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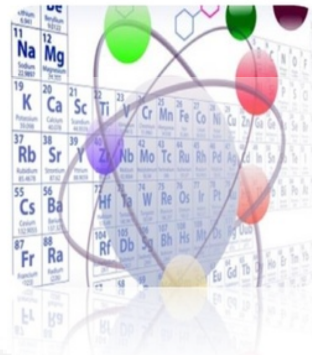

Characterization of Chitosan-Bentonite and Water Hyacinth Plant as a Potential Adsorbent

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ABSTRACT

Water hyacinth (Eichhornia crassipes) has a very rapid growth in the waters so it can cause eutrophication. The silica content of 5.56% allows water hyacinth can be utilized as a natural adsorbent. Bentonit has an advantage as an adsorbent because it has an inter-layered structure that can be easily modified with chitosan, resulting in better performance as an eco-friendly adsorbent. This research aims to determine the characterization of chitosan-bentonite and water hyacinth as a adsorbent of Pb(II) removal. Characterization tests were performed using X-ray difraction (XRD) and Fourier Transform Infra Red (FTIR) spectrophotometry. From the results of quantitative XRD analysis can be seen that the adsorbent of chitosan-bentonit and water hyacinth have different adsorbent characteristic, but has the same crystal system that is triclinic crystal system.

Keywords: *adsorben, chitosan-bentonit, FTIR, Pb(II), water hyacinth, x-ray difraction.*

I. Introduction

The presence of heavy metals can cause water pollution, including Pb (II). Disturbances in the peripheral, and central nerves, blood cells, chronic kidney disorders are a bad impact on the life of aquatic and human ecosystems if the concentration of lead metal exceeds the threshold.[1] Based on research by Ritonga et al.[2] the content of Pb^{2+} in the Belawan River is 0.241 mg / L. The content has exceeded the threshold value of quality standards set by Government Regulation No. 82 of 2001 concerning Management of Water Quality and Water Pollution for Pb (II) content which is equal to 0.03 mg / L. In fact, Belawan River is used by the community as a center for irrigation, drinking water, and industry. Some studies that can reduce the content of Lead metal waste, one of which is by using water hyacinth as an adsorbent.[3]

Water hyacinth or Eichhornia crassipes is a weed plant that lives in aquatic environments. One water hyacinth stalk in Lake Toba is able to develop an area of 1 m2 within 52 days or able to cover an area of water area of 7 m^2 within a period of 1 year (North Sumatra Environmental Impact Management Agency, 2003). A large population of water hyacinth can cause Eutrophication, due to the rapid growth of water hyacinth plants making it difficult to control. However, Rhizosfera and silica microbes contained in the water hyacinth root are able to absorb heavy metals. This adsorption power can be used as adsorbent.[4] Heavy metal adsorption occurs due to interactions between the active functional groups of the adsorbent, because the adsorption process can be influenced by the chemical structure of the adsorbent. [5]

The existence of bentonite as a mineral resource in Indonesia is quite abundant (380 million tons), and cannot be utilized optimally.[6] The use of bentonite as an adsorbent has advantages because it has an inter-layered structure that can be easily modified so that it will improve its absorption properties.[7] Although bentonite has a low ability to adsorb anions, bentonite is able to adsorb positively charged metal ions because of its negatively charged surface. To improve the adsorption properties, bentonite needs to be modified before it is used as an adsorbent.[8]

Based on previous research[6], bentonite has been modified with surfactants or polymers, but it can produce pollutants which are feared to cause pollution to the environment. Alternatives that can be used are natural organic materials or organic materials that are safe to use, namely chitosan. The results of the study Permanasari et al.[8], chitosan-bentonite adsorbent is a new adsorbent that is easy to synthesize which shows higher resistance and is affordable. Chitosan-bentonite also showed optimum performance as an adsorbent for some heavy metals such as Fe, Cd, and Cu with an average adsorption strength above 90%.[9] In addition, chitosan is an anti-oxidant material that does not contain toxic and is very safe to use.

II. Experimental Method

In this study, the main ingredients used were the stems of water hyacinth (Eichhornia crassipes), bentonite, and chitosan. While the supporting chemicals used are aquades, sodium chloride (NaCl) 1 M pa, acetic acid (CH_3COOH) 2%, sulfuric acid (H_2SO_4) 1.2 M, nitric acid (HNO_3) 1%, and lead nitrate (Pb (Pb (NO_3) $_2$).

Equipment used include: analytical balance; blender; oven; thermometer; centrifuge; vacuum filtration equipment; waterbaths, and laboratory glassware such as glass beakers, petri dishes, stirring rods, measuring cups, mortars and pestles, spatulas, erlenmeyers, measuring flasks, glass funnels, volume pipettes, and drop pipettes.

In testing the adsorbent characterization used several instruments such as, Fourier Transform Infra Red (FTIR) spectrophotometer and X-Ray Difraction (XRD).

2.1. Water Hyacinth Preparation

A total of 20 grams of water hyacinth stems that have been cleaned with water are dried using the sun's heat within 3 days, starting at 08.00 to 17.00 WIB / day with an ambient temperature of 25 ° C to 31 ° C. After 3 days (dry material), the material is processed using a blender for 2 minutes at a speed of 18,000-21,000 rpm. After smooth the material is filtered with a size of 60 mesh3. Then the weight of the sample is weighed to determine the moisture content in the sample.

2.2. Kitosan Solution Preparation

Preparation of 2% chitosan solution by weighing 10 grams of chitosan and dissolved with dilute acetic acid with a concentration of 2% as much as 500 mL into a 1 L beaker. The mixture is stirred with a magnetic stirrer to form a suspension for 2 hours.

2.3. Na-Bentonit Preparation

25 grams of bentonite were dispersed into 500 mL of 1 M NaCl solution. The suspension was stirred with a magnetic stirrer at 70°C for 24 hours. The mixture is separated by decantation and the precipitate is washed with distilled water to remove residual chloride ions.

2.4. Kitosan-Bentonit Preparation

In a 1 L beaker, 180 grams of Na-bentonite are added and 1 L of 1000 ppm chitosan is added. Then the sample mixture is shaken at 160 rpm for 30 minutes. The mixture was filtered using Whatman No.1 filter paper and the residue obtained was chitosan-bentonite. The chitosan-bentonite obtained was washed using distilled water until it was free of acid (neutral), then dried in an oven at 100°C. Dry chitosan-bentonite is mashed and a part of chitosan-bentonite is taken for 3 characterizations using FTIR and XRD test.

III. Results and Discussion

3.1 Water Hyacinth Preparation

Part of the water hyacinth plant used is the hyacinth stems. The water hyacinth sample is then washed and dried with direct sun heat / drying. After drying, the water hyacinth sample was weighed at 200 grams. The sample is then dried again in the oven for 2 hours at 150°C. This is done to eliminate the water content that is still present in the water hyacinth. The sample was then weighed again and a water hyacinth weight of 20.5 grams was obtained with a moisture content of 89.75%.

Furthermore, the dried sample was blended using a blender. Then the process of sieving the water hyacinth that has been refined using a 60 mesh sieve test sieve size in order to obtain the size of the adsorbent particles that have a larger and smoother surface area. Oscik & Cooper states that, the greater the surface area of the adsorbent the greater the capacity of an adsorbent to adsorb an adsorbate.[11] This sifting is the final step in the process of the preparation of water hyacinth in which the net weight of the sample is 19.5 grams.

3.2 Chitosan-Bentonite Preparation

Modification of Na-bentonite into chitosan-bentonite aims to change the surface character of bentonite from hydrophilic to hydrophobic. It indicate to improve the performance of chitosan-bentonite in adsorbing hydrophobic organic compounds.[10] The bentonite used is modified to Na-bentonite first. Based on the research of Syuhada et al. [6], the cation exchange capacity of Na^+ ions is greater than the smaller size of Ca^{2+} ions. Therefore, Na-bentonite will form a stronger bond with chitosan, compared to Ca-bentonite.

3.3 Adsorben Characterization

3.3.1 XRD Analysis (*X-Ray Difraction*)

Characterization with XRD was carried out to compare changes in the crystallinity structure that occurs in water hyacinth and chitosan-bentonite. XRD diffractogram images for Na-bentonite and chitosan-bentonite are shown in Figure 1 below.

X-ray diffraction is used to analyze changes in the crystallinity structure of chitosan-bentonite compared to Na-bentonite structure. The main changes will be seen in the interlayer section, and to further ensure that chitosan has interacted with bentonite. The XRD spectra of Na-bentonite have different absorption bands with chitosan-bentonite.

So, based on the diffractogram results above, it can be seen that Na-bentonite and chitosan-bentonite have structural changes which are marked by a significant change in diffraction of 2 angle. But there are still the same peaks between Na-bentonite and chitosan-bentonite. An increase in 2 point, shows the interaction between the Na-bentonite minerals with chitosan.

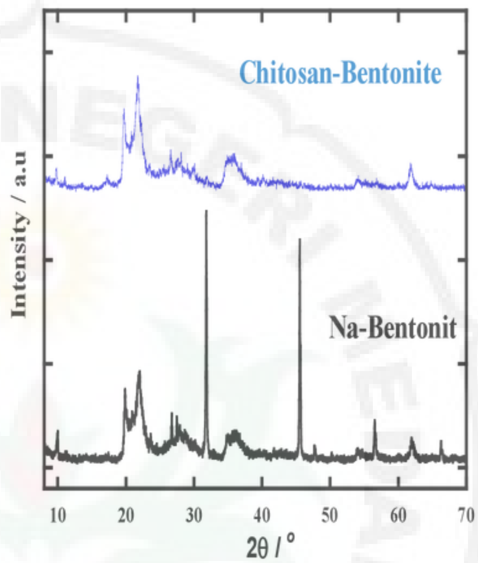

Figure 1. XRD Pattern of Na-Bentonite and Chitosan-Bentonite

Furthermore, the results of the analysis of differences in the structure of the crystallinity of water hyacinth and bentonite chitosan by the XRD Analysis. Based on the results of quantitative analysis using EXPO 2014 Analysis software, it can be seen that the chitosan-bentonite adsorbent and water hyacinth have different adsorbent properties, as indicated by the values of the lattice parameters a (Å), b (Å), c (Å), and the angle between the axes (°), (°), (°), which experience changes in value.

But chitosan-bentonite and water hyacinth have the same crystal system, which is triclinic. The Triclinic crystal system has an axial ratio (a ratio of axes) $a \neq b \neq c$, which means that the lengths of the axes are different from each other or there are no equal lengths. And also has a crystallographic angle $\alpha \neq \beta \neq \gamma \neq 90^{\circ}$, which means that the angles α, β and γ are not perpendicular to each other.

The diffraction patterns obtained were then analyzed qualitatively using the EXPO 2014 Analysis software and the results shown in table 1 below were obtained.

Tabel 1. Crystal Manager by EXPO 2014 Analysis

Adsorben	A(Å)	B(Å)	C(Å)	α (°)	β(°)	γ (°)	Crystal System
Chitisan-Bentonite	6.53	11.1	11.4	143.8	60.1	135.6	Triclinic
Water Hyacinth	16.5	9.3	19.5	78.6	30.5	79.5	Triclinic

IV. Conclusion

From the XRD diffractogram results, it can be seen that there are changes in the structure of Na-bentonite and chitosan-bentonite which is marked by a significant change in diffraction angle 2. But there is still the same peak between Na-bentonite and chitosan-bentonite which shows the interaction between minerals from Na-bentonite and chitosan. While the results of quantitative XRD analysis can be seen that the chitosan-bentonite adsorbent and water hyacinth have different adsorbent properties, but have the same crystal system that is triclinic. The Trichlinic crystal system has an axial ratio which means that the lengths of the axes are different from each other and also have a crystallographic angle $\alpha \neq \beta \neq \gamma \neq 90^\circ$.

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