

Adsorption of Cr on Liquid Waste of Tannery Industry using Banana Peel Charcoal in various pH and Time Activation

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ABSTRACT

The purpose of the research is to determine the effect of activation time of banana peel charcoal on the adsorption capacity of Cr metal's tannery industry. Banana peel charcoal is made by carbonization process followed by activation using HCl solution with varying time. The activated charcoal with optimum activation time is used to determine the optimum pH of tannery waste on adsorption Cr metal. Banana peel as much as 600 grams then carbonized can form 42 grams of banana peel charcoal. The concentration of Cr metal initial that contained in tannery waste was 292.1 ppm. The optimum activation time is 1 hour, with decreasing Cr metal as much as 141.87 ppm using 1 gram of banana peel activated charcoal. While the pH variation of waste does not provide a significant difference.

Keywords: adsorption, Cr metal, activated coal

1. INTRODUCTION

The waste generated from leather tanning industry in the form of solid waste, liquid and gas (Ozgunay et al, 2007). The most liquid waste is produced because this industry uses chemicals and water in large quantities for the production process (Durai & Rajasimman, 2011). The resulting liquid waste contains many chemical pollutants from process auxiliaries. If the waste not processed or imperfect processing, then discharged into the environment, it will arbitrarily harm the ecosystem (Alves, Renofio, & Barbosa, 2008). This is the problem of industrialized countries in the world, one of which is Indonesia. Based on Provincial Regulation DIY No. 2 of 2012, one example of waste from the tannery industry that pollute the environment is chromium (Cr). In the process of production in the tanning industry still utilize Cr as a tanner. The chromium element (Cr) is one of the heavy metals and can be carcinogenic (Mishra, Dwivedi & Singh, 2010).

The maximum permissible chromium content in drinking water is 0.05 mg/liter. Chromium content in freshwater is usually less than 0.001 mg/liter and in marine waters about 0.00005 mg/liter (Effendi, 2003).

Waste management is required to reduce chromium contamination before disposal into the environment. Efforts to control heavy metal ions are now widely developed, such as ion exchange, membrane separation, and adsorption using adsorbents (Peters, Ku, & Bhattacharyya, 1985). Adsorption with activated charcoal is one of the most effective and innovative methods for decreasing metal content in waters (Mohammad-Khah, & Ansari, 2009). Adsorbents can adsorb heavy metals in waste that can then be physically separated between the adsorbent and the liquid waste.

The adsorption mechanism can be illustrated by the surface of the adsorbent attracting the gas or liquid molecules that contact it physically and chemically (Quiquampoix et al,1995). In the physics process, molecules are bound through the van der Waals forces but the bonded molecule is very weak. The molecule will be more chemically bound, through the formation of chemical bonds (covalent bonds) beginning with the adsorption of physics. The things that influence the adsorption process include adsorbent, surface area of adsorbent, acidity degree (pH), contact time and concentration.

Activated charcoal can be made by activating various types of charcoal from natural sources (Gaikwad, 2004). In this study, banana peel is used as an adsorbent material. This is because the consumption of bananas tend to be large. In other hnd, the banana skin is not maximally utilized, usually used for feeding cattle even just thrown away. So hopefully this research can provide solution for the management of both types of waste that is tannery and banana leather industry.

2. RESEARCH METHOD

Making Banana Peel Charcoal

Banana peel is cleaned to remove the dirt. After that, put into the oven at 125 °C for 30 minutes. Dry banana peel is roasted until charcoal is formed. Banana peel charcoal then smoothed.

Measurement of Cr metal concentrations in the liquid tannery waste

A 50 mL of tannery waste is filtered using filter paper. Then put in 250 ml measuring flask and added aquadest to the limit line. The diluted waste analyzed by AAS to measured Cr concentration.

Determination of the optimum activation time

Banana peel charcoal is activated with 1 M HCl with variation of time. Each of 1 grams banana peel is inserted into a 250 ml beaker glass. Then as much as 150 ml of HCl is added to the beaker glass. The mixture of charcoal and HCl is stirred with a magnetic stirrer for 1, 3, and 5 hours. After stirring was complete, the mixture is filtered and washed with aquadest until the pH of the solution becomes neutral. The activated charcoal is dried with oven and cooled. After that, an 0.1 grams of activated charcoal mixed 50 ml of Cr waste tanning for 20 minutes, then filtered and dried. The residual waste solution was filtered and its absorbance was measured with AAS. The optimum activation time is then used for the next experimental step.

Determination of optimum pH

A 0.1 gram of banana peels were put into a 50 ml beaker glass. Then as much as 100 ml of HCl is added to the glass beaker. The mixture of charcoal and HCl is stirred at optimum activation time. Then, the pH of the waste solution is set to 2, 4, and 6. After that, the activated charcoal and Cr waste tanning solution are mixed with pH variation for 20 min. The residual waste solution was filtered and its absorbance was measured with AAS.

3. RESULTS AND ANALYSIS

This study is aimed to know the optimum activation of banana peel charcoal to adsorp Cr from the liquid waste of tanery industry. The result of adsorbtion of Cr in various activation times is shown in Table1 bellow.

Table 1 Measuring the activation time and adsorbtion of Cr

| Activation time (hours) | Concentration of adsorbed Cr (ppm) |
|-------------------------|------------------------------------|
| 1 | 150,234 |
| 3 | 150,346 |
| 5 | 152,351 |

The initial pH of liquid tannery industry is 3.5. The process of adsorption of Cr in liquid waste continued in various pH. The result is shown in Table 2 below.

Table 2. Adsorption of Cr in Waste at Variation of pH

| pH | Concentration of adsorbed Cr (ppm) |
|----|------------------------------------|
| 2 | 142,3 |
| 4 | 151,2 |
| 6 | 238,9 |

In this research, activated charcoal is made from banana peel waste. Banana peels have carbon atoms that can be used as adsorbents (Mopoung, 2008). The process of making charcoal is called carbonization process (Ramke et al, 2009). In the carbonization process occurs in heating banana peel at a certain temperature through several steps. The first step is the cultivation of banana peels. As many as 600 grams of banana peel put into oven with temperature 125°C for 30 minutes. The purpose of this step is to reduce the water contained in the banana peel.

The second steps are roasted the banana peel that has decreased the water contained. The result of this step is banana peel charcoal. Then pounded it until smooth, in order that surface area of the adsorbent more extensive than the chunk of charcoal. The more surface area of the adsorbent also the more number of pore, so the more amount of adsorbate that adsorbed because the collision between adsorbate particles and adsorbent are increases. In the carbonization process, is expected to occur the splitting process of organic materials into carbon elements and the release of non-carbon elements. The final result of banana peel charcoal is 42 grams.

This waste is obtained from a leather tannery industry located in Piyungan, Bantul. Samples of tannery wastewater are taken on the in let line or before using the waste water treatment plant. To determine the concentration of Cr metal in the tannery waste measured using AAS. 50 ml of tannery waste is filtered using filter paper. The purpose of this filtration is to remove the macroscopic impurities present in the waste. Then put the filtrat in 250 ml measuring flask and add aquadest to the limit. In order to concentrate the waste is not too thick so it needs to be diluted up to 10 times more. So overall waste is diluted up to 50 times. When measured with AAS, the yield obtained was 5.8424 ppm. So it can be concluded that Cr content of metal in the waste is 292.1 ppm.

The principle of this study is to activate 1 gram of carbon that has been formed using 1 M HCl solution with variation of 1, 3, and 5 hours using magnetic stirrer. After the activated carbon is obtained, use 0.1 gram of the carbon to be tested into Cr waste. Then silence the adsorption process for 20 minutes. The next step is to determine how the concentration of Cr (adsorbate) is absorbed by the activated carbon adsorbent from banana peels using AAS. From the results of the study, activation carbon have the same color at 1, 3 and 5 hour time variations. All three are in the form of black powder. Because the carbonization process is carried out at the same temperature. So the color of the adsorbent does not turn to ash color. Beside that, HCl solution can adsorb the minerals in the substance that will be formed active carbon, in order preventing the formation of ash on the active carbon (Meike S, 2012).

The physical adsorption has explained through the van der waals force, there is an attractive force due to the hydrogen atomic coordination bonds. While the chemically adsorption is the formation and termination of chemical bonds during the adsorption process (Castellan, 1985). In this study there is no treatment of temperature variables, where the amount of adsorbed substances inversely proportional to the increase in temperature. So the adsorption of Cr metal that occurs is in chemical adsorption.

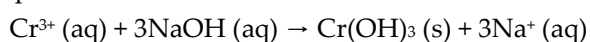
Based on the data, we can know the relationship between activation time and Cr concentration absorbed by active carbon adsorbent from banana peel. The activation time for activated carbon adsorbent has no effect on Cr absorption. This is in accordance with the research

Sudaryanto et al (2006), that there is no significant effect between the activation time on the rendement and the size of active carbon pores of cassava leather. Therefore, the activation time used in this study is efficient at the 1 hour activation time. From result of AAS resulted initial concentration of Cr without adsorbent equal to 292.12 ppm with 50 times dilution. This can be affected by the chromium-based tannery material in the form of chromium sulfate, so that the diluted chromium concentration is still quite high. The result of Cr absorption at 1 hour activation time with activator HCl 1 M is 150.234 ppm. Then at 3 hours activation time, Cr waste absorbed by adsorbent is 150.346 ppm. And at the activation of 5 hours, Cr waste absorbed adsorbent as much as 152.3515 ppm.

The pH setting of the waste is done by adding HCl or NaOH. At pH 2, the waste solution does not appear to change. While at pH 6, it appears that greenish turbid sediment formed after the addition of NaOH. The waste solution is filtered before the adsorption to remove the precipitate. Cr adsorption process by activated charcoal banana charcoal done for 20 minutes. During the adsorption process, activated charcoal is not evenly distributed in the waste solution. Most of the activated charcoal added is floating on the surface of the solution. Activation of banana peel charcoal with HCl solution causes the charcoal to be charged. The process of activated charcoal adsorption can occur physically and chemically. In this study, HCl activator causes ion exchange between H⁺ ion and Cr³⁺ metal so that Cr³⁺ ion will move from solution to adsorbent. Physical adsorption may also occur, because the cavities in the adsorbent will cause Cr metal ions trapped in the adsorbent cavities.

Cr concentration of metal in the initial waste was found to be 292.1 ppm. After adsorbed at pH 2, there was a decrease of Cr concentration of 142.3 ppm. At pH 4, Cr concentration was reduced by 151.2 ppm. At pH 6, there is a decrease in Cr concentration of the largest is about 238.95 ppm.

In theory, at low pH Cr is dominant as Cr (III) ions. While at a pH greater than 5, Cr will be predominant Cr(OH)₃. The addition of NaOH makes the Cr ion initially dominant in the waste transformed into Cr(OH)₃ deposits.



The change of physical form of the waste solution at pH 6 which was originally greenish became colorless due to the majority of Cr ion being deposited. In this study, the precipitate was filtered prior to the adsorption process. This causes the Cr content in the waste to decrease even before adsorption. So the decrease of Cr concentration at pH 6 is the greatest value after tested with AAS. However, the decrease in Cr concentration in waste is more due to the precipitation process than the adsorption process. Adsorption at pH 4 causes more Cr adsorption than pH 2. So at pH 4 the best adsorption occurs.

4. CONCLUSION

Based on the research that has been done, can be concluded:

- The mass of banana peel is 600 grams then can formed 42 grams charcoal.
- Variation of activation time does not give significant effect to Cr metal adsorbs, so with 1 hour is efficient activation time to adsorb metal Cr leather tannery.
- pH variation does not make a significant difference.

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