

Using Different Size of Montmorillonite Particles for Filtration-Adsorption of Nickel Metal in Electroplating Liquid Waste

Dyah Mustika Braniwati¹, Erfan Priyambodo²

¹ Chemistry Study Program, Universitas Negeri Yogyakarta

² Department of Chemistry Education, Universitas Negeri Yogyakarta

Article Info

Article history:

Received: May 7th, 2021

Revised: May 20th, 2021

Accepted: June 14th, 2021

*Corresponding Author:

Dyah Mustika Braniwati,
Chemistry Study Program
Universitas Negeri Yogyakarta
Email: dyah.mustika67@gmail.com

ABSTRACT

This study aims to know the effect of montmorillonite particle, which were granule and gravel of montmorillonite, prepared from the sintering method and its effectiveness in filtration-adsorption process of the nickel-metal in electroplating liquid waste. The granule and gravel of montmorillonite were prepared by compaction and sintering processes at a temperature of 900°C. The characterization of granule montmorillonite shows the notoriously random micropore material, which the pore surface area was 8.393 m²/g. While the gravel montmorillonite has a pore surface area of 4,381 m²/g. The test was carried out by flowing electroplating waste with the crossflow filtration method and batch adsorption. The most effective decrease in the concentration of nickel-metal occurred in the granules of montmorillonite with a mass ratio of material through filtration and adsorption was 2:3. The effectiveness of filtration-adsorption process for removing nickel metal from liquid waste of electroplating was 83.51%.

Keyword: *montmorillonite, granule, gravel, electroplating waste*

1. INTRODUCTION

The industrial sector has experienced a significant increase, one of which is the electroplating industry which is developing enough to meet the needs of various equipment including household appliances, most of which come from metal that requires coating to prevent rusting or corrosion (Cahyani, 2016; Jamaludin, 2019).

The waste produced in the electroplating industry can be in the form of solid, liquid, and gas emissions which are included in hazardous waste (Hazardous Toxic Materials) and contain heavy metals such as Fe, Cr, Zn, Cu, Ni, and Mn (Djaenudin, 2019). Regulation of the Minister of Environment of the Republic of Indonesia number 5 of 2014 concerning wastewater quality standards, states that nickel-metal parameters in waste do not exceed 1.0 mg/L (Menlhk, 2014; Baroroh, 2017).

Efforts to reduce heavy metal waste contamination in the electroplating industry can be carried out either physically, chemically, or biologically. Physical methods include filtration, adsorption, and sedimentation. Chemical methods include neutralization, precipitation, and coagulation (Prasetyaningrum, 2018).

Of all the existing methods, in general, filtration and adsorption have been widely used as methods to overcome environmental pollution problems due to industrial wastes, because this method is easy to do (Shatter, 2015; Peng, 2018; Yang, 2018; Sulistyanti, 2018). Montmorillonite is included in

the type of smectite material (Nawang, 2019) which consists of 2 layers of silica and 1 layer of aluminum (Ikhsan, 2005; Farid, 2016; Zhu, 2019). Montmorillonite has the potential to be used as a material that has a higher use value in various fields, either directly used or by prior treatment, for example, the sintering and pressing process is carried out (Sandra, 2014).

The size of the material used as the filtration-adsorption media affects the filter power of the media used. Broadly speaking, the size of the material is differentiated into 4 types, namely powder, granule, gravel, and block (Junaidi, 2011; Kusuma, 2010). Powder size is considered to be the smallest form which has advantages in terms of wide pores. However, the loss of powder material causes clogging. To overcome the flow jams in the filtration process, granule and gravel-sized materials are used (Rizani, 2016).

2. RESEARCH METHOD

The initial step of this research is montmorillonite powder material mixed with distilled water with a ratio of 80%: 20%. Then the mixture is put into a press to obtain montmorillonite solid. Before the montmorillonite solid is put in the muffle furnace at 900°C for 3 hours, the solid is oven-dried at 110°C for 1 hour. The sintered montmorillonite material is then crushed and sieved into 8 mesh (granule) and 4 mesh (gravel) sizes.

After all the adsorbent materials are ready, the filtration-adsorption process is carried out in the electroplating liquid waste by using each adsorbent (granule and gravel) in a set of filtration-adsorption tools. The filtration process uses the crossflow feed flow method and the adsorption process uses the batch method. XRD, SEM, and SAA were used to analyze the characterization of the montmorillonite adsorbent. Meanwhile, AAS was used to analyze the effectiveness of the adsorbent montmorillonite.

The absorption effectiveness of each adsorbent in the form of granule and gravel is determined based on the initial electroplating wastewater concentration and the electroplating wastewater concentration after the filtration-adsorption process. The filtration-adsorption process effectiveness can be determined through the equation

$$\text{The Effectiveness} = \frac{\text{initial level of Ni} - \text{final level of Ni}}{\text{initial level of Ni}} \times 100\%$$

The work flow of the research is given in Figure 1 bellow.

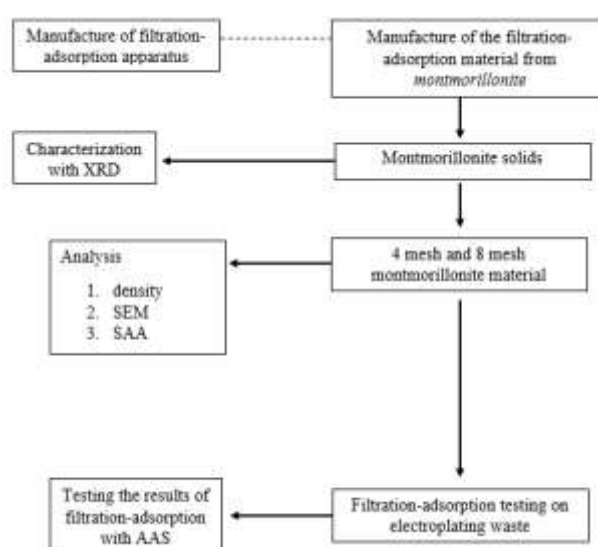


Figure 1. The research flow diagram

3. RESULTS AND DISCUSSION

The material of montmorillonite was analyzed using XRD. The result shows that the peaks of the montmorillonite material at angles of 2θ , $20,89^\circ$; $27,97^\circ$; $35,69^\circ$; $44,07^\circ$; $57,49^\circ$; and $66,95^\circ$ (Oueslati, 2015).

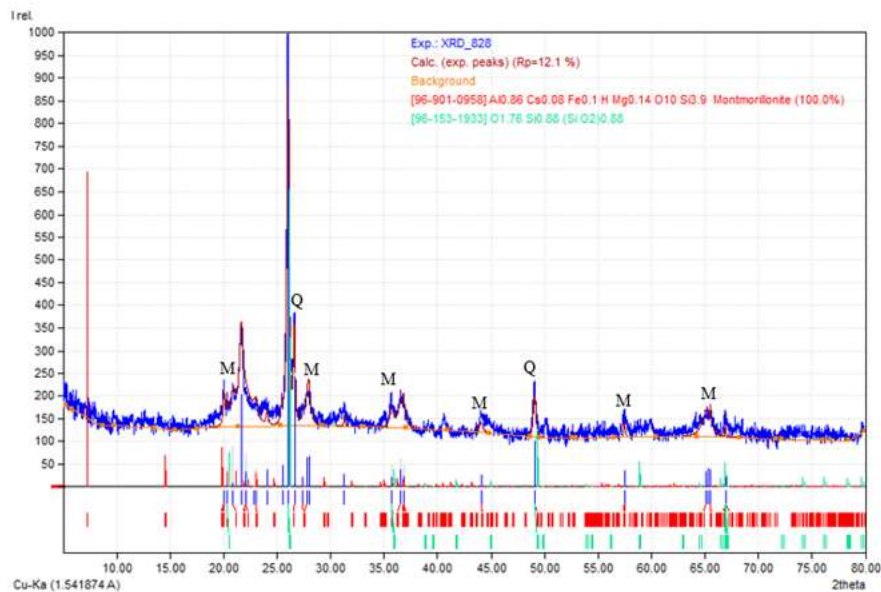


Figure 2. The XRD spectra of montmorillonite materials

The typical peaks generated from the XRD analysis showed other peaks besides montmorillonite. Another peak is quartz, which means that the montmorillonite material is impure and still contains impurities.

The surface morphology of granule and gravel montmorillonite using Scanning Electron Microscope (SEM) is given at Figure 3 bellow. The pore distribution was quite micro-sized and the pore surface area produced by the granule material is $8.393 \text{ m}^2/\text{g}$ and the gravel material is $4.381 \text{ m}^2/\text{g}$

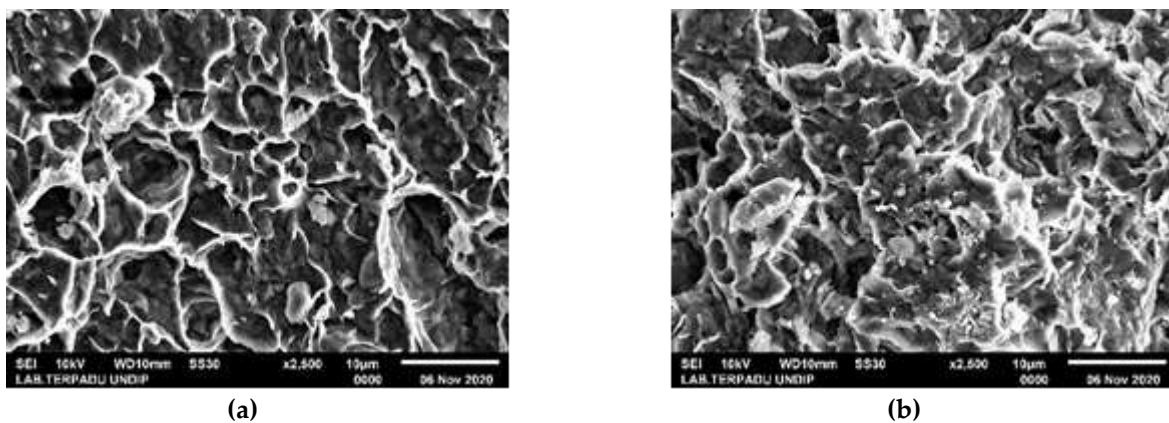


Figure 3. The surface morphology of granule (a) and gravel (b) montmorillonite using Scanning Electron Microscope (SEM) at magnification 2500X

To determine the effectiveness of the nickel metal filtration-adsorption process in electroplating liquid waste by montmorillonite, the liquid waste was put into a container that connected to the filtration-adsorption device. The filtration process uses the crossflow feed flow method and the adsorption process uses the batch method. Sampling was carried out at 20 minutes at each filtration-adsorption process and the data was obtained using AAS. The effectiveness of the nickel metal filtration-adsorption process in electroplating liquid waste by montmorillonite is shown in Table 1.

Table 1. The effectiveness of the nickel metal filtration-adsorption process in electroplating liquid waste by montmorillonite

Initial flow rate (L/min)	Particles	Mass ratio of montmorillonite (filtration : adsorption)	Effectiveness of nickel metal filtration-adsorption (%)
11.80	granule	1 : 2	69.75
		2 : 3	83.51
	gravel	1 : 2	60.87
		2 : 3	64.13

Based on Table 1, it can be seen that the smaller the particle size (granule is smaller than gravel) is related to the effectiveness of removing nickel metal from electroplating liquid waste. The smaller of particle size has the larger the surface area so that the physico-chemical interaction between nickel metal and montmorillonite is getting bigger. The ratio of montmorillonite mass used for filtration and adsorption process also related to the effectiveness of removing nickel metal from electroplating liquid waste. The more montmorillonite used for the filtration process is better in rejecting nickel from electroplating liquid waste, so that the adsorption-filtration process is higher.

4. CONCLUSION

The granule of montmorillonite is more effective in removing nickel metal from electroplating liquid waste rather than the gravel of montmorillonite. Based on the research, the effectiveness of granule of montmorillonite in removing nickel metal from electroplating liquid waste was 85.51% with 2:3 of the mass ratio of montmorillonite (filtration : adsorption).

REFERENCES

- Baroroh, A., Moelyaningrum, A. D., & Ellyke. (2017). Pemanfaatan Serbuk Selulosa Kulit Kakao Sebagai Adsorben Logam Berat Ni pada Limbah Cair Elektroplating. Jember: Universitas Jember.
- Cahyani, M., Andarani, P., & Zaman, B. (2016). Penurunan Konsentrasi Nikel (Ni) Total dan COD Menggunakan Tumbuhan Kayu Apu pada Limbah Cair Elektroplating. *Jurnal Teknik Lingkungan*, 5(4), 1-9.
- Djaenudin., Murdikaningrum, G., Kencanawati, K., et al. (2019). Sistem Pengolahan Air Limbah Elektroplating Berbasis Nikel. *Jurnal Sains dan Teknik*, 1(2), 57-68.
- Farid, M. (2016). Studi Hubungan Nilai Plastisitas dan Nilai N-SPT Tanah Terhadap Kadar Mineral Lempung Ekspansive (Montmorillonite, Illite, dan Kaolinite). Gowa: Fakultas Teknik Universitas Hasanuddin.
- Ikhsan, J. (2005). Memahami Proses Adsorpsi Ion Logam Oleh Clay Mineral. Yogyakarta: Kimia FMIPA UNY.
- Jamaludin. (2019). Pengaruh Ketebalan Elektroplating Menggunakan Nikel dan Krom pada Aluminium Alloy 2024 Terhadap Laju Korosi. Surabaya: Politeknik Penerbangan Surabaya.
- Junaidi dan Wigati, R. (2011). Analisis Parameter Statistic Butiran Sedimen Dasar Pada Sungai Alamiah. Semarang: Jurusan Teknik Sipil Politeknik Negeri Semarang.
- Kusuma, R. M. (2010). Kajian Sedimen Transpor dan Perubahan Morfologi Sungai Opak Pasca Erupsi Gunungapi Merapi Tahun 2010. -
- Nawang, R., Hussein, M. Z., Matori, K. A., Abdullah, C. A. C., et al. (2019). Sifat Fisikokimia Nanokomposit Hidroksiapatit/Montmorillonite Dibuat Dengan Sintering Serbuk. Selangor: Universiti Putra Malaysia.
- Peng, G., Yang, S., Li, T., Ai, B., et al. (2018). Highly Efficient Removal Of Enrofloxacin by Magnetic Montmorillonite Via Adsorption and Persulfate Oxidation. *Chemical Engineering Journal*.

- Peraturan Menteri Lingkungan Hidup Republik Indonesia. Nomor 5 Tahun 2014 tentang Baku Mutu Air Limbah diakses pukul 05:49 pada tanggal 09 Desember 2020 pada laman sebagai berikut: <http://menlhk.co.id/simppuh/public/uploads/files/MLH%20P.5.pdf>
- Prasetyaningrum, A., Dharmawan, Y., Djaeni, M., Sari, E. E., et al. (2018). Peningkatan Efisiensi Pengolahan Limbah Elektrolating Melalui Proses Koagulasi-Flokulasi pada Industri Logam Juwana Pati. Semarang: Universitas Diponegoro.
- Rizani, A & Suparno. (2016). Pengaruh Bentuk (Powder, Granule, dan Gravel) Karbon Aktif Kayu Akasia Mangium Terhadap Hasil Pengolahan Air Selokan Mataram. Yogyakarta: Fisika FMIPA UNY.
- Sandra, K. O., Budi, A. S., dan Susilo, A. B. (2014). Pengaruh Suhu Sintering Terhadap Densitas dan Porositas pada Membran Keramik Berpori Berbasis Zeolit, Tanah Lempung, Arang Batok Kelapa, dan Polyvinylalcohol (PVA). Jakarta: UNJ.
- Shatter, S. F. A., Zakaria, N. A., dan Foo, K. Y. (2015). Feasibility Of Montmorillonite-assisted Adsorption Process For The Effective Treatment of Organopesticides. Universiti Sains Malaysia.
- Sulistiyanti, D., Antoniker., & Nasrokhah. (2018). Penerapan Metode Filtrasi dan Adsorpsi Dalam Pengolahan Limbah Laboratorium. *Jurnal Kimia dan Pendidikan*, 3(2).
- Yang, S., Wu, P., Liu, J., Chen, M. Z., et al. (2018). Efficient Removal Of Bisphenol A By Superoxide Radical And Singlet Oxygen Generated From Peroxymonosulfate Activated With Fe0 - Montmorillonite. *Chemical Engineering Journal*.
- Zhu, T. T., Zhou, C. H., Kabwe, F. B., Wu, Q. Q., et al. (2019). Exfoliation Of Montmorillonite and Related Properties Of Clay/Polymer Nanocomposites. *Applied Clay Science*, 169, 48-66.

