

**PENGARUH PENCUCIAN TANAH GAMBUT DENGAN NATRIUM
HIDROKSIDA TERHADAP KAPASITAS ADSORPSINYA PADA ION
AMONIUM DALAM LARUTAN**

SKRIPSI

Diajukan Untuk Memenuhi Sebagian Dari Persyaratan Memperoleh Gelar
Sarjana Sains Program Studi Kimia



Oleh

Fira Nandatamadini

1505484

PROGRAM STUDI KIMIA

DEPARTEMEN PENDIDIKAN KIMIA

FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU

PENGETAHUAN ALAM

UNIVERSITAS PENDIDIKAN INDONESIA

2019

LEMBAR HAK CIPTA

**PENGARUH PENCUCIAN TANAH GAMBUT DENGAN NATRIUM
HIDROKSIDA TERHADAP KAPASITAS ADSORPSINYA PADA ION
AMONIUM DALAM LARUTAN**

Oleh

Fira Nandatamadini

Skripsi yang Diajukan untuk Memenuhi Sebagian dari Persyaratan Mendapatkan
Gelar Sarjana Sains Program Studi Kimia

©Fira Nandatamadini 2019

Universitas Pendidikan Indonesia

Juli 2019

Hak Cipta dilindungi Undang-Undang

Skripsi ini tidak boleh diperbanyak seluruhnya atau sebagian dengan dicetak
difotokopi, atau cara lainnya tanpa izin dari penulis

FIRA NANDATAMADINI

**PENGARUH PENCUCIAN TANAH GAMBUT DENGAN
NATRIUM HIDROKSIDA TERHADAP KAPASITAS
ADSORPSINYA PADA ION AMONIUM DALAM LARUTAN**

disetujui dan disahkan oleh pembimbing:

Pembimbing I



Galuh Yuliani Ph. D

NIP. 198007252001122001

Pembimbing II

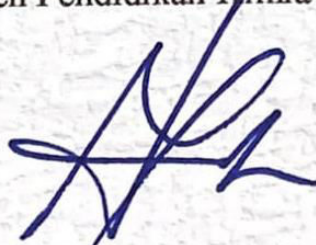


Dr. Agus Setiabudi, M.Si

NIP. 196808031992031002

Mengetahui

Ketua Departemen Pendidikan Kimia FPMIPA UPI



Dr. Hendrawan, M.Si.

NIP. 19661121991031002

ABSTRAK

Gambut merupakan material yang ketersediaannya melimpah, namun memiliki nilai ekonomis rendah. Gambut memiliki porositas dan kemampuan menukar ion yang tinggi, sehingga dapat dimanfaatkan sebagai adsorben untuk amonium dalam larutan. Pencucian adsorben dengan NaOH telah dilaporkan efektif untuk meningkatkan kapasitas penukar ion dari beberapa adsorben. Dalam penelitian ini, pengaruh pencucian gambut oleh NaOH terhadap kapasitas adsorpsinya pada ion amonium telah diteliti. Dari hasil analisis proksimat dan ultimat diketahui bahwa gambut merupakan material dengan kadar air yang tinggi dan mengandung unsur karbon dan oksigen yang cukup melimpah. Karakterisasi gambut sebelum dan setelah pencucian oleh NaOH dilakukan menggunakan FTIR dan SEM-EDS. Dari analisis FTIR terlihat berkurangnya intensitas puncak serapan -OH pada 3400 cm^{-1} , C=O (karboksilat) pada 1700 cm^{-1} dan C-O-H pada 1300 cm^{-1} yang disebabkan telah terjadinya penggantian H^+ (pada karboksilat) oleh Na^+ setelah pencucian dengan NaOH. Morfologi permukaan gambut memperlihatkan bahwa gambut termodifikasi memiliki permukaan yang lebih homogen dibandingkan dengan tanpa modifikasi. Dari analisis EDS teridentifikasi adanya kenaikan kandungan natrium pada gambut termodifikasi. Dari hasil penelitian diperoleh kondisi penjerapan amonium yang optimum pada waktu 360 menit dengan kapasitas adsorpsi tertingginya sebesar $26,35\text{ mg/g}$ yang diperoleh dari gambut termodifikasi 8 jam. Berdasarkan faktor korelasi yang didapat, data adsorpsi diidentifikasi mengikuti isoterm adsorpsi Langmuir.

Kata kunci: Amonium; gambut; modifikasi gambut; kapasitas adsorpsi; isoterm

ABSTRACT

Peat is abundant materials that still has low economic value. Due to its high porosity and ion exchange ability, peat may serve as an ideal adsorbent for ammonium in aqueous solution. It has been reported in the literature that base washing treatment may increase the ion exchange capacity of several adsorbents. In this study, washing treatment of peat using NaOH solution was conducted and its effects on adsorption capacity for ammonium ions has been investigated. From the results of proximate and ultimate analysis, it is evident that peat had high water content and high carbon and oxygen contents. Characterization of peat before and after base washing was carried out using FTIR and SEM-EDS. From FTIR analysis, it can be seen that the absorptions at -OH at 3400 cm^{-1} , C=O (carboxylates) at 1700 cm^{-1} and C-O-H at 1300 cm^{-1} were decreased, probably due to the substitution of H^+ (from carboxylates) by Na^+ upon washing. Peat surface morphology analysis indicated that modified peat possessed a more homogeneous surface compared to raw peat. The EDS analysis indicated an increase in sodium element content in the modified peat. From the adsorption study using ammonium ion, the optimum condition was achieved at 360 minutes with the highest adsorption capacity of 26.35 mg/g. This highest adsorption capacity was obtained using modified peat at 8 h washing time. Based on the correlation factors (R^2) obtained for isotherm adsorption study, the adsorption data fits the Langmuir adsorption isotherm suggesting a monolayer interaction.

Keywords: Ammonium; peat; peat modification; adsorption capacity; isotherm

DAFTAR ISI

LEMBAR HAK CIPTA.....	i
ABSTRAK.....	ii
<i>ABSTRACT</i>	iii
DAFTAR ISI.....	iv
DAFTAR GAMBAR.....	viii
DAFTAR TABEL.....	ix
DAFTAR LAMPIRAN.....	x
DAFTAR PUSTAKA.....	xi
BAB I PENDAHULUAN.....	1
1.1. Latar Belakang.....	1
1.2. Rumusan Masalah.....	3
1.3. Tujuan Penelitian.....	3
1.4. Manfaat Penelitian.....	4
1.5. Struktur Organisasi Skripsi.....	4
BAB II TINJAUAN PUSTAKA.....	5
2.1. Amonium.....	5
2.2. Gambut.....	6
2.2.1. Pengertian.....	6
2.2.2. Pembentukan.....	7
2.2.3. Sifat Fisik.....	8
2.2.4. Sifat Kimia.....	9
2.3. Karakterisasi Gambut.....	10

2.3.1. Fourier Transform Infra Red (FTIR)	10
2.3.2. Scanning <i>Electron Microscopy</i> - <i>Electron Diffraction Scattering</i> (SEM-EDS).....	11
2.3.3. <i>Surface Area Analyzer (SAA)</i> - BET	13
2.3.4. Spektroskopi UV/Vis (UV/Vis).....	13
2.4. Adsorpsi	14
2.5. Isoterm Adsorpsi	15
2.5.1 Isoterm Freundlich	16
2.5.2 Isoterm Langmuir.....	16
2.7. Modifikasi Adsorben.....	16
BAB III METODE PENELITIAN.....	18
3.1. Waktu dan Tempat	18
3.2. Alat dan Bahan.....	18
3.2.1. Alat.....	18
3.2.2. Bahan	19
3.3. Bagan Alir Penelitian	20
3.4. Prosedur Penelitian.....	20
3.4.1. Preparasi Gambut.....	20
3.4.2. Preparasi Larutan Ion NH_4^+ dari NH_4Cl	22
3.4.3. Uji Adsorpsi Gambut terhadap Ion Amonium	22
3.4.4. Prosedur Analisis Instrumen	24
BAB IV TEMUAN DAN PEMBAHASAN	26
4.1. Karakterisasi Gambut.....	26

4.1.1 Analisis Proksimat dan Ultimat	26
4.1.2 Hasil Analisis FTIR	27
4.1.3 Hasil Analisis Luas Permukaan BET	28
4.1.4 Hasil Analisis SEM-EDS	29
4.2. Uji Adsorpsi Gambut terhadap ion NH_4^+	30
4.2.1. Optimasi Waktu dalam Adsorpsi Ion Amonium terhadap Gambut	30
4.2.2. Pengaruh Variasi Konsentrasi Amonium terhadap Adsorpsi oleh Gambut	31
4.3. Penentuan Model Isoterm Adsorpsi	33
BAB V SIMPULAN, IMPLIKASI, DAN REKOMENDASI	37
5.1. Simpulan	37
5.2. Implikasi	38
5.3. Rekomendasi	38
LAMPIRAN	i
1.1 Pembuatan larutan NaOH 0,1 M	i
1.2 Pembuatan Larutan Induk Amonium 1000 ppm	i
1.3 Pembuatan Deret Standar Larutan Amonium	i
1.4 Penentuan Kurva Kalibrasi Standar Amonium	i
1.5 Pembuatan Larutan Adsorbat	ii
1.6 Optimasi Waktu Adsorpsi	ii
1.7 Variasi Konsentrasi Adsorbat	iii
1.8 Isoterm Adsorpsi	iv
2.1. Gambut Tanpa Modifikasi	vii

3.1. Gambut Tanpa Modifikasi	viii
3.1. Gambut Termodifikasi	ix

DAFTAR GAMBAR

Gambar 1 . Struktur amonium	5
Gambar 2 . Rawa dan gambut	7
Gambar 3 . Skema instrumen FTIR	11
Gambar 4 . Skema alat SEM-EDS	12
Gambar 5 . Skema alat Spektrometer UV-Vis	14
Gambar 6 . Bagan alir penelitian.....	20
Gambar 7 . Spektra FTIR Gambut tanpa modifikasi (biru) dan gambut termodifikasi (jingga).....	27
Gambar 8 . Hasil Analisis SEM (a) Gambut tanpa modifikasi (b) Gambut termodifikasi	29
Gambar 9 . Hasil analisis EDS (a) gambut tanpa modifikasi dan (b) gambut termodifikasi.	30
Gambar 10 . Reaksi substitusi Na^+ dari NaOH dengan H^+ dalam gambut ..	30
Gambar 11 . Kurva Hasil Optimasi Waktu Adsorpsi Ion NH_4^+ pada adsorben gambut.....	31
Gambar 12 . Kurva Hasil Adsorpsi Ion NH_4^+ dalam Variasi Konsentrasi larutan NH_4^+	32
Gambar 13 . Reaksi substitusi NH_4^+ dari larutan amonium dengan Na^+ dalam gambut termodifikasi	33
Gambar 14 . Kurva Isoterm Adsorpsi Langmuir dan Freundlich	34

DAFTAR TABEL

Tabel 1 . Komposisi Gambut di Indonesia	10
Tabel 2 . Analisis Proksimat dan Ultimat Tanah Gambut	26
Tabel 3 . Hasil Analisis Luas Permukaan BET Gambut	28
Tabel 4 . Persamaan Model Isoterm Adsorpsi	35

DAFTAR LAMPIRAN

Lampiran 1 . Perhitungan	i
Lampiran 2 . Hasil Analisis FTIR gambut tanpa modifikasi dan termodifikasi	vii
Lampiran 3 . Hasil Analisis SEM-EDS Gambut Tanpa Modifikasi dan Termodifikasi	viii
Lampiran 4 . Dokumentasi Penelitian	x

DAFTAR PUSTAKA

- Aditya, K. *et al.* (2016). *Penentuan Model Isoterm Adsorpsi Ion Cu(II) Pada Karbon Aktif Tempurung Kelapa*. 3(2), 1–6.
- Andriesse, J. P. (1988). *Nature and Management of Tropical Peat Soils*. 1st ed. Rome: FAO. Food Agricult. Organization, 1-165.
- Agus, F., & Subiksa, I. G. M. (2008). *Lahan Gambut : Potensi untuk pertanian dan aspek lingkungan*. Balai Penelitian tanah dan World Agroforestry Centre (ICRAFT), Bogor.
- Ajlouni, M. & Mesri, G. (2007) *Engineering properties of fibrous peat*. J. Geotech Geoenvironment Eng. 133(7): 850-866.
- Anonim. (2009). *Ultraviolet Visible Spectroscopy (UV)*. London: Royal Society of Chemistry.
- Anonim. (2016). *Scanning electron microscopy with EDX* [online]. Diakses dari <https://www.gems-inclusions.com/inclusions-studies/analytical-methods/se-m-eds-wds-analysis/>.
- Argun, M. E. & Dursun, S. (2006). *Removal of heavy metal ions using chemically modified adsorbents*. J. Int. Environmental Application & Science, Vol. 1 (1-2): 27-40.
- Bohl, H., Facklam, M., Marshall, S., & Render, M., Z. (1996). *Kulturtechnik Landentwicklung*. 37:185.
- Budiman, A. A. & Hafram, A. *Penentuan Kualitas Batubara pada Kabupaten Enrekang Berdasarkan Analisis Proksimat dan Ultimat*. Jurnal Geomine, 5(2), 53–58. 2017
- Chen, X. (2015). *Modeling of Experimental Adsorption Isotherm Data*. Information. (6):14-22.
- Chieng, H. I., Lim, L. B. L., & Priyantha, N. (2014). *Sorption characteristics of peat from Brunei Darussalam for the removal of rhodamine B dye from aqueous solution: adsorption isotherms, thermodynamics, kinetics and regeneration studies*. Desalination and Water Treatment, 55(3), 664–677.
- Chinomso J. O. A. (2010). *Determination of the concentration of ammonia that could have lethal effect on fish pond*. Journal of engineering and applied sciences. (5):2.
- Chynoweth, D. P. (1983). *A novel process for biogasification of peat*. Proc. Int. Symp. Peat Util., Bemidji, Minnesota, pp. 159-171.

- Cloutier, J., Leduy, A., & Ramalho, R. S. (1985). *Peat adsorption of herbicide 2,4-D from wastewaters*. The Canadian J. of Chem. Eng. 63: 250-257.
- Cooney, E. L., Booker N. A., Shallcross D. C., *et al.* (1999). *Ammonia removal from wastewaters using natural Australian Zeolite. I. Characterization of the Zeolite*. Sep Sci Technol. 34(12):2307–2327.
- De Souza, F. & Roca Braganca, S. (2018). *Extraction and characterization of humic acid from coal for the application as dispersant of ceramic*. J. Mater. Res. Technol. 7 (3), 254-260.
- Deboucha, S., Hashim, R., & Alwi, A. (2008). *Engineering properties of stabilized tropical peat soils*. J. Geotech. Eng., 13E: 1-9.
- Domenico, M. S. (1996). *Physical-Chemical Properties and Sorption Characteristics of Peat*. Dublin City University. School of Chemical Sciences.
- Driessen, P. M., & Suhardjo, H. (1976). *On the defective grain formation of sawah rice on peat*. Soil Res. Inst. Bull. 3: 20 – 44.
- Driessen, P. M. (1978). *Peat soils*. pp. 763-779. In: IRRI. Soil and rice. IRRI. Los Banos, Philippines.
- Dwipayani, A. R. (2013). *Penggunaan tanah liat sebagai adsorben dan coagulant aid dalam pengolahan limbah cair tekstil*. Laporan Tesis Program Studi Teknik Lingkungan. Institut Teknologi Bandung, Bandung.
- Errais E., Duplay J., Darragi F., *et al.* (2011). *Efficient anionic dye adsorption on natural untreated clay: kinetic study and thermodynamic parameters*. Desalination. 275(1):74–81.
- Fan Y., Wang B., Yuan S., Wu X., Chen J., & Wang L. (2010). *Adsorptive removal of chloramphenicol from wastewater by NaOH modified bamboo charcoal*. China: Environmental Science Research Institute. Bioresource Technology 101: 7661–7664.
- Farkas, A., Rozic, M., & Barbaric-Mikocevic, Z. (2005) J. Hazard Material. B117, 25-33.
- Freundlich, H. (1906). *Over the adsorption in solution*. J. Physical Chemistry. 57:385–471.
- Fuchsman, C. H. (1980). *Peat, Industrial Chemistry and Technology*. Academic Press.
- Goldstein, J., *et al.* (1992). *Scanning Electron Microscopy and X-Ray Microanalysis*. 2nd edition. New York: Plenum Press.

- Gupta, V. K., Sadegh, H., Yari, M., Ghoshekandi, R. S., Maazinejad, B., Chahardori, M. (2015). *Removal of ammonium ions from wastewater A short review in development of efficient methods*. Global Journal of Environmental Science Management. 1(2): 149-158.
- Haseena, P. V., Padmavathy K. S., Rohit, K. P., Madhu. G. (2016). *Adsorption of ammonium Nitrogen from Aqueous Systems Using Chitosan-Bentonite Film Composite*. Procedia Technology. 24, 733 – 740.
- Hassani, A., Vafaei, F., Karaca, S., *et al.* (2014). *Adsorption of a cationic dye from aqueous solution using Turkish lignite: kinetic, isotherm, thermodynamic studies and neural network modeling*. J Industr Eng Chem. 20(4):2615–2624.
- Jorgensen, T. C. & Weatherley, L. R. (2002). *Ammonia removal from wastewater by ion exchange in the presence of organic contaminants*. Christchurch: University of Catenbury.
- Katase, T., Hirotya, S., Naoi, M., Yamamoto, K., & Sumida, H. (1991). *A comparison of phenolic constituents in peat soils between subfrigid area, Japan and tropical areas of peninsular Malaysia and Thailand*. Malaysia, ISBN: 9679361276, pp. 57-65.
- Kemppainen, E. (1987). *Ammonia binding capacity of peat, straw, sawdust and cutter shavings*. Ann. Agric. Fenn. 26, 89-94.
- Kucic, D., Cosic, I., Vukovic, M., & Briski F. (2013). *Sorption Kinetic Studies of Ammonium from Aqueous Solution on Different Inorganic and Organic Media*. Croatia: University of Zagreb.
- Krisnawati. (2013). *Penjerapan Logam Cd, Fe dan Zn dengan Adsorben Cangkang Telur Bebek Yang Telah Diaktivasi*. Medan: USU.
- Kumar, D., Singh, B., Baudhdh, K., & Korstad, J. (2015). *Bio-oil and biodiesel as biofuels derived from microalgal oil and their characterization by using instrumental techniques*.
- Lea, F. M. (1956). *In the chemistry of cement and concrete*. ed. Lea and Desch, London: Edward Arnold Ltd.
- Li, C. Z. (2004). *Advances in the science of Victorian brown coal*. Amsterdam: Elsevier.
- Lin, L., *et al.* (2012). *Adsorption mechanisms of high-levels of ammonium onto natural and NaCl-modified Zeolites*. Separation and Purification Technology. 103: 15-20.
- Littlewood, T. (2014). *Bog and peat banks* [online]. Diakses dari <https://www.geograph.org.uk/photo/3957080>.

- Lucas, R. E. (1982). *Organic Soils (Histosols) Formation, distribution, physical and chemical properties and management for crop production*. Michigan State University, Research Report No. 435 (Farm Science).
- Malovanyy, A., Sakalova, H., Yatchyshyn, Y., *et al.* (2013). *Concentration of ammonium from municipal wastewater using ion exchange process*. *Desalination*. 329:93–102.
- Metcalf E. B., & Tchobanoglous, G. *Wastewater engineering: treatment disposal reuse*. New York (NY): Central Book Company. 1980
- Mizoch, L. (2007). *Ammonium* [online]. Diakses dari <https://commons.wikimedia.org/wiki/File:ammonium-2D.svg>
- Moazed, H. (2008). *Ammonium ion removal from wastewater by a natural resin*. *J. of Environmental Science and Technology*. 1(1):11-18.
- Mohan, D. & Chander S. (2006). *Removal and recovery of metal ions from acid mine drainage using lignite – a low cost sorbent*. *Journal of Hazard Material*. 137(3):1545–1553.
- Mussolini, K., Paul, J. W. & Kannangara, T. (1999). *Adsorption isotherms of ammonium on coir*. *Communications in Soil Science and Plant Analysis*, 30:1-2, 83-95.
- Mutalib, A., Lim, J. S., Wong, M. H. & Koonvai, L. (1991). *Characterization distribution and utilization of peat in Malaysia*. Proc. International Symposium on Tropical Peatland.6-10 May 1991, Kuching, Serawak, Malaysia.
- Naderi, M. (2015). *Surface Area: Brunauer-Emmett-Teller (BET)*. London: Elsevier.
- Nainggolan, G. D. (2010). *Pola Pelepasan Nitrogen dari Pupuk Tersedia Lambat (Slow Release Fertilizer) Urea - Zeolit - Asam Humat*. Departemen Ilmu Tanah dan Sumberdaya Lahan, Institut Pertanian Bogor : 89-96.
- Nasuha, N. & Hameed, B. H. (2010). *Adsorption of methylene blue from aqueous solution onto NaOH-modified rejected tea*. Malaysia: Universiti Sains Malaysia. *Chemical Engineering Journal* 166: 783–786.
- Nazari, M. A., *et al.* (2017). *Application of victorian brown coal for removal of ammonium and organics from wastewaters*. 39 (8): 1041-1051.
- Pavia, D., Lampman, G., Kriz, G., *et al.* (2008). *Introduction to spectroscopy*. Belmont: Cengage Learning.

- Peltola, I. (1986). *Use of peat as litter for milking cows. In Odour Prevention and Control of Organic Sludge and Livestock Farming*. Eds. V C Nielsen et al. pp 181-187. Elsevier Applied Science Publishers, London.
- Renou, S., Givaudan, J., Poulain, S., et al. (2008). *Landfill leachate treatment: review and opportunity*. *J Hazard Mater.* 150(3):468–493.
- Robalds, A., Dreijalte, L., Bikovens, O., & Klavins, M. (2016). *A novel peat-based biosorbent for the removal of phosphate from synthetic and real wastewater and possible utilization of spent sorbent in land application*. *Desalination and Water Treatment*, 57(28), 13285-13294.
- Rosyid, M., Nawangsih, E., & Dewita. (2012). *Perbaikan Surface Area Analyzer NOVA-1000 (Alat Penganalisis Luas Permukaan Serbuk)*. Prosiding Seminar Penelitian dan Pengelolaan Perangkat Nuklir (p. ISSN 1410-8178s).
- Sapek, B., & Sapek, A. (1987). *Int. Peat Journal* 2, 99. Sapek, B., Sapek, A., & Stawinski, J., “Proceedings, VIII International Peat Congress, Leningrad,” pp. 288 -294.
- Sapek, B., and Sapek, A. (1980). *Pol. J. Soil Sci.* 13, 125. Sapek, B., and Sapek, A. “Transactions, VIIIth International Symposium, Humus et Planta, Prague,” pp. 96-99.
- Schelkoph, G. M. & Hasset, D. J. (1983). *A comparative study of preparation and analytical methods for peat, Testing of Peat and Organic Soils*. ASTM STP 820, pp. 99-110.
- Shafirinia, R., et al. (2016). *Pengaruh Variasi Ukuran Adsorben dan Debit Aliran Terhadap Penurunan (Cr) dan Tembaga (Cu)*. 5(1), 1–9.
- Shaobin, W. & Yuelian, P. (2010). *Natural Zeolites as effective adsorbents in water and wastewater treatment*. *Chem Eng J* 156 : 11–24.
- Sillanpää, M., Ncibi, M. C., Matilainen, A., Vepsäläinen, M. (2018). *Removal of natural organic matter in drinking water treatment by coagulation: A comprehensive review*. *Chemosphere*. 190:54-71.
- Spedding, P. J. (1988). *Fuel*. 67, 883-900.
- Stevenson, F. J. (1994). *Humus Chemistry. Genesis, Composition, and Reactions*. John Wiley and Sons, Inc. New York. 443.
- Svehla, G. (1979). *Vogel's Textbook of Macro and semimicro qualitative inorganic analysis* (5th ed.). London: Longman Group. pp. 293–294. ISBN 0-582-44367-9.

- Swapp, S. (2017). *Scanning Electron Microscopy (SEM)* [online]. Diakses dari https://serc.carleton.edu/research_education/geochemsheets/techniques/SEM.html
- Tan. (1993). *Principles of Soil Chemistry*. Marcel Dekker, Inc. New York. pp 362.
- Tanasale, Matheis F. J. D. P, *et al.* (2014). *Aplikasi Kitosan Berderajat Destilasi Tinggi Sebagai Adsorbent Zat Warna Tartrazina*. Universitas Pattimura, Ambon.
- Tchobanoglous, G. & Schroeder, E. D. (1987). *Water Quality*. Addison-Wesley Publishing Co., Inc. Massachusetts, USA.
- Teh C. Y, Budiman P. M, Shak K. P. Y., & Wu, T. Y. (2016). *Recent advancement of coagulation-flocculation and its application in wastewater treatment*. Industrial and Engineering Chemistry Research. 55(16):4363-4389.
- Thermo Nicolet. (2001). *Introduction to Fourier Transform Infrared Spectrometry*. USA: Thermo Nicolet Corporation.
- The Editors of Encyclopedia Britannica. (2019). *Adsorption: Surface Phenomenon* [online]. Diakses dari <https://www.britannica.com/science/adsorption>.
- Ting, G. (2015). *An Overview of Peat Related Chemistry*. Kokkola: Centria University of Applied Science.
- Tjahjono. (2007). *Kajian Potensi Endapan Gambut Indonesia Berdasarkan Aspek Lingkungan*. Departemen Energi Sumber Daya Mineral (ESDM).
- Wahab, M. A., Jellali, S., & Jedidi, N. (2010). *Ammonium biosorption onto sawdust: FTIR analysis, kinetics and adsorption isotherms modeling*. Bioresource Technology, 101(14), 5070–5075.
- Wahyunto, & Heryanto, B. (2005). *Sebaran Gambut dan Status Terkini di Sumatera*. In. CCFPI. *Pemanfaatan Lahan Gambut Secara Bijaksana Untuk Manfaat Berkelanjutan*. Wetlands International-Indonesia Programe. Bogor.
- Wang, X., Lü, S., Gao, C., Xu, X., Zhang, X., Bai, X., Liu, M., Wu, L. (2014). *Highly Efficient Adsorption of Ammonium onto Palygorskite nanocomposite and Evaluation of its Recovery as a Multifunctional Slow-release Fertilizer*. Chemical Engineering Journal.
- Zheng, Y., & Wang, A. Q. (2010). *Preparation and ammonium adsorption properties of biotite-based hydrogel composites*, Ind. Eng. Chem. Res. 49 6034-6041.
- Yuliusman, Purwanto, W. W., dan Nughor, Y. S. (2013). *Pemilihan adsorben untuk penjerapan karbon monoksida menggunakan model adsorpsi isotermis Langmuir*. 14 (3): 225-2.

Zhang, D., Li, W., Huang, X., Qin, W., & Liu, M. (2013). *Removal of ammonium in surface water at low temperature by a newly isolated Microbacterium sp. strain SFA13*. *Bioresource Technology*, 137, 147–152