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Effectiveness of Activated Coconut Shell Charcoal Filtering Device to Reduce Mercury Levels in Gold Palm Waste Water in Padesa Village, Lantung District

Nurlaila Agustikawati[1*], Lina Eta Safitri[1], Luh Putu Yuliastuti[2], Desy Fadilah Adina Putri[2], Fitri Setianingsih[2]

[1] Prodi Kesehatan Masyarakat, STIKES Griya Husada Sumbawa, Sumbawa Besar, NTB, Indonesia
[2] Prodi Kebidanan, STIKES Griya Husada Sumbawa, Sumbawa Besar, NTB, Indonesia

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Corresponding Author:
Nurlaila Agustikawati
Agustikawatighs@gmail.com

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Abstract: The progress of the traditional gold mining industry has a positive impact on improving the quality of life of the people, but on the other hand the progress of this industry has a negative impact on the environment. Mercury contamination from traditional gold mining occurs when the processing takes place which results in the holding tank being full, so that the tailings overflow and flow into the river, especially if it rains, then mercury contamination occurs in the surrounding environment. The purpose of this study was to analyze the effectiveness of a simple filtering device for activated coconut shell charcoal to reduce mercury levels in the waste water of the logs which included optimum contact time, optimum particle size, and optimum reuse. This type of research is True Experimental Design by providing treatment (contact time, particle size and repeated use of activated charcoal). It was concluded that the absorption of mercury waste with the highest efficiency value was activated charcoal particles measuring 35 mesh (0.5 mm) with an absorption percentage of 75.81%, the highest absorption percentage of mercury waste with a contact time of 180 minutes was 88.89%, and the optimal variation of the repetition of the use of activated charcoal is 5 times.

Keywords: Mercury; Activated Charcoal; Coconut Shell; ASGM; Pollution.

Introduction

The progress of the traditional gold mining industry has a positive impact on improving the quality of life of the people, but on the other hand, the progress of this industry has a negative impact on the environment (Rianto, 2012). Progress in the traditional gold mining industry that is not supported by good technology and knowledge will cause environmental pollution by mining waste and interfere with the health of workers (Yulis, 2018).

Government Regulation of Republic of Indonesia (RI) No 101 of 2014 concerning Hazardous and Toxic Waste Management, article 31 paragraph 1 states that everyone who produces B3 waste is required to collect the B3 waste produced. However, in reality, the gold processing business by amalgamation has disposed of the waste from its processing to the surrounding environment. This has resulted in high levels of mercury in waters, soil, and sediments in the environment around traditional gold mining (Putranto, 2011). Based on Sembel (2015), the quality standard for soil not polluted by mercury may not exceed a set threshold of 0.3 ppm.

Mercury is a heavy metal that is liquid at room temperature, silvery white in color and has fairly good electrical conductivity. Mercury occurs naturally in the environment in three main forms, namely: metal mercury (HgO), organic mercury (MeHg,) and inorganic mercury (Hg2+) (Delgado, et al., 2012). Heavy metal mercury (Hg) is very dangerous for aquatic ecosystems. Heavy metals that enter the aquatic environment will experience precipitation, dilution, and dispersion, then be absorbed by organisms that live

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in these waters. Mercury contained in water will be converted into methyl mercury by certain bacteria called biomethylation (Gasong, et al., 2018).

Mercury in the form of methyl-mercury (MeHg), has strong toxic and binding properties and high solubility. If consumed by biota, it will experience bioaccumulation (Narasiang, 2015). in the body and if consumed by humans for a long time, it can cause various types of diseases up to death (Hamzah, et al., 2017). Symptoms of acute mercury toxicity are inflammation of the throat (pharyngitis), abdominal pain, nausea, vomiting accompanied by blood and shock. Meanwhile, for chronic toxicity, namely disorders of the digestive system (eg inflammation of the gums) and the nervous system (Kim, 2011).

To prevent and overcome environmental pollution and health problems caused by mercury, it is necessary to carry out actions to treat and manage mercury waste (Palar, 2008). The process of managing mercury wastewater that is often carried out today is by adsorption technique with activated carbon which is a method for removing pollutants. The adsorbent commonly used in the treatment of wastewater into raw water is activated carbon, a natural compound that is widely found in agricultural or industrial waste, which is a potential cheap adsorbent (Zikra et al, 2015). Activated carbon is a type of carbon that can be produced from carbon-containing materials or from charcoal which is treated in a special way to get a wider surface area (Kurniawan, el al., 2014). One adsorbent that is often used is activated charcoal from coconut shells. Most of the coconut shell is only considered as coconut processing industrial waste, its abundant availability is considered an environmental problem, but it is renewable and cheap. Even though this coconut shell charcoal can still be processed again into products that have high economic value, namely as activated carbon or activated charcoal (Lestari, 2016).

Mercury contamination from traditional gold mining occurs when the processing takes place which results in the holding tank is full, so that the tailings overflow and flow into the river, especially if it rains, then mercury contamination occurs in the surrounding environment (Sihite, 2018). In addition, the urgency of this research is the condition of the holding basin which is only a soil excavation without an anti-water absorption layer so that the waste water from the logs can still be absorbed by the pores of the soil. For this reason, the general objective of this research is to analyze the effectiveness of a simple filtering device for activated coconut shell charcoal to reduce mercury levels in wastewater from logs. The specific objectives are (1) to determine the optimum contact time of activated coconut shell charcoal absorbing mercury in the effluent, (2) to determine the optimum particle size of the activated coconut shell charcoal to absorb mercury in the effluent, and (3) to determine the repeatability Optimum use of activated coconut shell charcoal absorbs mercury in the coconut shell waste.

Method

This type of research is True Experimental Design by providing treatment (contact time, particle size and repeated use of activated charcoal):

Sample preparation

The sample used is spindle wastewater from the first holding tank, put into a sample bottle and added 5 mL of HNO3 and given a code.

Particle size testing

Prepare activated coconut shell charcoal with particle sizes of 5 mesh (4.00 mm), 10 mesh (2.00 mm), 18 mesh (1.00 mm) and 35 mesh (0.50 mm) each 1 gram and Add 25 ml of HgCL2 30 ppm pH=2 into Erlenmeyer and stir using a magnetic stirrer for 60 minutes at 60 rpm. Measure the absorption of mercury with a mercury analyzer.

Optimum time testing

Prepare coconut shell activated charcoal for optimum particle size at point 2 above and add 25 ml of HgCL2 30 ppm pH=2 into Erlenmeyer and stir using a magnetic stirrer at 60 rpm with time variations of 10 minutes, 30 minutes, 60 minutes, 120 minutes, and 180 minutes. Measure the absorption of mercury with a mercury analyzer.

Activated Charcoal Repetition Test

Prepare a filter with the optimum particle size of activated coconut shell charcoal, and pour the waste water from the spindles with variations 1 time, 2 times, 3 times, 4 times, 5 times, 6 times, 7 times, 8 times, 9 times, 10 times during the time optimum obtained in point 3 above. Measure the absorption of mercury with a mercury analyzer.

Result and Discussion

Particle size testing

The existence of variations in size aims to reduce the size of the activated charcoal particles so that they affect the surface area of the activated charcoal and will increase the pores in each carbon particle. The wider the pore surface area, the heavier metal levels that can be absorbed (Suwantiningsih et al., 2020). Testing the effect of variations in particle size can be seen in Table 1.

Tabel 1. Optimum particle size testing of Coconut Shell Activated Charcoal

Particle size (Mesh)	Initial Concentration of Mercury Waste (mg/L)	Final Concentration of Mercury Waste (mg/L)	Mercury Absorption Efficiency (%)
5	0.0711	0.05139	27.72
10	0.0711	0.0437	38.57
18	0.0711	0.0291	59.07
35	0.0711	0.0172	75.81

The existence of variations in size aims to reduce the size of the activated charcoal particles so that they affect the surface area of the activated charcoal and will increase the pores in each carbon particle. The more pores on the surface of activated carbon that are formed and open, this causes heavier metal to be absorbed by activated carbon, causing the heavy metal concentration to decrease (Meilianti, 2020). Based on table 5.2, it can be concluded that the absorption of mercury waste with the highest efficiency value is activated charcoal particles with a size of 35 mesh (0.5 mm) with an absorption percentage of 75.81%. The smaller the particle size, the wider the surface area of the activated charcoal, so it is very possible for mercury waste to enter the pores of the activated charcoal to be bound. The same thing was stated by Suwantiningsih et al., (2020) who stated that the wider the pore surface area, the greater the level of heavy metals that can be absorbed. This is in line with research conducted by Zhou (2018) which reported that the surface area of coconut shell activated carbon of 61.82 m2/g was able to absorb impurities of 71.13%. There is an effect of the size of the adsorbent on the surface area of the contact area, so in the end, it will affect the ability to absorb metals (Fatmawati, 2021).

Optimum Time Testing

Waktu kontak pada proses adsorpsi arang aktif merupakan salah satu parameter penting dalam proses adsoprsi. Waktu kontak merupakan waktu interaksi yang diperlukan arang aktif agar dapat mengadsorpsi logam secara optimal. Testing the optimum contact time can be seen in Table 2.

Table 2. Optimum Time Testing of Coconut Shell Activated Charcoal

Contact Time (Menit)	Particle Size (Mesh)	Initial Concentration of Mercury Waste (mg/L)	Final Concentration of Mercury Waste (mg/L)	Mercury Absorption Efficiency (%)
10	35	0.0711	0.0488	31.36
30	35	0.0711	0.0297	58.23
60	35	0.0711	0.0172	75.81
120	35	0.0711	0.0093	86.92
180	35	0.0711	0.0079	88.89

Contact time is one of the factors that affect the absorption process. This is because the adsorption process is closely related to the reaction rate which is expressed as the rate of change of substance concentration per unit time (Calvin, 2018). Determination of the contact time is carried out to determine the minimum time needed by the adsorbent to absorb the metal to the maximum until it reaches an equilibrium state (Widihati et al., 2012). The results of adsorption at several contact times can be seen in Table 5.3, namely the highest percent absorption of mercury waste with a contact time of 180 minutes of 88.89%. This is in line with Musafira (2021) which states that in general, the amount of metal ions absorbed increases with increasing contact time. This is because at the maximum contact time, the pores of the activated charcoal have been covered by metal ions so that if the contact time is increased again there will be no additional absorption of metal ions, in other words the adsorbent is saturated (Yuliono et al., 2014). Activation time affects the absorption of activated charcoal because it affects the structure and pores of the carbon (Sandi & Astuti, 2014) as well as the surface area of the carbon (Saka, 2012).

Activated Charcoal Repetition Test

The repetition of the use of activated charcoal is intended to see the optimization of the use of charcoal in the screening tool. This is needed to be able to know how many times the activated charcoal must be used before being replaced with new activated charcoal. The efficiency of mercury absorption based on variations in the repetition of its use can be seen in Table 3:

Table 3. Optimum Repetition Testing of Charcoal use

Variation of repeated use of charcoal aktif (kali)	Contact Time (Menit)	Partikel Size (Mesh)	Initial Concentration of Mercury Waste (mg/L)	Final Concentration of Mercury Waste (mg/L)	Mercury Absorption Efficiency (%)
1	180	35	0.0711	0.0079	88.89
2	180	35	0.0711	0.0079	88.89
3	180	35	0.0711	0.0079	88.89
4	180	35	0.0711	0.0079	88.89

Variation of repeated use of charcoal aktif (kali)	Contact Time (Menit)	Partikel Size (Mesh)	Initial Concentration of Mercury Waste (mg/L)	Final Concentration of Mercury Waste (mg/L)	Mercury Absorption Efficiency (%)
5	180	35	0.0711	0.0079	88.89
6	180	35	0.0711	0.0197	72.29
7	180	35	0.0711	0.0217	69.78
8	180	35	0.0711	0.0436	38.68
9	180	35	0.0711	0.0621	12.66
10	180	35	0.0711	0.0701	0.28

After obtaining the maximum particle size of 35 mesh (05 mm) and the maximum time for activated charcoal, which is 180 minutes), it is followed by an analysis of variations in the repetition of the use of activated charcoal to remove mercury levels in the waste water of the logs in ASGM activities in Padesa Village, Lantung District. The optimal variation of the repetition of the use of activated charcoal is 5 times. This can be seen in Table 5.4 where when the same coconut shell activated charcoal was applied to mercury waste the percent absorption value of mercury waste was still the same, namely 88.89% and began to decrease in the sixth iteration to 72.29% and so on it decreased until the tenth iteration. In the tenth iteration, the percent absorption value of mercury waste is only 0.28%.

This is because the pores of the activated charcoal have all been filled with mercury waste and there are no more places for binding. This is in line with what was conveyed by A'yunina et al (2022) which states that if the time is too little then the metal contaminants in the water are not bound properly, likewise if the contact time is too long, the empty surface will decrease so that the ability of the adsorbent to absorb the metal contamination decreased which resulted in the rate of releasing metal contaminants back into the water, this indicated that the adsorbent had reached the optimum contact time for absorption. In line with this research, where the contact time between activated charcoal and mercury waste is getting longer, the percentage value of its application is also high.

Conclusion

Based on the description of the discussion above, from the results of this study it can be concluded that several things are in accordance with the purpose of conducting this research, namely: (1) The optimum particle size of activated charcoal for the adsorption of mercury waste is activated charcoal with a size of 35 mesh (0.5 mm) with an absorption percentage of 75.81%; (2) The optimum contact time of activated charcoal on the adsorption of mercury waste is 180 minutes with an absorption percentage value of 88.89%; (3) The effectiveness of repeated use of charcoal in the activated coconut shell charcoal filtering device in absorbing mercury waste is 5 repetitions of use with an absorption percentage of 88.89%.

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