Adsorption of Heavy Metal (Cu, Pb and Cd) in Leachate of Terjun Landfill by using Activated Charcoal Made of Biomass Waste

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Abstract: The research is about the adsorption of heavy metal (Cu, Pb and Cd) in leachate of Terjun Landfill by using activated charcoal from biomass waste which has been conducted by employing complete random design with one factor which was the variety of the raw materials of activated charcoal (cob of corn, coconut shell, frond of palm, and sawdust) and three replications. The testing of the activated charcoal quality was based on the quality standard of activated charcoal SNI 06-3730-1995. The activated charcoal was tested their ability in adsorbing Cu, Pb and Cd contained in the leachate of Landfill. The results of adsorption ability of the activated charcoal showed that the activated charcoal from coconut shell yielded the highest Pb and Cd adsorption with 58.09% and 80% respectively. The highest Cu adsorption was yielded from the charcoal made of sawdust i.e. 59.52%. The results of this research demonstrate that the activated charcoal of biomass wastes (corn cob, coconut shell, palm frond, and sawdust) is potential to be used in the management of metal pollution in the environment.

1 INTRODUCTION

Increasing human population and urban development have resulted in changes of pattern in high public consumption year to year, leading to a critical pressure towards environment within a fixed area of land. Human activities in fulfilling their living needs from agriculture, industry and household activities will always produce wastes that contribute to a decrease in water quality Mahyudin (2010). Water pollution caused by waste contamination may occur from open dumping disposal and landfill filled with wastes in which later be decomposed together with rainwater, producing leachate Suriawiria (2003).

Leachate is a kind of contaminant with potential interference to environment and human health. Leachate can seep into the ground, or flow on the land surface and lead to the flow of streams. Leachate containing organic and inorganic compounds with a concentration of 5000 times higher than groundwater, may enter the groundwater and freshwater causing pollution Maramis (2008). Heavy metals are often found in leachate i.e. arsenic, cadmium, chromium, mercury, nickel, zinc, copper and lead. The heavy metals tend to accumulate and settle inside organisms for a long time as accumulated toxins Fatmawinira (2005).

Corn cobs, coconut shells, oil palm fronds, and sawdust are examples of biomass wastes that are potential to be used as activated charcoal, because of their abundance in environment. Up until now, people tend to utilize corn cobs, coconut shells, oil palm fronds, and sawdust as material for animal feed, fuel or just neglected into the environment. To avoid this, the utilization of corn cobs, coconut shells, palm fronds, and sawdust is investigated, one of which is to be utilized as raw materials for activated charcoals Mutmainnah (2012).

Activated charcoal is a porous solid containing 85-95% carbon, produced from carbon-containing materials. In the manufacture of activated charcoal consists of two main stages, namely the process of carbonation of raw materials and the activation process. Carbonation of raw materials is an indoor process in the absence of oxygen and other

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chemicals in the process of pore formation, while the formation of activated charcoal functions to enlarge the pores of activated charcoal to enhance the maximum adsorption of heavy metals. The results of this study are expected to reveal the potential use and utilization of corn cobs, coconut shells, oil palm fronds, and sawdust for processing and to expose the more more beneficial aspect of these wastes for the environment, especially for the adsorption of heavy leachate in the Medan Landfill, North Sumatera.

2 MANUSCRIPT PREPARATION

2.1 Study Site

The study was conducted in the adsorption of heavy metal (Cu, Pb and Cd) in leachate of Terjun Landfill by using activated charcoal from biomass waste of Medan. The duration of study was five months, starting from mid-Maret to mid-Juli 2017.

2.2 Data Collection

The sample used in this study is leachate taken from the Waste End Containment Site (TPA) Terjun, Medan. The tests carried out in this study consisted of measurements of yield, moisture content, volatile content, ash content, bonded carbon content, benzene absorption, iodine absorption, and methylene blue absorption at the USU Faculty of Mathematics and Natural Sciences. Tests of heavy metals in the form of Cu, Pb and Cd were carried out at SUCOFINDO Medan branch and the Medan Class I Environmental Health and Disease Control Engineering Center (BTKLPP). For surface morphology testing on activated charcoal was carried out at the Faculty of Physics at UNIMED.

2.3 Data Analysis

2.3.1 Preparation Stage

Biomass wastes i.e. corn cobs, coconut shells, oil palm fronds and sawdust were dried under sunlight to obtain dry materials. Biomass wastes were then cut into small pieces for carbonization stage.

2.3.2 Carbonization Stage

The process of carbonization is the process of breaking organic materials into carbon with high temperature and without air Salamah (2008). Each sample of corn cob, coconut shell, palm oil frond, and sawdust were inserted into a furnace and then burned at 600^{o}C for 2 hr until becoming charcoals Kurniati (2008). The carbonization products were cooled for 24 hr and then smoothed so as to pass a 60 mesh sieve.

2.3.3 Activation Stage

The smoothed charcoals were then subjected to a chemical and physical activation process. Each charcoal samples were then chemically activated by immersing each charcoal sample in NaOH solutions with a concentration of 1% for 24 hr to enable the activating agent to work properly, then the activated charcoals were dried Pujiati R and Sutapa RJG (2005). Each charcoals were then physically activated by heating into a furnace at a temperature of 700^{o}C for 60 min. After activation completed, the activated charcoals were allowed to cool yet to stabilize their forms.

2.3.4 Adsorption of Leachate using Activated Charcoals

One gram of each activated charcoals (corn cobs, coconut shells, oil palm fronds and sawdusts) was suspended into 600 mL leachate water for 30 min. The leachate water was then filtered. Five mililitre of HNO_3 was added into solution and then the solutions were homogenized using shaker for 20 min. The heavy metal content within the solution were then measured before and after application of activated charcoals Braun RD (1982).

3 RESULT AND DISCUSSION

The results of experiment using activated charcoals of corncob, coconut shell, palm oil midrib, and sawdust in adsorbtion heavy metals Cu, Pb, and Cd in leachate waterfill TPA Terjun done by soaking 30 minutes for each activated charcoal. The following results are coconut shell activated coconut, corncobs, sawdust, and palm oil preparations of Cu, Pb, and Cd heavy metals in Table 1.

Table 1: Heavy metal contents in leachate water and adsorption percentage of activated charcoals

Activated charcoals	Heavy Metals					
	Cu		Pb		Cd	
	Adsorption (ppm)	Percentage (%)	Adsorption (ppm)	Percentage (%)	Adsorption (ppm)	Percentage (%)
Control	0.090	-	0,110	-	0.140	-
Corn cob	0.037	40.99	0.038	34.91	0.067	47.57
Coconut shell	0.036	39.90	0.064	58.09	0.112	80.00
Oil palm frond	0.032	35.27	0.038	36.72	0.071	50.36
Sawdust	0.054	59.52	0.055	50.00	0.072	51.07

The results showed that there was a decrease in heavy metal content of Cu, Pb, and Cd after being processed by adsorption using activated charcoal from cob of corn, coconut shell, frond of palm, and sawdust. From the results of heavy metal adsorption test contained in leachate water showed that the activated charcoal from coconut shell yielded the highest ability to adsorb metal Pb and Cd respectively 58.09% and 80%. While the highest adsorption of Cu metal is obtained from activated charcoal sawdust powder that is equal to 59,52%. It is thought to be caused by the immersion time and the materials used in the production of activated charcoal. The different types of active charcoal materials used for heavy metal adsorbents Cu, Pb, and Cd have different characteristics, such as different surface area, different structure, and different properties.

The results obtained decreased metal concentrations in the solution along with the length of time immersion by activated charcoal. This is due to the process of adsorption of metal ions by activated carbon. The decrease in heavy metal concentration occurs before the activated charcoal becomes saturated reaching a state where the activated carbon can not readsorb the heavy metal molecule. Adsorption is the binding of molecules or particles to a solid surface (Cheremisinoff, 2002).

The adsorption process on activated charcoal occurs due to Van der Waals forces. Atoms on the surface of solids such as activated charcoal have unbalanced forces compared to the arrangement of atoms in solids in general. Thus, foreign molecules will seek to meet these imbalances to be attracted to the surface of activated carbon. Adsorbents (metal ions) form a single layer (monolayer) on the adsorbant surface (Fatmawinira, 2005). The metal ion diffuses into the pores of the activated carbon due to differences in the adsorbate concentration present in the solution with the carbon pores.

The results of this study indicate that activated charcoal from biomass waste (cob of corn, coconut shell, frond of palm, and sawdust) has the potential to be used in the management of metal contaminants in the environment.

4 CONCLUSIONS

Activated charcoal is the adsorption material, one of them as the adsorption of heavy metals. From the results of heavy metal absorption experiments (Cu, Pb and Cd) in leachate of Terjun Landfill by using activated charcoal from biomass waste by cob of corn, coconut shell, frond of palm, and sawdust had good absorption performance against heavy metals (Cu, Pb, and Cd). So that heavy metals contained in landfill leachate Landfill decreases and reduces the impact on the environment.

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