RESEARCH ARTICLE | DECEMBER 05 2017

Treatment of ammonia in liquid hospital waste using activated carbon FREE

Riyanto; Lena Hayati

AIP Conf. Proc. 1911, 020030 (2017)
https://doi.org/10.1063/1.5016023

Treatment of Ammonia in Liquid Hospital Waste Using Activated Carbon

Riyanto[1,a)] and Lena Hayati[2)]

[1-2]*Department of Chemistry, Faculty of Mathematics and Natural Science, Islamic University of Indonesia, Jalan Kaliurang KM 14,5 Sleman Yogyakarta Indonesia 55584*

[a)]Corresponding author: riyanto@uii.ac.id

Abstract. In this research study of the treatment of ammonia in liquid hospitals waste using activated carbon. This study aims to the effect of activated carbon weight and precipitation time to the treatment of ammonia in liquid hospitals waste. Hospital liquid waste has been taken from Jogja International Hospital (JIH) Yogyakarta, Indonesia. Hospital liquid waste 100 mL is mixed with activated carbon with the varied weight that is 15, 30 and 60 g. After added with activated carbon then stirred with a magnetic stirrer for 15 minutes and a precipitation time of 0.5, 1.0 and 2.0 hours. The next step is the filtrate analyzed ammonia concentrations before and after treatment using UV-Vis Spectrophotometer. The results showed that activated carbon can reduce ammonia concentration in hospital liquid waste. The amount of the active carbon and the time of stirring, the greater the ammonia concentration decreases in hospital liquid waste. The best condition for the decrease of the ammonia concentration was obtained with active carbon and precipitation time is 60 g and 1.0 hours, respectively with ammonia decrease of 95.93%. The conclusion is that activated carbon can reduce ammonia concentration in hospital liquid waste.

INTRODUCTION

Wastewater from the hospital or domestic waste is one of the potential sources of water pollutants. Hospital wastewater contains high concentrations of organic compounds, possibly containing other chemical compounds and pathogenic microorganisms that can cause the disease to the surrounding community. One of the pollutants in hospital waste is the presence of ammonia in the waste. Ammonia is present in low concentrations and the amount of discharge may be low. However, if dissolved ammonia in wastewater cannot be evaporated because ammonia gas will cause serious environmental problems [1]. Because of the potential impact of hospital waste on public health is very large, and then every hospital is required to process the waste until it meets the requirements of standard quality standards. Health-care waste includes all waste derived from health installations, research facilities, and laboratories. In addition, health-care waste also includes wastes derived from small or scattered sources such as home-grown wastes [2].

Wastewater management is the management of all wastes from hospitals likely to contain microorganisms, chemicals, and radioactive. Wastewater treatment of hospitals is a very important part of the efforts of environmental sanitation hospital that has the purpose of protecting the community from the dangers of environmental pollution. Wastewater that is not handled properly will cause negative impacts especially on health, so it needs good management so that when disposed in a certain area does not cause pollution supported by Wastewater Treatment Plant owned by the hospital itself [2]. Negative effects have that may arise as a result of unhealthy environmental conditions due to improper hospital waste management, including the presence of disease-causing pathogenic bacteria. Hospital wastewater has potentially hazardous to health so it is necessary to handling wastewater and properly, that is by the existence of wastewater treatment installation [3].

Development of Chemical Education in 21st Century Learning
AIP Conf. Proc. 1911, 020030-1–020030-6; https://doi.org/10.1063/1.5016023
Published by AIP Publishing. 978-0-7354-1603-1/$30.00

Based on these problems, it is necessary to do further research on waste treatment to be friendly to the environment, one of them with adsorption waste treatment method. Adsorption is the event of the change of concentration of molecules, ions or atoms between surfaces in two phases. Substances that are absorbed or collected are called adsorbate while those collecting are called adsorbents. The mechanism of the adsorption process can be carried out in the event of a binding process by the surface of the adsorbent in the form of solids and liquids to the adsorbate of atoms, ions or molecules of gas molecules or other liquids. The most important aspect of the adsorption process is the selection of the type of adsorbent. The most potential adsorbent is activated carbon because it has a high surface area so that its adsorption ability is large.

Many researchers have been the treatment of ammonia in hospital wastewater. The treatment of ammonia in hospital wastewater has been done using an integrated anaerobic-aerobic fixed film bioreactor (Rezaee et al. 2005) [4], biologically active zeolite ion exchange columns [5], electrocoagulation [6], ozone [7], photocatalytic ozonation [8], fungal [9, 10], and Fenton oxidation [11]. The weaknesses of some researchers' methods for treatment of hospital waste are costly, difficult to process and generate new waste.

In this paper is presented the research study of the treatment of ammonia in liquid hospitals waste using activated carbon. This study aims to the effect of activated carbon weight and precipitation time to the treatment of ammonia in liquid hospitals waste. Activated carbon was used treatment of ammonia in liquid hospitals waste is activated carbon. Activated carbon is used as an adsorbent for the treatment of ammonia in liquid hospitals waste because is very simple preparation.

EXPERIMENTAL METHOD

Instrumentation and material

The instrument used in this research is UV-Vis Spectrophotometer (Hitachi U 2010), magnetic stirrer and analytical balance (Ohaus). The materials used in this research are the liquid waste hospital in Yogyakarta Indonesia, activated carbon, distillate water, phenol, and sodium nitroprusside. UV-Vis Spectrophotometer (Hitachi U 2010) has been used in the analysis of ammonia in liquid hospitals waste. All chemicals were used in this research from Merck and pro analysis (analytical grade) and dilution in distillate water.

Sampling

A Sampling of liquid hospitals wastewater was taken at Jogjakarta International Hospital (JIH), Yogyakarta, Indonesia. The sampling of wastewater in the wastewater treatment plant was conducted on the inlet. Inlet is the first and only temporary waste shelter. Prior to sampling, bottles and water containers are cleaned first and labeled about type, date, location, time and weather. Sampling was done using a clean bucket and then the sample was poured into the first rinsed bottle with the sample.

Liquid Waste Water Treatment Using Activated Carbon

Treatment of liquid hospital wastewater has done using activated carbon with batch method. Equipment for treatment of ammonia in hospital wastewater using adsorption with batch can be seen in Fig. 1A. Hospital wastewater treatment in this study was carried out by weighing the activated carbon as much as 15 g and then inserted into a 250 mL beaker glass. Furthermore, wastewater of hospital waste is added to activated carbon. The mixture has to stir with a magnetic stirrer for 10 minutes. The process is also done for weight variations of activated carbon is 30 and 60 g. After stirring with a magnetic stirrer this mixture has needed precipitation time for 0.5, 1.0 and 2.0 hours on each weight variation and then filtered using filter paper. Analysis of ammonia before and after treatment has been done using UV-Vis spectrophotometer.

Analysis of Ammonia with UV-Vis Spectrophotometers

Ammonia in liquid hospital wastewater before and after treatment was performed by using a double beam UV-Vis spectrophotometer. Ammonia reacts with hypochlorite and phenol catalyzed by sodium nitroprusside to form an indophenol blue compound. Samples of 25 mL were included in the erlenmeyer, plus 1 ml of phenol solution, 1 mL of sodium nitroprusside and 2.5 mL of the oxidizing solution (A mixture of 100 mL of an alkali citrate solution with 25 mL of sodium hypochlorite) then homogenized. Erlenmeyer is then covered with aluminum foil and left for 1 hour. The solution is measured using UV-Vis Spectrophotometer with a maximum wavelength of 640 nm.

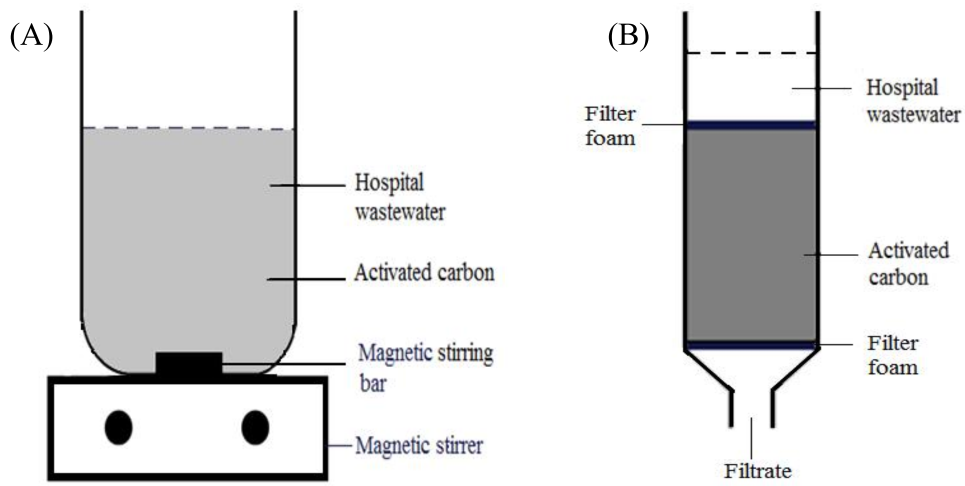

FIGURE 1. Equipment for treatment of ammonia in hospital wastewater using adsorption with batch (A) and flow method (B)

RESULT AND DISCUSSION

Characterizations of Activated carbon

The material was used to adsorb ammonia in hospital waste is activated carbon. Activated carbon made by physics activation method that is heating with the furnace at temperature 400 ^{o}C. Temperature is very influential in the process of activation. Temperature is too high will result in structure activated carbon broken, while low temperatures cause organic compounds have not burned. Fig. 2 shows the results of activated carbon analysis using SEM-EDX. Fig. 2A-2D shows the SEM image with magnification 2550x, 8100x, 8700x and 14000x, respectively. Fig. 2 is shows that activated carbon contain pores that cause ammonia to adsorption. The bigger the magnification analysis with SEM, the clearer the pore of activated carbon.

Fig. 3A is shows spectra EDX and Fig. 3B show comparison of element data in activated carbon (A). Fig. 3A show activated carbon is seen to contain element so as to form the pore. Activated carbon has pores so that ammonia can be adsorption through physical and chemical techniques. Fig. 3B shows EDX spectra from activated carbon. The element composition of activated carbon is shown in Table 1. The element composition of activated carbon is C, O, Si in large quantities while the elements of Cl, Al, Mg and Ca in small quantities. The content of elements in activated carbon is C, O, Si with levels of 53.00, 42.70, and 1.71%, respectively. The large amounts of Si and O cause the formation of SiO_2 compounds to allow ammonia to be bound by the O atoms.

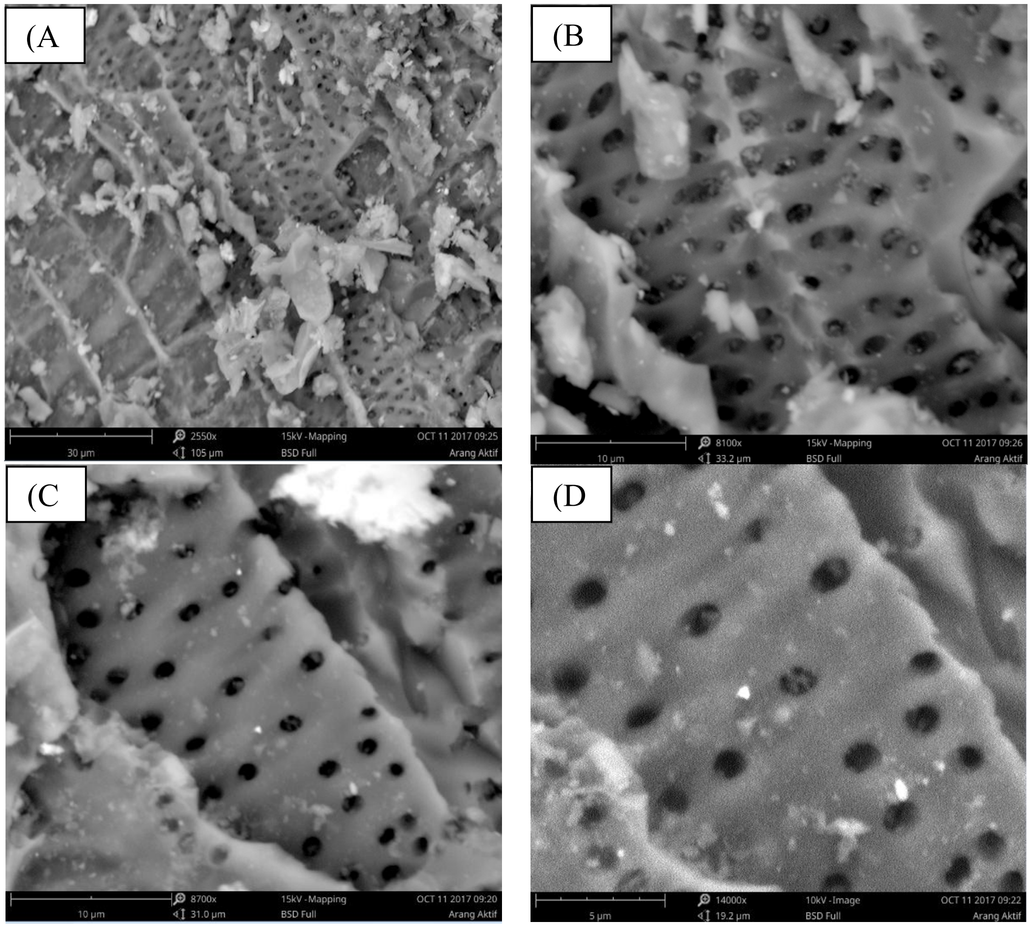

FIGURE 2. Image of SEM with magnification 2550x (A) 8100x (B) 8700x (C) and 14000x

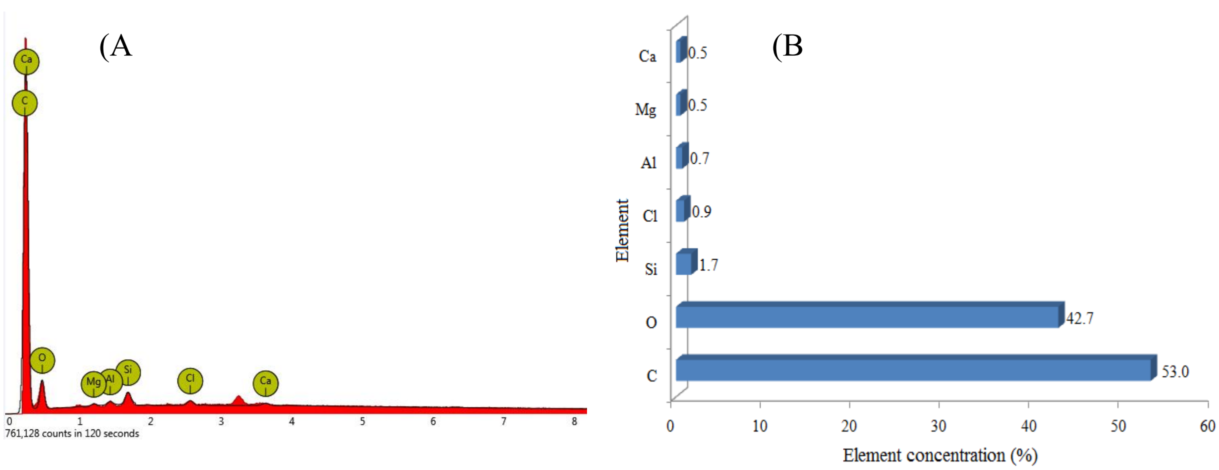

FIGURE 3. Spectra EDX (A) and comparison of element data in activated carbon (A)

TABLE 1. Element data form EDX activated carbon

Element	Atom%
C	53.00
O	42.70
Si	1.70
Cl	0.90
Al	0.70
Mg	0.50
Ca	0.50
Total	100.00

Treatment of ammonia in hospital wastewater

Table 2 shows the results of the analysis of ammonia in hospital wastewater before and after treatment using UV-Vis spectrophotometer. Ammonia concentration has analysis using UV-Vis Spectrophotometer with a maximum wavelength of 640 nm. Hospital liquid waste contains ammonia with a concentration of 29.11 mg/L. Hospital liquid waste after being processed decreased ammonia concentration to 1.19 mg/L. Amount of ammonia that adsorption is 95.93%. This study uses activated carbon weight variations of 15, 30 and 60 g. This study also conducted variation of precipitation time of 0.5, 1.0 and 2.0 hours. Ammonia in hospital wastes has decreased significantly by using activated carbon 60 g and a precipitation time of 2.0 hours. The weight of adsorbent and precipitation time is an important factor in the processing of hospital waste ammonia. The more activated carbon and precipitation time are more ammonium adsorbed. More activated carbon causes more space and active sites to catch more ammonia. Deposition time greatly influences the ammonia adsorption process. Deposition time is required to form bonds and the entry of ammonia in the pores. The longer the precipitation time, the more ammonia is adsorbed.

Table 2 shows a good concentration rate reduction in hospital wastewater treatment using active carbon as much as 15 g, which in the results of the processing showed an increasing number at each hour. So it can be said that the longer the time of immobilization the adsorption of ammonia compound by the active char even better. In effluent treatment by using activated carbon as much as 30 and 60 g which indicate that the duration of time of residence does not affect the amount of concentration of ammonia compound that is absorbed. However, the processing of waste with activated carbon made after the stirring process affects the amount of concentration of ammonia that is absorbed.

TABLE 2. Percentage reduction in ammonia concentration in hospital waste 100 mL that has been adsorbed by activated carbon

Activated carbon weight (g)	Precipitation time (hours)	Absorbance		Ammonia concentration (mg/L)		% Degradation
		Before	After	Before	After	
15	0.5	0.5822	0.3750	29.11	18.75	35.59
	1.0	0.5822	0.3560	29.11	17.80	38.85
	2.0	0.5822	0.3333	29.11	16.65	42.80
30	0.5	0.5822	0.2469	29.11	12.35	57.59
	1.0	0.5822	0.1838	29.11	9.19	68.43
	2.0	0.5822	0.1842	29.11	9.21	68.36
60	0.5	0.5822	0.0973	29.11	4.87	83.29
	1.0	0.5822	0.0237	29.11	1.19	95.93
	2.0	0.5822	0.0330	29.11	1.65	94.33

Table 2 is show the largest ammonia concentration was decreased, 95.93% at 60 g with precipitation time is 1 hour. The adsorption of ammonia process decrease can be caused when the ammonia compound that has been absorbed by activated carbon. In the active carbon weight variation shows that the more activated carbon used, the greater the decrease of ammonia compound in the hospital liquid waste, and this could be because the more activated carbon used the activated carbon on the liquid waste increases, which is quite large. Fig. 4 shows the effect of the weight of activated carbon and precipitation time to ammonia concentration.

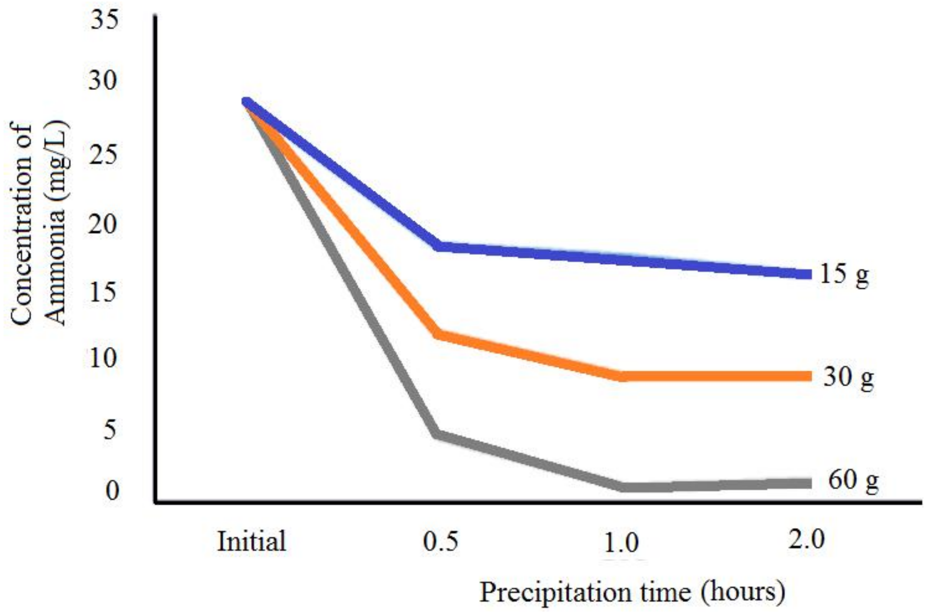

FIGURE 4. Effect of weight of activated carbon and precipitation time to ammonia concentration

CONCLUSION

The results of the analysis obtained the best active carbon weight and precipitation time to adsorption the ammonia compound in the liquid waste of the hospital as much as 60 g and 1 h, respectively. Based on the result of analysis by using UV Vis spectrophotometer obtained the best decrease of ammonia concentration up to 95.93%. Activated carbon can reduce ammonia concentration in hospital liquid waste using batch system.

REFERENCES

1. Bhattacharya and K. Pransant, J. Memb. Sci. **390-391**, 76-83 (2011).
2. A. Amouei, H.A. Asgharnia, A.A. Mohammadi, H. Fallah, R. Dehghani and M.B. Miranzadeh, Int. J. Phys. Sci. **7, 31**, 5213-5217 (2012).
3. T.Y. Pai, Y.P. Tsai, H.M. Lo, C.H. Tsai and C.Y. Lin, Comput. Chem. Eng. **31, 10**, 1272-1281 (2007)
4. A. Rezaee, M. Ansari, A. Khavanin, A. Sabzali and M.M. Aryan**,** Am J Environ Sci**.**, **1, 4**, 259-263 (2005).
5. A. Almutairi, R. Laurence and Weatherley, J. Environ. Manage. **160**, 128-138 (2015).
6. D. R. Arsand, K. Kummerer, F. Ayrton and Martins, Sci. Total Environ. **443,** 351-357 (2013)
7. K.M.S. Hansen, A. Spiliotopoulou, R.K. Chhetri, M.E. Casas, K. Bester, R. Henrik and Andersen, Chem. Eng. J., **290**, 507-514 (2016).
8. D.I. Kern, R.O. Schwaickhardt, G. Mohr, E.A. Lobo, L. Enio and E.L. Machado, Sci. Total Environ. **443**, 566-572 (2013)
9. D.M. Lucas, T.F. Fabregat, G. Vicent, S. Caminal, R. Mozaz, J.L. Balcazar and D. Barcelo, Chemosphere, **152**, 301-308 (2016).
10. C.C Morato, D. Lucas, M. Llorca, S.R. Mozaz and E.M. Urrea, Sci. Total Environ. **493**, 365-376 (2013).
11. M. Munoz, P.G. Munoz, G. Pliego, Z.M. Pedro, J.A. Zazo, J.A. Casas, J. Juan and Rodriguez, J. Environ. Chem. Eng. **4, 4**, Part A, 4107-4112 (2016).