The Use of Activated Carbon of Palm Shell and Chitosan from 'Belangkas' as Adsorbent to Reduce Metal Level of Hg

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Abstract. The objective of this research was to make an activated carbon from the waste of palm shell through dehydration, carbonization, dan activation where the activation process using H_3PO_4. The processing of Chitosan from 'belangkas' that is a biopolymer can be obtained through deproteinization, demineralization, and distilation. Activated carbon and chitosan which produced are used to reduce the metal level of Hg. The pore structure of activated carbon surface is opened, thus it has higher adsorption, so that, chitosan which is cationic polyelectrolyte can be used as adsorbent. The reduction of metal level of Hg compared to commercial activated carbon. Determination of reduction of metal level of Hg reduction is analyzed by using inductively coupled plasma-atomic emission spectrometer (ICP-AES).

Keywords: Activated carbon; 'belangkas'; adsorbent; Hg

Introduction

Mining activities in Indonesia are often considered as a factor that causes environmental pollution. Especially small-scale gold mining, gold ores processing are done with amalgamation process in which Mercury (Hg) is used as a media to bind the gold, and the wastes that were generated due to processing and refining of gold are often discharged into rivers [1]. In North Sumatera, river water pollution due to processing and refining activities of gold ores occurs in Batangtoru, South Tapanuli. The waste that might pollute the rivers is Mercury (Hg). Mercury is a dangerous waste that can damage the nervous system, brain, kidneys, and even fetus. Mercury poisoning have occurred in Japan, known as Minamata tragedy that caused the death of 110 people. This tragedy also occurred in Indonesia in 2004, known as Teluk Buyat tragedy, in which the residents of affected area suffered from the bumps that appear all over their body. This tragedy was caused by the waste that was thrown to the sea by the mining company [2]. Many ways can be done in order to overcome the water pollution including the use of adsorbents to reduce levels of metals contained in the waste water. The absorbent that usually used is activated carbon,

chitosan and so on. The modification of the absorbent has also been done in order to improve the quality of the absorbent. The waste of palm shells can be used as activated carbon. Activated carbon can be used as an absorbent. Absorption is determined by the size of the surface of the particle and this ability could get higher if the activated carbon is made by chemical compounds such as H_2SO_4, H_3PO_4, or by heating it in high temperature. Thus, the charcoal will experience the change of its phisical and chemical properties. The manufacturing process of activated is several stages of process including: dehydration process, carbonization process and activation process. Aranaz used chitosan as an adsorbent for the adsorption of pollutant metals, such as Fe, Al, and Cu [3]. Chitosan can also be produced by using shell "Belangkas" (Tachypleus gigas). Both of these adsorbents, activated carbon and chitosan also be used to absorb ions Hg in the wastewater. So, we wanted to determine the ability of the two adsorbents to absorb Hg ions. Analysis of Hg ions by using ICP-AES.

Experimental

Materials

Palm Shell from Adolina PTPN IV in North Sumatera, Belangkas (*Tachypleus gigas*) from beach of Cermin, H_3PO_4, CH_3COOH, HCl, NaOH.

The Manufacturing of Activated Carbon from Oil Palm Shell

300 g of oil palm shells that have been cleared are placed into a beaker glass and put in an oven for over 3 h at a temperature of 110^oC to remove the water content. Then the oil palm shells will be carbonized at 400^oC for about 2-3 h in a furnace. The calculation of the time will be started when the temperature has reached 400^oC. After the carbonization process, and the result is carbon. Carbon will be activated by adding H_3PO_4 7% at a ratio of 1:10 (b/b). Then stirer the compound for 60 min and soak it for 24 h. And then the result filtered, and dried in an oven at 150^oC temperature for 24 h. After the carbon has been dried, then heated in the furnace at a temperature of 600^oC for about 2 – 2.5 h, where the time will be calculated when the temperature has reached 600^oC. After the heating process, the activated carbons are washed by using HCl 5N for several times to remove the chloride. After that, the activated carbon washed by using hot aquadest (hot distilled water) to get a neutral pH, and than washed by using cold aquadest (cold distilled water) to remove the phosphor content. The activated carbon dried in the oven at 120 ^oC, then it

crushed and blended. After activated carbon is refined, it is filtered by using 400 mesh sieve [4].

The Manufacturing of Chitin from the Shells of "Belangkas"

The shell of "belangkas" are washed by water, dried in the room temperature. The shell of "belangkas" are submerged into NaOH 0,5% solution with 1:8 (b/b) composition for 24 h. The shell of "belangkas" are washed by using flowing water until it has neutral pH. The next process, the shell of "belangkas" is deproteinization by using NaOH 5% solution with 1:8 (b/b) composition for 24 h. Then, the shells washed by water until it has neutral pH, then dried in the room temperature. The demineralization process is done by using HCl 5% solution with 1:8 (b/b) composition for 24 hours, then it is washed by water until it has neutral pH, then dried at room temperature. After the shells dried, then it is crushed to get dry chitins, and test the solubility of chitin with 98% formiat acid 1:100 (v/v) composition [5].

The Deacetylation Process of Chitin from The Shell of "Belangkas" to Produce Chitosan

Dry chitin from that were obtained from the shell of 'Belangkas' submerged into NaOH 50% solution with 1:14% (b/b) for 6 days and stired everyday, so that the submersion become homogen. Then it is filtered to obtain wet chitosan. The wet chitosan is washed by using flowing water until it reach neutral pH, and dried at room temperature. After the chitosan dried, then it is crushed to get dry chitosan. Test the solubility of chitosan with 1% acetate acid 1:100 (v/v) [6].

The Determination Process of Mercury (Hg) ion with Chitosan and Activated Carbon as Adsorbent

Chitosan is inserted into the waste water contains high levels of mercury ions (Hg), and then left for a while with varied time (5, 10, 15, 20, 25 s), and filtered, then the results are analyzed using Inductively Coupled Plasma-Atomic Emission spectrometer (ICP AES) instrument. Activated carbon from palm shell inserted into the waste water contains high levels of mercury ions (Hg), and then left for a while with varied time (5, 10, 15, 20, 25 s), and filtered, then the results were analyzed by using inductive coupled Plasma-Atomic Emission Spectrometer (ICP AES) instrument. The same treatment was also carried out for commercial activated carbon [7].

Results and Discussion

The concentration of ion Hg in waste water after using adsorbent

Waste water contains ions Hg at 4 mg / L. Then into the waste water is added to the variation of the adsorbent (chitosan, palm shell activated carbon, activated carbon commercial) for (5, 10, 15, 20, and 25 min), then filtered, and the water content in the analysis by ICP-AES. The results of the analysis are shown as Fig. 1 below. Fig.1 shows the relationship between the concentration of Hg ions with a time of contact using multiple adsorbent.

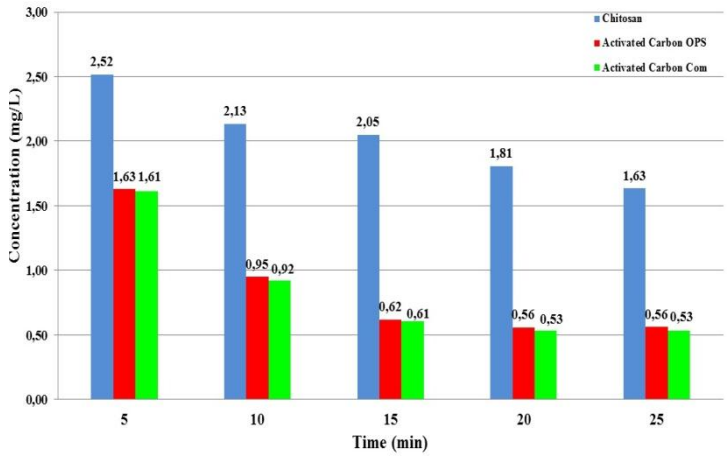

Figure 1. Graph Relations Concentration With Contacts Time Using Multiple Adsorbent

From the results obtained that the best adsorbent activated carbon absorption is commercial, with the best contact time is between 20-25 min. While the adsorbent of oil palm shell results are also almost as good as the contact time between 20-25 min with the difference in concentration of only 0.03 mg/L. For chitosan, are also capable of absorbing ions Hg but the results are not good enough compared to activated carbon, with the best contact time is 25 min. Based on these data, it can be obtained the value percentage Hg ion absorption by some of the adsorbent using the following equation:

$$\%\ \text{Adsorption of Hg ion} = \left[\frac{\text{Initial Concentration of ion Hg} - \text{Final Concentration of ion Hg}}{\text{Initial Concentration of ion Hg}} \right] \text{x } 100\% \qquad (1)$$

From these equations it is known that the initial concentration of Hg ions in wastewater is 4 mg / L, while the final concentration was adjusted to the data of the graph in Figure 1. Figure 2 below is a graph of the percentage of absorption with contact time using multiple adsorbent.

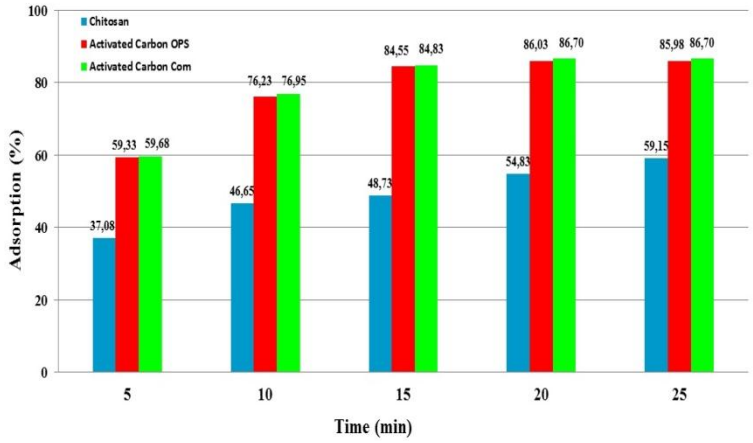

Figure 2. Graph Percentage of Absorption With Contacts Time Using Multiple Adsorbent

From the Fig. 2, it is known that the percentage of Hg ion absorption is best Commercial Activated Carbon that is equal to 86.70% with the best contact time is between 20-25 min. While activated carbon made by utilizing palm shell results is not much different, with the same contact time between 20-25 min, produces the best absorption of 86.03%. the difference of both absorption is just 0.72%. The percentage of absorption using chitosan is well only at 59.15% with a contact time of 25 min. In order to overcome this problem, which can lead to the absorption of up to above 95% with by reference to these data, it will be generated adsorbent better absorption if both types of adsorbents modified, namely chitosan from Belangkas and palm shell activated carbon to form a composite.

Conclusion

The use of chitosan from crab as an adsorbent to reduce levels of Hg ions in wastewater was only produce absorption of 59.15% with a contact time of 25 min. The use of activated carbon as an adsorbent to reduce levels of Hg ions in wastewater are able to produce the absorption of 85.98% with a contact time of between 20-25 min, this result is not much different from commercial activated carbon which produces absorption of 86.70% with the same contact time.

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