Adsorption of Heavy Metals of Activities Disposal in Laboratory Using Active Carbon and Bentonite

by Nuniek Herdyastuti

Submission date: 05-Feb-2020 07:50PM (UTC+0700)
Submission ID: 1251914310
File name: Artikel_ICST_2018.pdf (209.48K)
Word count: 2953
Character count: 15175

Proceedings of 2018 International Conference on Science and Technology (ICST 2018)

Adsorption of Heavy Metals of Activities Disposal in Laboratory Using Active Carbon and Bentonite

Nuniek Herdyastuti[1], Rusmini, Sari Edi Cahyaningrum
Department of Chemistry
Universitas Negeri Surabaya
Surabaya, Indonesia
[1]nuniekherdyastuti@unesa.ac.id

***Abstract*— Laboratory waste can be in the form of organic and inorganic materials if accumulated so that it can endanger the surrounding environment such as soil, water and plants. Some heavy metals are removed without processing in advance so that it is feared that they can cause environmental pollution. The purpose of this study is to identify heavy metals from the disposal of laboratory activities and the reduction of heavy metals using activated carbon and bentonite. Adsorption method using adsorbents such as activated carbon and bentonite is widely used to reduce metal contamination in waste and to analyze metal content using atomic absorption spectrophotometer. The results of the analysis showed the presence of several heavy metals such as Pb, Cu, Ag, Co, Cd, Cr and Hg. The results of metal waste were idenfied at 35 g / L for Cu, 1200 ppm for Pb and 220 ppm Ag metals. Adsorption using carbon and bentonite showed a reduction of Cu metal in laboratory waste 90.8 and 83.9% respectively with the amount of adsorbent 2gram. This shows that carbon and bentonite can be used as adsorbents to reduce metals in laboratory waste.**

Keywords*— *adsorption; bentonite; carbon; heavy metals; laboratory; waste

I. INTRODUCTION

Waste is a waste produced from a production process both industrial and domestic (households) whose presence at a certain time and place is not desired by the environment because it has no economic value. Laboratory waste is a waste that comes from the laboratory, in this case in particular is a chemical laboratory. This waste can come from chemicals, equipment for laboratory work and others. In a certain amount with a certain level, its presence can damage health and even kill humans or other lives so that the limits that are permitted in the environment at certain times need to be determined. Laboratory waste in the form of organic and inorganic materials can produce quite hazardous waste. The reagents or heavy metals used when accumulated can endanger the surrounding environment. The presence of heavy metal ions is a major concern due to their toxicity to many life forms. Humans can become exposed to heavy metals in several routes which include ingestion, inhalation, and dermal absorption [1]. Mainly related to the heavy metals lead, mercury and cadmium but covering other heavy metals like chromium as well extensive documentation of the potential harmful effects to humans and the environment is available.

Waste is a waste of chemicals that have been used, raw materials expire, or product processes in the laboratory such as the rest of the specimen. Organic or inorganic waste with certain concentration and quality can have a negative impact on the environment, especially for human health so that it is necessary to handle waste. As it is known that metals such as chromium, copper, lead, manganese, mercury, cadmium are very dangerous for human and environmental health because of their toxic nature [2].

The laboratory is mentioned as one of the sources of solid, gas or liquid waste. Laboratory waste is a waste that comes from the laboratory, in this case in particular is a chemical laboratory. This waste can come from chemicals, equipment for laboratory work and others. This laboratory waste has a dangerous risk to the environment and living things. When reviewed chemically, this waste consists of chemicals of organic compounds and inorganic compounds. The level of danger of poisoning caused by waste depends on the type and characteristics of the waste. Characteristics of waste are influenced by particle size (micro), dynamic, wide spread and long or long impact. While the quality of waste is influenced by the volume of waste, waste content, pollutant content and frequency of waste disposal.

As a waste, the presence is quite alarming, especially those sourced from chemical laboratories because toxic and hazardous materials are widely used in chemical laboratories. Disposing of a number of hazardous materials into the environment can cause problems for the environment because the existence of these materials is difficult to biodegrade. In a certain amount with a certain level, its presence can damage the food chain in the environment and endanger the health and even kill humans or other life so that the boundaries that are allowed in the environment at certain times need to be set [3]. Heavy metals are a global issue for the environment and human health due to their toxicity, bioaccumulation in the human body and food chains, carcinogenic and can cause mutations in some organisms [4].

II. METHODOLOGY

Equipment used in addition to standard glass equipment, also used special equipment such as: centrifuges (Eppendorf 5810), atomic absorption spectrophotometers (Perkin Elmer

AAnalyst 700) and voltammeters (Metrohm, 797 VA Computrace).
The ingredients used are: nitric acid (Merck), standard solutions of Pb, Cu, Ag, Hg, Mg, Cr, Co and Cd

A. Collection of samples in the laboratory

Samples from the disposal of practicum activities in each laboratory are accommodated in a container for one activity. Samples were added concentrated nitric acid and filtered using filter paper, obtained filtrate that was ready for analysis.

B. Adsorption of metals in waste

Taken 20 grams of adsorbent soaked in aquademin with a volume ratio of 1: 50 and stirred for 2 hours using a magnetic stirrer at a speed of 100 rpm. The mixture was precipitated and left for 2 days then filtered and the residue dried in an oven at 105ºC for 24 hours. The adsorbent is mashed with a size of 100 mesh. For the adsorption process, 5 cups of chemicals were prepared and each added 0.4; 0.8; 1.2; 1.6 and 2 grams and 25 mL of laboratory waste were added to each beaker. The mixture is stirred using a shaker for 12, 20, 30, 45 and 60 minutes at a speed of 200 rpm. The mixture is filtered using filter paper to separate the filtrate from the adsorbent. Filtrates were added with HNO3 several drops and analyzed for Cu and Pb ion content using AAS.

C. Determination of heavy metals from each laboratory

The filtrate from the samples of each laboratory determined the metal content (Pb, Cu, Ag, Hg, Mg, Cr, Co and Cd) by using AAS and Hg metal using voltammeter. The concentration of each metal is determined based on the linear regression equation of the standard curve for each metal.

III. RESULT AND DISCUSSION

The laboratory in general is a place where a chemical trial or analysis process is carried out involving human resources, hazardous chemicals and by-products of the reactions that occur. The laboratory is very unique because all the dangerous chemicals that are in it are small but able to produce potential waste against environmental damage [5].

Some heavy metals that are considered dangerous as a waste of activities in the laboratory have been analyzed. Heavy metal is categorized as an element that has an atomic weight between 63.5 - 200.6 which is harmful to health and the environment [13]. According to Ahalya [6] states that those classified as heavy metals in industrial waste are lead, chromium, mercury, uranium, selenium, zinc, arsenic, cadmium, silver, gold and nickel. In analytical chemistry laboratories there are several heavy metals which are quite diverse including Cu, Cr, Co, Cd, Ag, Mg and Pb. The amount of these metals was found in varying concentrations between 0.25 - 212.87 ppm as shown in Figure 1. Some of the metal dumps were generated from the results of practicum activities in the laboratory using the reagents of the compounds in concentration. and the amount is high enough so that the waste that is wasted is still quite high in concentration. It is also found in some wastes in organic, inorganic and physical chemistry laboratories as in Figures 2 to 4.

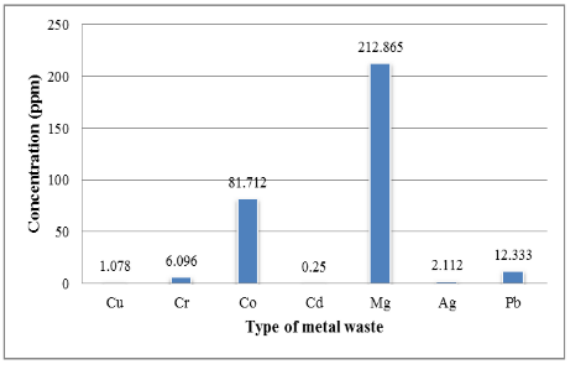

Fig. 1. Types of metal discharges in analytical chemistry laboratories

Copper metal is found in all laboratories with varying amounts and very high concentrations in organic laboratories. Copper is an indispensable element in the metabolism of carbohydrates and fats and maintains the activity of the heart and blood vessels. According to WHO the maximum allowable concentration in drinking water is 1.5 mg / L and in the adult body contains 100-150 mg Cu2 +. If it exceeds that concentration will be toxic to the body and cause health problems such as nausea, headaches, respiratory problems, anemia bleeding in the gastrointestinal, liver, kidney failure and death [7].

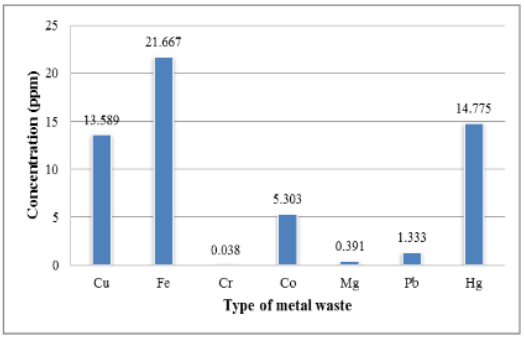

Fig. 2. Types of metal discharges in anorganic chemistry laboratories

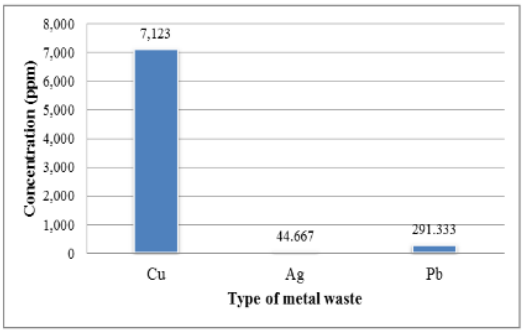

Fig. 3. Types of metal discharges in organic chemistry laboratories

In inorganic chemistry laboratories there were also found a number of hazardous metals such as Cu, Fe, Cr, Co, Mg, Pb and Hg (Figure 2), as well as in organic chemistry laboratories (Figure 3) with a fairly high amount. Metal sequences that have high toxicity are as follows: Hg2 +> Cd2 +> Ag +> Ni2 +> Pb2 +> As3 +> Cr2 +> Sn2 +> Zn2 + [8]. Based on this sequence mercury has the highest order of toxicity. The mercury metal is found in an inorganic chemical laboratory with a concentration of 14.8 ppm. According to SNI 7387 (2009) states that mercury toxicity is 0.005 mg / kg bw as total mercury or 0.0016 mg / kg bw as methyl mercury. Mercury is one of the metals whose presence is toxic to the environment, where mercury can enter the food chain. If the concentration is large, it can accumulate in humans and animals which can cause adverse effects on health [9]. Methyl mercury is believed to inhibit enzymatic activity in the cerebellum, which is the area responsible for nerve growth and in chronic conditions can cause mental retardation. This effect is seen medically for adults at concentrations of 0.2 - 0.5 mg / kg in the blood or below 15-20 g / kg in hair. Based on this, it is necessary to remove Hg (II) from wastewater before being discharged into the surrounding environment [10]. (Kadirvelu et al., 2004).

The presence of silver is also found to be quite high in organic laboratories. Considering the dangers posed, the maximum limit for silver allowed in wastewater is very small. Based on Regulation of the Minister of Energy and Mineral Resources of the Republic of Indonesia No.45 of 2006 concerning TCLP quality standards (Toxicity Characteristic Leaching Procedures) pollutants in waste for determination of characteristics of toxins , silver content (Ag) is allowed at 5.0 mg / L (Anonim, 2006).

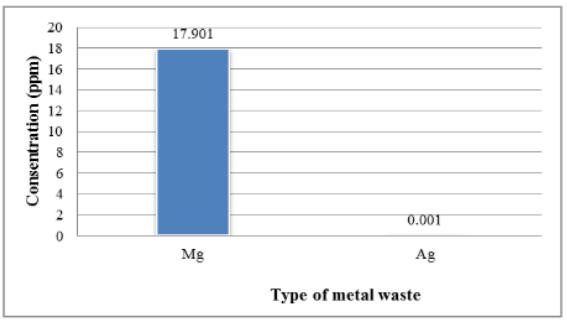

Fig. 4. Types of metal discharges in physics chemistry laboratories

Lead or Pb metals were found in almost all laboratories with concentrations of 1,3 - 291,3 ppm. Research by [1] related to the development of procedures for handling waste containing a lot of heavy metals, stating that ten metals such as Pb, Cd, Cu, Cr, Zn, Ag, Hg, Sn, Mn Ni are categorized as heavy metals so it must be reduced. Lead is one of the heavy metals with the highest toxicity which is very dangerous for living things because it is carcinogenic, can cause mutations, decompose for a long time and its toxicity does not change [11]. The presence of lead is found in many water areas such as in the Dumai area of 1.8 ppm and in the sediment area of the industrial area of 64.2 ppm [14]. Lead metal is also found in plants such as in kale, even though the amount is below normal limits [12].

The presence of these metals can be reduced by adding adsorbents such as activated carbon or bentonite. Bentonite in mineralogical science belongs to a large group of clay soils, is a rock formed from volcanic ash and contains montmorillonite minerals. There are two types of bentonite stones, namely Bentonite Na and Bentonite Ca, each of which has a different function. The results of the analysis show that there is a reduction in metal ions as in Figure 5.

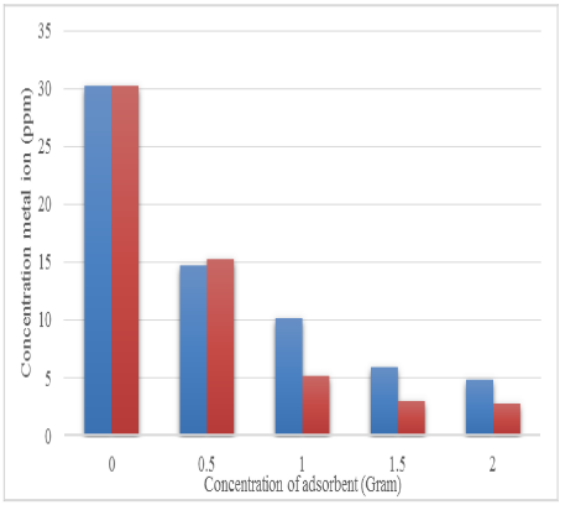

Fig. 5. Adsorption of metal ions using bentonite and carbon at several concentrations

Based on the data obtained in Figure 5 shows that there is a reduction in metal concentrations in waste when compared with controls (without the addition of adsorbents). With the increase in the concentration of adsorbent both bentonite and carbon have almost the same effect, namely a decrease in metal concentration. The decrease was 90.8% using activated carbon and 83.9% with bentonite respectively at 2 gram adsorbent concentration (Table 1). This shows that the presence of these two adsorbents can reduce the presence of metal waste in laboratory waste disposal. At 30 ppm of heavy metals, the removal percentages were 90, 86, 83.6, 83 &50.6, for Ni, Cd, Zn, Pb & Cr respectively (Karnib et al, 2014). Activated carbon and rice husk were successfully applied for the removal of Fe(III) and Mn(II) ions from El-Umum drain water, Alexandria coast, Egypt [13]. The maximum removal of Cu using natural zeolite was 91% at copper ion concentration 10 mg/l, and the maximum removal of zinc using natural zeolite was 96% at a metal concentration 10 mg/l [15].

TABLE I. EFFECTIVENESS OF ADSORBENTS ON METAL REDUCTION IN LABORATORY WASTE

No.	Adsorbent Type	Adsorbent concentration (g)	Concentration of metal (ppm)	Effectiveness (%)
1.	Control	-	30.24	0
2.	Bentonite	0.5	14.68	51.5
		1.0	10.14	66.5
		1.5	5.92	80.4
		2.0	4.87	83.9
3.	Carbon	0.5	15.21	56.8
		1.0	5.20	82.8
		1.5	2.99	90.1
		2.0	2.78	90.8

IV. CONCLUSION

Activities in the laboratory can produce residual waste from several dangerous heavy metals with a high enough concentration. The highest concentration of metals found is Cu with a concentration of 7123 ppm, Pb 291.3 ppm and Ag 44.7 ppm. With the addition of bentonite adsorbents and activated carbon can reduce copper metal in laboratory waste by 80-90%.

ACKNOWLEDGMENT

Thank you was conveyed to the Ministry of Research and Technology's Ministry, which has provided funding for the 28 nas Institusi on 2018. Students and laboratory assistants who have helped implement this research

REFERENCES

[1] J.C. Lou and C.K. Chang, "Completely Treating Heavy Metal Laboratory Waste Liquid By An Improved Ferrite Process," Sep. and Purif. Technol., vol. 57, pp. 513 – 518, 2007.

[2] Yasemin B. and Zeki T. 2007. Removal of heavy metals from aqueous solution by sawdust adsorption. Journal of Environmental Sciences 19 : 160–166.

[3] Lakherwal D. 2014. Adsorption of Heavy Metals : A Review International. Journal of Environmental Research and Development. Vol 4 (1) : 41-48.

[4] Rahman M.S and Sathasivam K.V. 2015. Heavy Metal Adsorption onto Kappaphycus sp. From Aqueous Solutions: The Use of Error Functions for Validation of Isotherm and Kinetics Models. BioMed Research International. http://dx.doi.org./10.1155/2015/126298.

[5] Turang Y.Y. 2006. Pengelolaan kimia sisa bahan laboratorium (Studi kasus di laboratorium PT.Pupuk Kaltim Bontang). Tesis. Program Master Ilmu Lingkungan Universitas Diponegoro. Semarang

[6] Ahalya N, Ramachandra TV, Kanamadi RD (2003). Biosorption of heavy metals. Res. J. Chem. Environ. 7: 71-78.

[7] Ahamed A.J. and Begum A. S. 2012. Adsorption of copper from aqueous solution using lowcost adsorbent. Archives of Applied Science Research. 4 (3) : 1532-1539.

[8] Darmono. 2001. Lingkungan hidup dan pencemaran: hubungan dengan toksikologi senyawa logam. UI Press, Jakarta.

[9] Silva H.S., Ruiz S.V., Granados D.L., and Santángelo J.M. 2010. Adsorpstion of mercury (II) from liquid solutions using modified activated carbons. Materials Research. 13 (2).

[10] Kadirvelu K., Kanmani P., Senthilkumar P., and Subburam V. 2004. Separation of Mercury(II) from Aqueous Solution by Adsorption onto an Activated Carbon Prepared from Eichhomia crassipes. Adsorption Science & Technology. Vol. 22 (3) : 207 -221.

[11] Brass,G.M. and Strauss, W. 1981. Air pollutioncontrol. Part IV. John Willey &Sons. New York.

[12] Mulyani. S., Triyani I.G.A.L., E.N. Sujana.A. 2012. Identifikasi cemaran logam Pb dan Cd pada kangkung yang ditanam di daerah kota Denpasar. Jurnal Bumi Lestari. 12 (2) : 345-349.

[13] Masoud, M.S., El-Saraf, W.M., Abdel - Halim, A.M., Alaa E. Ali, Mohamed, E.A., Hasan, H.M.I. 2016. Rice husk and activated carbon for waste water treatment of El-Mex Bay, Alexandria Coast, Egypt. Arabian Journal of Chemistry 9 : 590–596.

[14] Annao, W.L, Nurdans, D.A , Cheung, K.C., Andmingh, W. 2008. Heavy Metals Concentrations of Surface Dust from e-Waste Recycling and Its Human Health Implications in Southeast China. Environ. Sci. Technol. 42, 2674–2680.

[15] Anonim. 2009. SNI No 7387-2009 Tentang batas maksimum cemaran logam berat dalam bahan pangan. Badan Standarisasi Nasional. ICS.67.220.20 Jakarta.

[16] Karnib, M., Kabbani, A., Holail, H., Olama, Z. 2014. Heavy Metals Removal Using Activated Carbon, Silica and Silica Activated Carbon Composite. Energy Procedia 50 : 113 – 120.

[17] Mattar B.B.W., Mortha G., Boufi S., Aloui L.E., and Belgacem M.N. (2016). Adsorption of heavy metal on charcoal from lignin. Cellulose Chem. Technol. 50 701 – 709.

[18] Ong S.A, Toorisakaa E., Hirataa M., Hanoa T. 2010. Adsorption and toxicity of heavy metals on activated sludge. Science Asia. 36 : 2014-209.

[19] Omar E. Abdel Salam, Neama A. Reiad, Maha M. ElShafei, 2011. A study of the removal characteristics of heavy metals from wastewater by low-cost adsorbents. Journal of Advanced Research 2 : 297–303.

[20] Widowati, dkk. 2008. Efek toksik logam pencegahan dan penanggulangan pencemaran. CV. Andi Offset, Yogyakarta.

Adsorption of Heavy Metals of Activities Disposal in Laboratory Using Active Carbon and Bentonite

ORIGINALITY REPORT

18%	13%	12%	16%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Omar E. Abdel Salam, Neama A. Reiad, Maha M. ElShafei. "A study of the removal characteristics of heavy metals from wastewater by low-cost adsorbents", Journal of Advanced Research, 2011 Publication	1%
2	eprints.upnjatim.ac.id Internet Source	1%
3	docplayer.net Internet Source	1%
4	Submitted to SolBridge International School of Business Student Paper	1%
5	www.linknovate.com Internet Source	1%
6	resources.rainharvestingsupplies.com Internet Source	1%
7	Submitted to University of KwaZulu-Natal Student Paper	

		1%
8	Submitted to Universitas Islam Indonesia Student Paper	1%
9	www.scribd.com Internet Source	1%
10	Md. Sayedur Rahman, Kathiresan V. Sathasivam. " Heavy Metal Adsorption onto sp. from Aqueous Solutions: The Use of Error Functions for Validation of Isotherm and Kinetics Models ", BioMed Research International, 2015 Publication	1%
11	www.bluesfuse.nl Internet Source	1%
12	Baba Koki Isa, Salihi Bayero Amina, Umar Aminu, Yusuf Sabo. "Health risk assessment of heavy metals in water, air, soil and fish", African Journal of Pure and Applied Chemistry, 2015 Publication	1%
13	polen.itu.edu.tr Internet Source	1%
14	K Kadirvelu, M Kavipriya, C Karthika, N Vennilamani, S Pattabhi. "Mercury (II) adsorption by activated carbon made from sago waste", Carbon, 2004 Publication	1%

15	Mona Karnib, Ahmad Kabbani, Hanafy Holail, Zakia Olama. "Heavy Metals Removal Using Activated Carbon, Silica and Silica Activated Carbon Composite", Energy Procedia, 2014 Publication	1%
16	Submitted to Universiti Teknologi MARA Student Paper	<1%
17	Health Evaluation of Heavy Metals in Infant Formula and Junior Food, 1983. Publication	<1%
18	Sugiyanto Sugiyanto, Samsul Kamal, Joko Waluyo, Adhika Widyaparaga. "Resonator Influence Simulation of Designed Close-Open Standing Wave Thermoacoustic Engine", Advances in Science, Technology and Engineering Systems Journal, 2019 Publication	<1%
19	S Saputro, M Masykuri, L Mahardiani, D Kurniastuti. "The synthesis of corncobs (zea mays) active charcoal and water hyacinth (eichornia crassipes) adsorbent to adsorb Pb(II) with it's analysis using solid-phase spectrophotometry (sps)", IOP Conference Series: Materials Science and Engineering, 2018 Publication	<1%
	Submitted to Institute of Graduate Studies, UiTM	

20	Student Paper	<1%
21	hdl.handle.net Internet Source	<1%
22	Y N Widhitama, A Lukito, S Khabibah. "Problem Solving-based Learning Materials on Fraction for Training Creativity of Elementary School Students", Journal of Physics: Conference Series, 2018 Publication	<1%
23	Submitted to South Bank University Student Paper	<1%
24	academic.hep.com.cn Internet Source	<1%
25	K. Kadirvelu, P. Kanmani, P. Senthilkumar, V. Subburam. " Separation of Mercury(II) from Aqueous Solution by Adsorption onto an Activated Carbon Prepared from ", Adsorption Science & Technology, 2016 Publication	<1%
26	Submitted to Federal University of Technology Student Paper	<1%
27	link.springer.com Internet Source	<1%
28	imtc.ctgroup.co.in	

Internet Source

<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		