a ratio of 45% of the total weight [10]. Precipitation is carried out for 4 hours before being stored in a desiccator before use.

2.3. Microwave Adsorption Process
Adsorption is done by weighing 5 g of organokaolin and then putting it into erlenmeyer. A total of 100 mL of artificial waste samples were then covered with aluminum foil. Then it was put into the microwave with an operating temperature of 55 ° C and analyzed using AAS and adsorbent in the characteristic test using FTIR and SEM.

3. Result and Discussion
Research that has been done shows the performance of organokaolin adsorbents in absorbing artificial waste using microwaves, from the analysis of the ability of kaolin adsorbents modified with surfactants in reducing the concentration of iron and magnesium ions (Fe and Mg)²⁺ in artificial wastewater solutions with an initial concentration of 100 mg / L. To see the performance of the adsorbent before and after the activation process is obtained and the data for the reduction of Fe and Mg metal content is obtained.
Figures 1 and 2 show very significant differences between modification and non-modification adsorbents. The modified adsorbent is more efficient at absorbing Fe metal than non-modified adsorbent. This is because the modified kaolin using anionic surfactant (ABS) is able to reduce Fe metal content by 72.25% in the first minute which is 30 minutes, this is because Fe metal contained in the waste has been absorbed in the organokaolin pores due to increased movement the molecules found in wastewater, so that the interaction between organokaolin and metal ions is more common, the longer the irradiation time decreases the absorption efficiency obtained due to saturation of the adsorbent in absorbing Fe metal. while the absorption efficiency on the non-modification results obtained the best results at 30 minutes irradiation time of 63%.

This shows that in addition to the increase in the performance of adsorbents due to the microwave adsorption process can also accelerate the process of waste absorption because of the presence of microwaves that can heat the reaction mixture very quickly, uniformly and directly without obstructing the problem of heat transfer through the wall so that it captures more ions Fe and Mg metals (Deng, et al, 2015), This is consistent with previous studies which explained that the preparation of synthetic clay samples using microwave irradiation can increase silica levels in clay [11].

3.1. Determination of the characteristics of the adsorbent using Fourier Transform Infrared Spectroscopy (FTIR)

The characterization of functional groups in kaolin is very important, this is due to knowing the functional groups of Si-O-Al bonds. The existence of these functional groups will indicate effectiveness in the process of artificial waste absorption and will indicate effectiveness in sample preparation.

IR spectra of kaolin modification of anionic surfactant before adsorption (Figure 3) shows that the vibration changes of Si-O strain at wavelengths 10496.13 cm⁻¹ and 1126.4 cm⁻¹ became O-H deformation (840.96 cm⁻¹). In the anionic surfactant spectra after Fe metal adsorption, the vibration of Si-O deformation (699.23 cm⁻¹) changes to a vibration of O-H deformation with a wavelength of 894.58 cm⁻¹ and 911.4 cm⁻¹.
The increase in spectrum area at wave number 1113.94 cm\(^{-1}\) indicates that the appearance of Si-O vibration is strain. The absorption peak experienced a change in absorption intensity which showed the absorption process of Fe metal in the modified kaolin surfactant. The last peak in both spectra shows the octahedral O-H vibration.

3.2. Determination of adsorbent characteristics using Scanning Electron Microscope (SEM)

The results of SEM photo analysis on organokaolin material before the metal adsorption process showed that the organokaolin surface still had many large pores (Figure 4). The results of SEM photo analysis on organokaolin material before the metal adsorption process showed that the organokaolin surface still had many large pores (Figure 5).

The results of SEM photo analysis on organokaolin material before the metal adsorption process showed that the organokaolin surface still had many large pores (Figure 4). Meanwhile, in observing organokaolin after the metal adsorption process (figure 5), there are cavities that have coincided and have small pores. These cavities and pores are formed due to the absorption of Fe metal in organokaolin.
4. Conclusion
The results of the study can be concluded Absorption of artificial wastes from Fe and Mg using Organokaolin adsorbents can be increased by using a microwave. At 30 minutes irradiation time, the highest Fe metal adsorption wastes were obtained by 72% while Mg was obtained at 30 minutes irradiation time of 61%.

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