PENENTUAN KEBERKESANAN PENJERAP KOMPOSIT BAGI KAJIAN LARUT RESAPAN

IZAT BIN YAHAYA

Tesis ini dikemukakan sebagai
memenuhi syarat penganugerahan
Ijazah Doktor Falsafah

Fakulti Kejuruteraan Awam dan Alam Bina
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Untuk insan tersayang Ayahanda dan Bonda,
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ABSTRAK

Larut resapan merupakan bahan pencemar yang boleh mengancam persekitaran dan kesihatan manusia. Satu penjerap komposit baharu terdiri daripada enapcemar sisa kertas, kulit kerang, karbon teraktif, dan zeolit dibangunkan bagi meminimumkan penggunaan penjerap konvensional disamping menyelesaikan masaalah larut resapan stabil di Tapak Pelupusan Simpang Renggam (TPSR), Johor. Parameter sasaran merupakan ammonia nitrogen (NH_3-N) dan permintaan oksigen kimia COD. Kajian ini merupakan kajian gabungan penjerap alternatif dengan penjerap konvensional membentuk penjerap komposit. Ujikaji pencirian menunjukkan enapcemar sisa kertas dan karbon teraktif dikategorikan sebagai hidrofobik manakala kulit kerang dan zeolit pula adalah hidrofilik. Nisbah campuran penjerap komposit baharu dengan simen Portland adalah (30:70). Nilai pH bagi penjerap komposit baharu adalah pada pH 9.0 di mana analisis XRF menunjukkan kehadiran karbon dan silika oksida yang tinggi sebagai sebatian utama disamping kumpulan berfungsi terdiri daripada karboksil, karbonil dan hidroksil. Kesan kelajuan goncangan, saiz partikel, pH, masa goncangan dan dos penjerap optimum adalah 150 rpm, 1.18 mm, pH 7, 300 minit dan 50g. Model isoterma dan kinetik penjerapan menunjukkan kecenderungan terhadap model langmuir dan pseudo-tertib kedua. Kajian perbandingan isoterma dan kinetik penjerapan memperlihatkan keupayaan yang setanding bagi kesemua penjerap tersebut. Kajian penjerapan turus menunjukkan ianya lebih terarah kepada model Thomas dan Yoon-Nelson berbanding Adams-Bohart manakala kesan kadar alir berbeza adalah pada 1.0 mL/min. Kajian nyaherapan menunjukkan larutan NaCl 0.5 M pada pH 12 memberi keseimbangan tindak balas yang lebih cepat disamping perbandingan diantara penjerap komposit baharu dengan menjana semula menunjukkan peratus penyingkiran NH_3-N dan COD melebihi 80%. Keberkesanan penjerap komposit baharu ini di dorong oleh kehadiran komposisi karbon dan silika disamping mempunyai struktur mikroliang dan mesoliang yang tinggi serta berpotensi bagi rawatan larut resapan stabil di tapak pelupusan sampah.

ABSTRACT

Leachate is a pollutant that poses threats to the environment and human health. A new composite adsorbent made of waste paper sludge, shell, activated carbon, and zeolite was developed to reduce the use of conventional adsorbents while also addressing the issue of stable leachate at the Simpang Renggam Landfill (TPSR) in Johor. The target parameters are ammonia nitrogen (NH_3-N) and COD chemical oxygen demand. In this study, the alternative adsorbents and conventional adsorbents were combined to create composite adsorbents. Waste paper sludge and activated carbon were classified as hydrophobic by characterisation experiments, whereas shell and zeolite were hydrophilic. The ratio of new composite adsorbent mixture with the obtained Portland cement was (30:70). The pH value of new composite adsorbent is at pH 9.0 where XRF analysis shows the presence of high carbon and silica oxide as the main compounds in addition to the main functional groups consisting of carboxyl, carbonyl and hydroxyl. The effects of shaking speed, particle size, pH, contact time and adsorbent dosage at optimum conditions were 150 rpm, 1.18 mm, pH 7, 300 min and 50g respectively. The isotherm and kinetic adsorption models show a tendency towards langmuir and second-order pseudo model. A comparative isotherm and kinetic adsorption study showed a comparable ability for all the adsorbents. The column adsorption study showed that it was more oriented to the Thomas and Yoon-Nelson model than the Adams-Bohart while the effect of different flow rates showed at a flow rate of 1.0 mL/min. A desorption study showed the use of 0.5 M NaCl solution at pH 12 gave a faster equilibrium reaction in addition to the results of the comparison between new and regenerated composite adsorbent which showed the removal percentage of NH_3-N and COD was above 80%. The effectiveness of new composite adsorbent is driven by the presence of carbon and silica composition by having a high microporous and mesoporous structure which could potentially lead to treat stable leachate in landfill sites.

KANDUNGAN

SENARAI JADUAL

SENARAI RAJAH

SENARAI SINGKATAN

AC	-	*Activated Carbon*
APHA	-	*American Public Health Association*
ASTM	-	*American Society for Testing and Materials*
ATR	-	*Attenuated Total Reflection*
AWWA	-	*American Water Works Association*
BET	-	*Brunauer, Emmet, Teller*
BOD	-	Permintaan Oksigen Biokimia
BS	-	*British Standards*
CCD	-	*Charge-Coupled Device*
COD	-	Permintaan Oksigen Kimia
EBCT	-	*Empty Bed Contact Time*
ESK	-	Enapcemar Sisa Kertas
FA	-	Asid Fulvik
Fe	-	Ferum
FKAAB	-	Fakulti Kejuruteraan Awam dan Alam Bina
FTIR	-	Spektroskopi Inframerah Transformasi Fourier
GAC	-	*Granular Activated Carbon*
HA	-	Asid Humik
HCl	-	Asid Hidroklorik
JAS	-	Jabatan Alam Sekitar
KPK	-	Kapasiti Pertukaran Kation
KT	-	Karbon Teraktif
KK	-	Kulit Kerang
LOI	-	*Loss of Ignition*
MPRC	-	Pusat Penyelidikan Pencemar Mikro
MSW	-	*Municipal Solid Waste*

MTZ	-	*Mass Transfer Zone*
NaCl	-	Natrium Klorida
NaOH	-	Natrium Hidroksida
NH_3-N	-	Ammonia-Nitrogen
OPC	-	Simen Portland Biasa
PAC	-	*Powdered Activated Carbon*
Pt.Co	-	*Platinum Cobalt*
RBC	-	Penyentuh Biologi Berputar
RECESS	-	Pusat Penyelidikan Tanah Lembut
RPM	-	Pusingan Per Minit
SEM	-	Mikroskop Imbasan Elektron
SS	-	Pepejal Terampai
TPSR	-	Tapak Pelupusan Simpang Renggam
UTHM	-	Universiti Tun Hussein Onn Malaysia
VFA	-	Asid Lemak Meruap
WCAT	-	*Water Contact Angle Test*
WDPT	-	*Water Drop Penetration Test*
WEF	-	*Water Environment Federation*
XRF	-	Analisis Pendarkilau Sinar-X
ZEO	-	Zeolit

RUJUKAN

Abas, S. N. A., Ismail, M. H. S., Kamal, M. L. & Izhar, S. (2013). Adsorption process of heavy metals by low-cost adsorbent: A review. *World Applied Sciences Journal*, 28(11), 1518-1530.

Abbas, A., Al-Amer, A. M., Laoui, T., Al-Marri, M. J., Nasser, M. S., Khraisheh, M., & Atieh, M. A. (2016). Heavy metal removal from aqueous solution by advanced carbon nanotubes: critical review of adsorption applications. Separation and Purification Technology, 157, 141-161.

Abdullah, R., Ishak, C. F., Kadir, W. R. & Abu Bakar, R. (2015). Characterization and feasibility assessment of recycled paper mill sludges for land application in relation to the environment. International Journal of Environmental Research and Public Health, 12(8), pp. 9314 - 9329

Abu Amr, Aziz H. A,Adlan N. M (2013). Optimization of stabilized leachate treatment using ozone/persulfate in the advanced oxidation process. Waste Management. 1434-1441.

Abubakar Ndagia, Mohd Saleh Jaafar (2019). Geo-Polymer Binder as Portland Cement Alternative: Challenges, Current Developments and Future Prospects. Jurnal Kejuruteraan 31(2) 2019: 281-286. https://doi.org/10.17576/jkuk-2019-31(2)-12

Adeleke, A. O., Latiff, A. A. A., Gheethi, A. A. A. & Daud, Z. (2017). Optimization of operating parameters of novel composite adsorbent for organic pollutants removal from POME using response surface methodology. *Chemosphere*, 174(2017), 232-242.

Adhikari, B. dan Khanal, S. N. (2015). Qualitative study of landfill leachate from different ages of landfill sites of various countries including Nepal. *IOSR*

Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), 9(1), 23-36

Adon, R., Bakar, I., Wijeyasekera, D. C. & Zainorabidin, A. (2012). Overview of the sustainable uses of peat soil in Malaysia with some relevant geotechnical assessments. International Journal of Integrated Engineering-Special Issue on ICONCEES, 4(3), 38-4

Ahmad, A. A. & Hameed, B. H. (2010). Fixed-bed adsorption of reactive azo dye onto granular activated carbon prepared from waste. *Journal of Hazardous Materials*, 175(1-3), 298-303.

Ahmad R. I, Fauziah S. H, Sharifah M. & Kheng S.T. (2017). Removal of organic matter from stabilized landfill leachate using Coagulation-Flocculation-Fenton coupled with activated charcoal adsorption. Waste Management & Research: The Journal for a Sustainable Circular Economy. Volume 35, Issue 7.

Ahmadi, S. & Mostafapour, F. K. (2017). Tea waste as a low cost adsorbent for the removal of COD from landfill leachate: Kinetic Study. *Journal of Scientific and Engineering Research*, 4(6), 103-108.

Aksu, Z. & Gonen, F. (2004). Biosorption of phenol by immobilized activated sludge in a continuous packed bed: prediction of breakthrough curves. *Process Biochemistry*, 39(5), 599-613.

Alam, M. Z., Ameem, E. S., Muyibi, S. A. & Kabbashi, N. A. (2009). The factors affecting the performance of activated carbon prepared from oil palm empty fruit bunches for adsorption of fenol. *Chemical Engineering Journal*, 155(1-2), 191-198.

Ali, A. A. M. (2012). Low cost adsorbents for the removal of organic pollutants from wastewater. Journal of environmental management, 113, 170-183.

Alias, N. H. M., Halim, A. A. & Wahab, M .I. A. (2011). Penyingkiran boron daripada larutan berair menggunakan penjerap komposit berasaskan karbon-mineral. *Sains Malaysiana*, 40(11), 1271-1276.

American Public Health Association (APHA), American Water Works Association (AWWA), Water Environment Federation (WEF) (2012). Standard Methods for the Examination of Water and Wastewater. Edisi ke-21. Washington, DC.

Amir D., Zawawi D., Arif R., Halizah A. & Baharudin R. (2021). Review on COD and ammoniacal nitrogen removal from landfill leachate using low-cost adsorbent.

Journal of the Air & Waste Management AssociationVolume 72, 2022 - Issue 1. Pages 10-23

Anisuzzaman, S. M., Joseph, C. G., Yap, Y. H. T., Krishnaiah, D. & Tay, V. V. (2015). Modification of commercial activated carbon for the removal of 2,4-dichlorophenol from simulated wastewater. *Journal of King Saud University – Science*, 27(4), 318-330.

Aopreeya, M., Arunlertaree, C., Yuwaree, C., Boonprasert, R., & R, H. (2013). Blood Cockle Shell: an agro-waste for N and P Removal of Shrimp Farm Effluent. Environment and Natural Resources Journal, 11(1), 58-69.

Areeprasert, C., Zhao, P., Ma, D., Shen, Y. & Yoshikawa, K. (2014). Alternative solid fuel production from paper sludge employing hydrothermal treatment. *Energy Fuels, 28(2)*, pp. 1198 - 1206.

ASTM-D-3922-89 (1993) e1, Practice for Estimating the Operating Performance of Granular Activated Carbon for Removal of Soluble Pollutants from Water, ASTM International, West Conshohocken, PA.

ASTM D4607-14, Standard Test Method for Determination of Iodine Number of Activated Carbon, ASTM International, West Conshohocken, PA.

ASTM D2330-02, Standard Test Method for Methylene Blue Active Substances (Withdrawn 2011), ASTM International, West Conshohocken, PA.

ASTM D3663-03(2008), Standard Test Method for Surface Area of Catalysts and Catalyst Carriers, ASTM International, West Conshohocken, PA.

ASTM D6851-02(2011), Standard Test Method for Determination of Contact pH with Activated Carbon, ASTM International, West Conshohocken, PA.

Ataman, E., Andersson, M. P., Ceccato, M., Bovet, N. & Stipp, S. L. S. (2016). Functional group adsorption on calcite: ii. nitrogen and sulfur containing organic molecules. *The Journal of Physical Chemistry C*, 120(30), 16597-16607.

Aziz, H. A., Adlan, M. N., Zahari, M. S. M. & Alias, S. (2004). Removal of ammoniacal nitrogen (N-NH_3) from municipal solid waste leachate by using activated carbon and limestone. *Waste Management & Research*, 22(5), 371-375.

Aziz, H.A.., Yussof, M.S., Adlan, M.N., Adnan, N.H. Dan Alias, S. (2004a) Physico-Chemical Removal Of Iron From Semi Aerobic Landfill Leachate By Limestone Filter. Waste Management, Vol. 24, Issue 4, 2004, Pages 353-358.

Aziz, H. A., Hin, L. T., Adlan, M. N., Zahari, M. S., Alias, S., Ahmed, Foul, A. A. M. A., Selamat, M. R., Bashir, M. J. K., Yusoff, M. S. & Umar, M. (2011). Removal of high-strength colour from semi-aerobic stabilized landfill leachate via adsorption on limestone and activated carbon mixture. *Research Journal of Chemical Sciences*, 1(6), 1-7.

Aziz, H. A., Foul, A. A., Isa, M. H. & Hung, Y. T. (2010). Physico-chemical treatment of anaerobic landfill leachate using activated carbon and zeolite-batch and column studies. *International Journal of Environment and Waste Management*, 5(3/4), 269-285.

Azmi, N., Bashar, M. J. K., Sethupathi, S. & Ng, C. A. (2016). Anaerobic stabilized landfill leachate treatment using chemically activated sugarcane bagasse activated carbon: kinetic and equilibrium study. *Desalination and Water Treatment*, 57(9), 3916-3927.

Azouaou, N., Sadaoui, Z. & Mokaddem, H. (2014). Removal of lead from aqueous solution onto untreated coffee grounds: A fixed-bed column study. *Chemical Engineering Transactions*, 38, 151-156.

Babic, B., Kokunešoski, M., Gulicovski, J., Prekajski, M., Pantić, J., Mihajlović, A. R. & Matović, B. (2011). Synthesis and characterization of carbon cryogel/zeolite composites. *Processing and Application of Ceramics*, 5(2), 91-96.

Badmus, M. A. O. & Audu, T. O. K. (2009). Periwinkle shell: Based granular activated carbon for treatment of chemical oxygen demand (COD) in industrial wastewater. *The Canadian Journal of Chemical Engineering*, 87(1), 69-77.

Bandura, L., Franus, M., Józefaciuk, G., & Franus, W. (2015). Synthetic zeolites from fly ash as effective mineral sorbents for land-based petroleum spills cleanup. *Fuel*, 147, 100-107.

Baral, S. S., Das, N., Ramulu, T. S., Sahoo, S. K., Das, S. N. & Roy Chaudhury, G. (2009). Removal of Cr (VI) by thermally activated weed Salvinia cucullata in a fixed-bed column. *Journal of Hazardous Materials*, 161(2-3), 1427-1435.

Bartczak, P., Norman, M., Klapiszewski, L., Karwańska, N., Kawalec, M., Baczyńska, M., Wysokowski, M., Zdarta, J., Ciesielczyk, F. & Jesionowski, T. (2015). Removal of nickel (II) and lead (II) ions from aqueous solution using peat as a low-cost adsorbent: A kinetic and equilibrium study. *Arabian Journal of Chemistry*, 2015, 1-14.

Bashir, M. J., Aziz, H. A., S.S., A., S.A.P, S., C.A, N., & J.W., L. (2015). The competency of various applied strategies in treating tropical municipal landfill leachate. Desalination and Water Treatment, 54(9), 1-4.

Bashir, M. J. K., Aziz, H. A., Yusoff, M. S. & Aziz, S. Q. (2012). Color and chemical oxygen demand removal from mature semi-aerobic landfill leachate using anion-exchange resin: An equilibrium and kinetic study. *Environmental Engineering Science*, 29(5), 297-305.

Benltoufa, S., Fayala, F., Cheikhrouhou, M. & Ben Nasrallah, S. (2007). Porosity determination of jersey structure. *AUTEX Research Journal*, 7(1), 63-69.

Berge, N. D., Reinhart, D. R. & Townsend, T. G. (2005). The fate of nitrogen in bioreactor landfills. *Critical Reviews in Environmental Science and Technology*, 35(4), 365-399.

Bhat, I. U. H., Mungkar, A. N., Lee, K. E. & Khanam, Z. (2014). Oil palm root as biosorbent for heavy metals: biosorption, desorption and isothermal studies. *International Journal of ChemTech Research*, 6(1), 163-177.

Björklund, K. & Li, L. (2015). Evaluation of low-cost materials for asorption of hydrophobic organic pollutants in stormwater. Journal of Environmental Management, 159(2015), 106-114.

Boehm, H. P. (1994). Some aspects of the surface chemistry of carbon blacks and other carbons. *Carbon*, 32(5), 759-769.

Bohart, G. S. & Adams, E. Q. (1920). Some aspects of the behavior of charcoal with respect to chlorine. *Journal of the American Chemical Society*,42(3), 523-544.

Boopathy, R., Karthikeyan, S., Mandal, A. B. & Sekaran, G. (2013). Adsorption of ammonium ion by coconut shell-activated carbon from aqueous solution: kinetic, isotherm, and thermodynamic studies. *Environmental Science and Pollution Research International*, 20(1), 533-542.

Bove, D., Merello, S., Frumento, D., Al-Arni, S., Aliakbarian, B. & Converti, A. (2015). A critical review of biological processes and technologies for landfill leachate treatment. *Chemical Engineering & Technology*, 38(12), 2115-2126.

Božic´, D., Stankovic´, V., Gorgievski, M., & Bogdanovic´, G. (2009). Adsorption of heavy metal ions by sawdust of deciduous trees. Journal of hazardous materials,171(1-3), 684-692.

Bruker AXS. (2007). *S4 EXPLORER / S4 PIONEER X-ray Spectrometer*. Karlsruhe, GRMN.

BS-1881-122 (1983). Water absorption of concrete cylinders. British Standards Institution, London.

BS-1377-2 (1990). Determination of particle density. British Standards Institution, London.

Calace, N., Nardi, E., Petronio, B. M. & Pietroletti, M. (2002). Adsorption of phenols by papermill sludges. Environmental Pollution, 118(3), pp. 315 - 319.

Calero, M., Hernáinz, F., Blázquez, G., Tenorio, G. & Martín-Lara, M. A. (2009). Study of Cr (III) biosorption in a fixed-bed column. *Journal of Hazardous Materials*, 171(1-3), 886-893.

Castilla, C. M. (2004). Adsorption of organic molecules from aqueous solutions on carbon materials. *Carbon*, 42(1), 83-94.

Cazetta, A. L., Vargas, A. M., Nogami, E. M., Kunita, M. H., Guilherme, M. R., Martins, A. C., Silva, T. L., Moraes, J. G. & Almeida, V. C. (2011). NaOH-activated carbon of high surface area produced from coconut shell: Kinetics and equilibrium studies from the methylene blue adsorption. *Chemical Engineering Journal*, 174(1), 117-125.

Champagne, P. & Khalekuzzaman, M. (2014). A semi-passive peat biofilter system for the treatment of landfill leachate. *Journal of Water Sustainability*, 4(2), 63-76.

Champagne, P., & Li, C. (2009). Use of Sphagnum peat moss and crushed mollusk shells in fixed-bed columns for the treatment of synthetic landfill leachate. Journal of Material Cycles and Waste Management, 11(4), 339-347.

Chen, S., Yue, Q., Gao, B., Li, Q., Xu, X. & Fu, K. (2012). Adsorption of hexavalent chromium from aqueous solution by modified corn stalk: A fixed-bed column study. *Bioresource Technology*, 113(2012), 114-120.

Chowdhury, Z. Z., Hamid, S. B. A. & Zain, S. M. (2015). Evaluating design parameters for breakthrough curve analysis and kinetics of fixed bed columns for adsorption studies of Cu(II) cations using lignocellulosic wastes. *BioResources*, 10(1), 732-749.

Christensen, T. (2012). Sanitary Landfilling: Process, Technology and EnvironmentalImpact. In T. Christensen (Ed.), London: Academic Press Limited.

Christensen, T.H. Kjeldsen, P., Bjerg, P.L., Jensen, D.L, Christensen, J.B, Baun, Anders, Alberchtsen, Hans-Jorgen, Heron Dan Grom (2001) Biogeochemistry Of Landfill Leachates Plumes. Applied Geochemistry, 16,659-668.

Cooney, D. O. (1998). *Adsorption Design for Wastewater Treatment*. New York: CRC Press.

Chien, S. H. & Clayton, W. R. (1980). Application of Elovich equation to the kinetics of phosphate release and sorption on soils. *Soil Science Society of America Journal*, 44(2), 265-268.

Cyrus, J. S. & Reddy, G. B. (2011). Sorption and desorption of ammonium by zeolite: Batch and column studies. *Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering*, 46(4), 408-414.

Dabwan, A. H. A., Egusa, K., Imai, D., Katsumata, H., Suzuki, T. & Kaneco, S. (2012). Utilization of paper sludge wastes for treatment of wastewater from food processing industries. Pakistan Journal of Analytical & Environmental Chemistry, 13(2), pp. 103 - 106.

Daud, Z., Abubakar, M. H., Awang, H., Ahmed, Z.B., Rosli, M.A., Ridzuan, M.B., Aliyu, R. Ajarudin, H.A., (2019). Optimization of Batch Conditions for COD and Ammonia Nitrogen Removal Using cockle shells Through Response Surface Methodology. International Journal of Integrated Engineering, 10(9).

Daud, Z., Abubakar, M. H., Abdul Kadir, A., Latiff, A. A. A., Awang, H., Halim, A. A.A. & Marto, A. (2017b). Batch study on COD and ammonia nitrogen removal using granular activated carbon and cockle shells. *International Journal of Engineering, 30(7),* pp. 937 – 944.

Daud, Z., Abubakar, M. H., Kadir, A. A., Latiff, A. A. A., Awang, H., Halim, A. A. & Marto, A. (2017(a)). Adsorption studies of leachate on cockle shells. *International Journal of GEOMATE*, 12(29), 46-52.

Daud, Z., Abubakar, M. H., Kadir, A. A., Latiff, A. A. A., Awang, H., Halim, A. A. & Marto, A. (2017). Leachate treatment optimization with granular activated carbon and cockle shells. *IJE TRANSACTIONS A: Basics*, 30(7), 937-944.

Daud, Z., Ibrahim, F. N. D., Latiff, A. A. A., Ridzuan, M. B., Ahmad, Z., Awang, H. & Marton, A. (2016). Ammoniacal nitrogen and COD removal using zeolite feldspar mineral composite adsorbent. *International Journal of Integrated Engineering*, 8(3), 9-12.

Detho A. , Zawawi D., Abdulaziz I. A , Sattam F. A. , Abdul F. A. , Asif A. M. , Saleem R. S., Arif R. , Halizah A. , Baharudin R. , Mohamad A. K , Azhar A. H. (2022). Adsorption efficiency and isotherm of COD and NH3-N removal from stabilized leachate using natural low-cost adsorbent green mussel. Desalination and Water Treatment 245:191-201.

Detho A. , Z. Daud, M.A. Rosli, M.B. Ridzuan, H. Awang, M.A. Kamaruddin, H.A. Tajarudin, A.A. Halim (2021). COD and ammoniacal nitrogen reduction from stabilized landfill leachate using carbon mineral composite adsorbent, Desal. Water. Treat., 210 (2021) 143–151.

Deurer, M., Muller, K., Dijssel, C. V. D., Mason, K., Carter, J. & Clothier, B. E. (2011). Is soil water repellency a function of soil order and proneness to drought? A survey of soils under pasture in the North Island of New Zealand. *European Journal of Soil Science*, 62(6), 765-779.

Devi, P. & Saroha, A. K. (2014). Synthesis of the magnetic biochar composites for use as an adsorbent for the removal of pentachlorophenol from the effluent. *Bioresource Technology*, *169(2014)*, pp. 525 - 531.

Devi, P. & Saroha, A. K. (2015). Effect of pyrolysis temperature on polycyclic aromatic hydrocarbons toxicity and sorption behavior of biochars prepared by pyrolysis of paper mill effluent treatment sludge. *Bioresource Technology*, *192*, pp. 312 - 320.

Dias, J. M., Alvim-Ferraz, M. C. M., Almeida, M. F., Utrilla, J. R. & Polo, M. S. (2007). Waste materials for activated carbon preparation and its use in aqueous-phase treatment: A review. *Journal of Environmental Management*, 85(4), 833-846.

Dias, N. C., Steiner, P. A. & Braga, M. C. B. (2015). Characterization and modification of a clay mineral used in adsorption tests. *Journal of Minerals and Materials Characterization and Engineering*, 3(4), 277-288.

Diaz, L. F., Eggerth, L. L. & Savage, G. M. (2007). *Management of solid waste in developing countries*. Padova, Italy: CISA.

Dong, J.S. Kim, Y.J , Lee D. H., & Ham S. Yee. (2007). Characterization of dissolved organic matter in leachate discharged from final disposal sites which contained municipal solid waste incineration residues. 148(3):679-92.

Drioli, E., Criscuoli, A. & Curcio, E. (2011). *Membrane Contactors: Fundamentals, Applications and Potentialities*. Edisi ke-11. Elsevier Science.

Du, Q., Liu, S., Cao, Z. & Wang, Y. (2005). Ammonia removal from aqueous solution using natural Chinese clinoptilolite. *Separation and Purification Technology*, 44(3), 229-234.

Ekpete, O. A. & Horsfall, M. JNR. (2011). Preparation and characterization of activated carbon derived from fluted pumpkin stem waste (Telfairia occidentalis Hook F). *Research Journal of Chemical Sciences*, 1(3), 10-17.

Ekpete, O. A., Horsfall, M. JNR. & Tarawou, T. (2011). Evaluation of activated carbon from fluted pumpkin stem waste for fenol and chlorofenol adsorption in a fixed–bed micro-column. *Journal Applied Science and Environmental Management*, 15(1), 141-146.

Elaigwu, S. E., Rocher, V., Kyriakou, G., & Greenway, G. M. (2014). Removal of Pb2+ and Cd2+ from aqueous solution using chars from pyrolysis and microwave-assisted hydrothermal carbonization of Prosopis africana shell. Journal of Industrial and Engineering Chemistry, 20(5), 3467-3473.

Environmental Protection Agency (2000). Landfill manuals and Landfill site design (EPA) [Online] Capaian maklumat pada 14 Disember 2014 dari https://www.epa.ie/pubs/advice/waste/waste/EPA_landfill_site_design_guide.pdf

Frías, M., Rodríguez, O. & Sánchez de Rojas, M. I. (2004). Paper sludge, an environmentally sound alternative source of MK-based cementitious materials. A review. Construction and Building Materials, 74, pp. 37 – 48.

Fettig, J. (1999). Removal of humic substances by adsorption/ion exchange. *Water Science and Technology*, 40(9), 171-182.

Foo, K. Y. & Hameed, B. H. (2010). Insights into the modeling of adsorption isotherm systems. *Chemical Engineering Journal*, 156(1), 2-10.

Foo, K. Y., Lee, L. K. & Hameed, B. H. (2013). Batch adsorption of semi-aerobic landfill leachate by granular activated carbon prepared by microwave heating. *Chemical Engineering Journal*, 222(2013), 259-264.

Foul, A. A., Aziz, H. A., Isa, M. H. & Hung, Y. -T. (2009). Primary treatment of anaerobic landfill leachate using activated carbon and limestone: Batch and column studies. *International Journal of Environment and Waste Management*, 4(3/4), 282-298.

Freundlich, H. M. F. (1906). Over the adsorption in solution. *Journal of Physical Chemistry*, 57, 385-470.

Gandhimathi, N. D. J, P. V. N. & Ramesh T. S (2013). Use of Combined Coagulation-Adsorption Process as Pretreatment of Landfill Leachate. Iranian Journal of Environmental Health Science & Engineering 10(1):24.

Gao, J., Kong, D., Wang, Y., Wu, J., Sun, S. & Xu, P. (2013). Production of mesoporous activated carbon from tea fruit peel residues and its evaluation of methylene blue removal from aqueous solutions. *BioResources*, 8(2), 2145-2160.

García, R., Vigil de la Villa, R., Vegas, I., Frías, M. & Sánchez de Rojas, M. I. (2007). The pozzolanic properties of paper sludge waste. Construction and Building Materials, 22, pp. 1484 – 1490.

Gluth, J. G. G., Lehmann, C., Rübner, K. & Kühne, H. (2013). Reaction products and strength development of wastepaper sludge ash and the influence of alkalis. Cement & Concrete Composites, 45, pp. 82 – 88.

Gupta, V., Carrott, P., Singh, R., Chaudhary, M., & Kushwaha, S. (2016). Cellulose: A review as natural, modified and activated carbon adsorbent. Bioresource technology, 216, 1066-1076.

HACH (2012). DR/6000 Spectrophotometer User Manual HACH Company, USA.

Halim, A. A. (2008). *Olahan Larut resapan Semi-Aerobik Menggunakan Penjerap Komposit Berasaskan Bahan Mineral dan Organik.* Universiti Sains Malaysia: Tesis Ph.D.

Halim, A. A. & Ahmad, M. F. (2013). Isoterma dan kinetik penjerapan boron oleh batu kapur sebagai penjerap berkos rendah. *Sains Malaysiana*, 42(12), 1689-1696.

Halim, A. A. (2008). Olahan Larut resapan Semi-Aerobik Menggunakan Penjerap Komposit Berasaskan Bahan Mineral dan Organik. Universiti Sains Malaysia: Tesis Ph.D

Halim, A. A, Aziz, H. A., Megat Johari, M. A, Ariffin, K. S. & Hung, Y. T. (2009). Removal of ammoniacal nitrogen and COD from semi-aerobic landfill leachate using low-cost activated carbon-zeolite composite adsorbent. *International Journal of Environment and Waste Management*, 4(3/4), 399-411.

Halim, A. A, Aziz, H. A., Megat Johari, M. A. & Ariffin, K. S. (2010). Comparison study of ammonia and COD adsorption on zeolite, activated carbon and composite materials in landfill leachate treatment. *Desalination*, 262(1-3), 31-35.

Halim, A. A., Abidin, N. N. Z., Awang, N., Ithnin, A., Othman, M. S. & Wahab, M. I. (2011). Ammonia and COD removal from synthetic leachate using rice husk composite adsorbent. *Journal of Urban and Environmental Engineering*, 5(1), 24-31.

Halim, A. A, Aziz, H. A., Megat Johari, M. A, Ariffin, K. S. & Bashir, M. J. K. (2012). Semi-aerobic landfill leachate treatment using carbon-minerals composite adsorbent. *Environmental Engineering Science*, 29(5), 306-312.

Halim, A. A., Han, K. K. & Hanafiah, M. M. (2015). Removal of methylene blue from dye wastewater using river sand by adsorption. *Nature Environment and Pollution Technology*, 14(1), 89-94.

Halimoon, N. & Yin, R. G. S. (2010). Removal of heavy metals from textile wastewater using zeolite. *Environment Asia 3 (special issue)*, 124-130.

Hamdan, R., Arshad, N. A. N. M., & Ahmad, S. Z. N. (2018). The Effects of PO 4 3- Removal from Aqueous Solution with Varied Concentrations of Metal Oxides in Steel Slag Filter System. Journal of Physical Science, 29, 71-80.

Haseena, P. V., Padmavathy, K. S., Krishnan, P. R. & Madhu, G. (2016). Adsorption of Ammonium Nitrogen from Aqueous Systems Using Chitosan-Bentonite Film Composite. *Procedia Technology*, 24(2016), 733-740.

Hasfalina, C. B. M., Akinbile, C. O. & Jun, C. X. (2015). Coconut husk adsorbent for the removal of methylene blue dye from wastewater. *BioResources*, 10(2), 2859-2872.

Hilal, N. M., Emam, A. A., El-Bayaa, A. A., Badawy, N. A. & Zidan, A. E. (2013). Adsorption of barium and iron ions from aqueous solutions by the activated carbon produced from mazot ash. *Life Science Journal*, 10(4), 75-83.

Hofman, M. & Pietrzak, R. (2012). NO2 removal by adsorbents prepared from waste paper sludge. Chemical Engineering Journal, 183, pp. 278 - 283.

Ho, Y. S. (2006). Isotherms for the sorption of lead onto peat: comparison of linear and non-linear methods. *Polish Journal of Environmental Studies*. 15(1), 81-86.

Ho, Y. S. & McKay, G. (2002). Application of kinetic models to the sorption of copper(II) on to peat. *Adsorption Science and Technology*, 20(8), 797-815.

Ho, Y. S., Porter, F. & McKay, G. (2002). Equilibrium isotherm studies for the sorption of divalent metal ions onto peat: copper, nickel and lead single component systems. *Water, Air and Soil Pollution*, 141(1), 1-33.

Hojamberdiev, M., Kameshima, Y., Nakajima, A., Okada, K. & Kadirova, Z. (2008). Preparation and sorption properties of materials from paper sludge. Journal of Hazardous Materials, 151(2-3), pp. 710 - 719.

Huang, C. C., Li, H. S. & Chen, C. H. (2008). Effect of surface acidic oxides of activated carbon on adsorption of ammonia. *Journal of Hazardous Materials*, 159(2-3), 523-527.

Huang, D. J. & Leu, T. S. (2013). Fabrication of high wettability gradient on copper substrate. *Applied Surface Science*, 280(2013), 25-32.

Igwe, J. C. & Abia, A. A. (2007). Adsorption kinetics and intraparticulate diffusivities for bioremediation of Co (II), Fe (II) and Cu (II) ions from waste water using modified and unmodified maize cob. *International Journal of Physical Sciences*, 2(5), 119-127.

Itodo, A. U., Abdulrahman, F. W., Hassan, L. G., Maigandi, S. A. & Itodo, H. U. (2010). Application of methylene blue and iodine adsorption in the measurement of specific surface area by four acid and salt treated activated carbons. *New York Science Journal*, 3(5), 25-33.

Jabatan Alam Sekitar Malaysia (2010). [Online] Capaian maklumat pada 8 September 2019 dari http://www.doe.gov.my/eia/wp-content/uploads/2012/03/A-Guide-For- Investors1.pdf

JEOL: Scanning Electron Microscope (2002). *Instruction JEOL: Scanning Electron Microscope*. Tokyo, Japan.

Jha, V. K., Kameshima, Y., Nakajima, A., Okada, K. & Mackenzie, K. J. D. (2006). Multifunctional uptake behaviour of material prepared by calcining waste paper sludge. Journal of Environmental Science and Health, 41(4), pp. 703 - 719.

Jokela, J. P. Y., Kettunan, R. H., Sormunen, K. M. & Rintala, J. A. (2002). Biological nitrogen removal from municipal landfill leachate: low-cost nitrification in biofilters and laboratory scale in-situ denitrification. Water Research, 36(16), pp. 4079 - 4087.

Jördening, A. H.-J., & Winter, J. (Eds.). (2000). Environmental biotechnology. Science, 18.

Jorgensen, T. C. & Weatherley, L. R. (2003). Ammonia removal from wastewater by ion exchange in the presence of organic contaminants. *Water Research*, 37(8), 1723-1728.

Kalmykova, Y., Moona, N., Stromvall, A. M. & Bjorklund, K. (2014). Sorption and degradation of petroleum hydrocarbons, polycyclic aromatic hydrocarbons, alkylphenols, bisphenol A and phthalates in landfill leachate using sand, activated carbon and peat filters. *Water Research*, 1(56), 246-257.

Kamaruddin, M . A., Yusoff, M. S., Aziz, H. A. & Hung, Y-T. (2015). Sustainable treatment of landfill leachate. *Applied Water Science*, 5(2), 113-126.

Kamaruddin, M. A., Yusoff, M. S., Aziz, H. A. & Ismail, M. N. (2013). Preparation and characterization of composite embedded clinoptilolite for the removal of color and lead from textile waste water. *International Journal of Scientific Research in Inventions and New Ideas*, 1(2), 37-47.

Kanawade, S. M. (2016). Treatment on synthetic effluent by using limestone and granular activated carbon for removal of ammoniacal nitrogen. *International Journal of Advanced Research and Development*, 1(3), 55-63.

Karadag, D., Tok, S., Akgul, E., Turan, M., Ozturk, M. & Demir, A. (2008). Ammonium removal from sanitary landfill leachate using natural Gordes clinoptilolite. *Journal of Hazardous Materials*, 153(1-2), 60-66.

Keeren S. R., Daljit S. K., Ahmad I. A., (2020). Evaluating the leachate contamination impact of landfills and open dumpsites from developing countries using the proposed Leachate Pollution Index for Developing Countries (LPIDC). Environmental Nanotechnology, Monitoring & Management. Volume 14, 100372

Kaur, K, Mor, S. & Ravindra, K. (2016). Removal of chemical oxygen demand from landfill leachate using cow-dung ash as a low-cost adsorbent. *Journal of Colloid and Interface Sciene*, 469(1), 338-343.

Kerdsuwan, S., Laohalidanond, K., & Jangsawang, W. (2015). Sustainable Development and Eco-friendly Waste Disposal Technology for the Local Community. Energy Procedia, 79, 119-124.

Khamidun, M. H. & Fulazzaky, M. A. (2015). Adsorption of phosphate from synthetic solution onto the limestone in a plug-flow column. *International Journal of Advanced and Applied Sciences*, 2(12), 7-13.

Khanday, W. A., Marrakchi, F., Asif, M., & Hameed, B. H. (2017). Mesoporous zeolite–activated carbon composite from oil palm ash as an effective adsorbent for methylene blue. Journal of the Taiwan Institute of Chemical Engineers, 70,32-41.

Kibami, D., Pongener, C., Rao, K. S. & Sinha, D. (2014). Preparation and characterization of activated carbon from Fagopyrum esculentum Moench by HNO_3 and H_3PO_4 chemical activation. *Der Chemica Sinica*, 5(4), 46-55.

Kim, Y. K., Rajesh, K. P., & Yu, J. S. (2013). Zeolite materials prepared using silicate waste from template synthesis of ordered mesoporous carbon. Journal of hazardous materials, 260, 350-357.

Kim, Y. K., Kim D., Kang S.W., Ham Y. H., Choi J., Hong Y.P. and , Ryoo K.S. (2018). Use of Powdered Cockle Shell as a Bio-Sorbent Material for Phosphate Removal from Water. Bulletien of The Korean Chemical Society. Volume 39. Issue 13. Pages 1362-1367.

Kjeldsen, P., Barlaz, M. A., Rooker, A. P., Baun, A., Ledin, A. & Christensen, T. H. (2002). Present and long-term composition of MSW landfill leachate: A review, *Critical Reviews in Environmental Science and Technology*, 32(4), 297-336.

Kořenková, L. & Urik, M. (2015). Basic soil properties as a factor controlling the occurrence and intensity of water repellency in rankers of the White Carpathians. *Folia Forestalia Polonica, series A*, 57(3), 129-137.

Kulikowska, D. & Klimiuk, E. (2008). The effect of landfill age on municipal leachate composition. *Bioresource Technology*, 99(3), 5981-5985.

Kulkarni, S. J. (2013). Removal of organic matter from domestic waste water by adsorption. *International Journal of Science, Engineering and Technology Research (IJSETR)*, 2(10), 1836-1839.

Lakhera, S. K., Sree, H. A. & Suman, S. (2015). Synthesis and characterization of 13x zeolite/ activated carbon composite. *International Journal of ChemTech Research*, 7(3), 1364-1368.

Langmuir, I. (1918). The adsorption of gases on plane surface of glass, mica and platinum, *Journal of American Chemical Society*, 40(9), 1361-1403.

Lee, A. H., Nikraz, H. & Hung, Y. T. (2010). Influence of waste age on landfill leachate quality. International Journal of Environmental Science and Development, 1(4), pp. 347 - 350.

Lei, L., Xiaojuan, L. & Zhang, X. (2008). Ammonium removal from aqueous solutions using microwave-treated natural Chinese zeolite. *Separation and Purification Technology*, 58(3), 359-366.

.

Li, C., & Champagne, P. (2010). Fixed-bed column study for the removal of cadmium (II)and nickel (II) ions from aqueous solutions using peat and mollusk shells. Journal of Hazardous Materials, 171(1–3), 872-8.

Likon, M., Cernec, F., Svegl, F., Saarela, J. & Zimmie, T. F. (2011). Papermill industrial waste as a sustainable source for high efficiency absorbent production. Waste Management, 31(6), pp. 1350 - 1356.

Lim, C. K., Bay, H. H., Neoh, C. H., Aris, A., Majid, Z. A. & Ibrahim, Z. (2013). Application of zeolite-activated carbon macrocomposite for the adsorption of Acid Orange 7: isotherm, kinetic and thermodynamic studies. *Environmental Science and Pollution Research*, 20(10), 7243-7255.

Lim, C. K., Seow, T. W., Neoh, C. H., Nor, M. H. M., Ibrahim, Z., Ware, I. & Sarip, S. H. M. (2016). Treatment of landfill leachate using ASBR combined with zeolite adsorption technology. *3 Biotech*, 6(195), 1-6.

Limam, Z., Selmi, S., Sadok, S., & Abed, A. E. (2011). Extraction and characterization of chitin and chitosan from crustacean by-products: Biological and physicochemical properties. African journal of biotechnology, 10(4), 640-647.

Ling, F. N. L., Kassim, K. A., Karim, A. T. A., Tan, C. K. & Tiong, K. P. C. (2014). Geotechnical Properties of Malaysian Organic Soils: Case Study in Batu Pahat, Johor. *International Journal of Integrated Engineering*, 6(2), 52-59.

Lin, W., Tadai, O., Takahashi, M., Sato, D., Hirose, T., Tanikawa, W., Hamada, Y. & Hatakeda, K. (2015). An experimental study on measurement methods of bulk density and porosity of rock samples. *Journal of Geoscience and Environment Protection*, 3(2015), 72-79.

Liu, Q. -S., Zheng, T., Wang, P., Jiang, J. -P. & Li, N. (2010). *Adsorption isotherm, kinetic and mechanism studies of some substituted phenols on activated carbon fibers. Chemical Engineering Journal*, 157(2-3), 348-356.

Lorenzen. L, J.S.Jvan Deventer and W.MLandi (1995). Factors affecting the mechanism of the adsorption of arsenic species on activated carbon. Mineral Engineering. Volume 8, Issues 4–5, April–May 1995, Pages 557-569.

Manocha, S. M. (2003). Porous carbons. *Sadhana*, 28(1-2), 335-348.

Marsh, H. & Rodriguez-Reinoso, F. (2006). *Activated Carbon*. Amsterdam: Elsevier Science & Technology Books.

Martins T. H., Souza T.S.O and Foresti E. (2017). Ammonium removal from landfill leachate by Clinoptilolite adsorption followed by bioregeneration. Journal Of

Enviromental Chemical Engineering. Volume 5, Issue 1, February 2017, Pages 63-6

Mashal, A., Dahrieh, J. A., Ahmad, A. A., Oyedele, L, Haimour, N., Ali, A. A. H. & Rooney, D. (2014). Fixed-bed study of ammonia removal from aqueous solutions using natural zeolite. *World Journal of Science, Technology and Sustainable Development*, 11(2), 144-158.

Masomi, M., Ghoreyshi, A. A., Najafpour, G. D., & Mohamed, A. R. B. (2014).Adsorption of phenolic compounds onto the activated carbon synthesized from pulp and paper mill sludge: equilibrium isotherm, kinetics, thermodynamics and mechanism studies. Int J Eng Trans A Basics, 27, 10-1485.

Metcalf & Eddy, INC. (2003). *Wastewater Engineering: Treatment and Reuse* (McGraw Hill series in civil and environmental engineering). Edisi Keempat. New York: McGraw-Hill.

Meyer M. L and Bloom P. R (1997). Boric and Silicic Acid Adsorption and Desorption by a Humic Acid. Journal of Enviromental Quality. Volume 26. Issue 1. Pages 63-69.

Mihelcic, R. J. & Zimmerman, B. J. (2014). *Environmental Engineering: Fundamentals, Sustainability, Design*. Edisi Kedua. Wiley.

Mahmoud H. A. B. (2019), Removal of COD and NH_3 using combined adsorbent of GAC, Zeolite, Feldspar and Cockle Shells Thesis.

Mohamad A.K, Suffian .Y, Lo M. R., Awatif M. I., (2017). An overview of municipal solid waste management and landfill leachate treatment: Malaysia and Asian perspectives. Environmental Science and Pollution Research volume 24, pages 26988–27020 (2017).

Mohamed, R. M. S. R., Chan, C. M., Senin, H. & Kassim, A. H. M. (2014). Feasibility of the direct filtration over peat filter media for bathroom greywater treatment. *Journal of Materials and Environmental Science*, 5(6), 2021-2029.

Mohammadizaroun, M. & Yusoff & M. S. (2014). Review on landfill leachate treatment using physical-chemical techniques: their performance and limitations. *International Journal of Current Life Sciences*, 4(12), 12068-12074.

Moideen S. N. F, M. F. D, Ponraj M., Badaruddin Y. & Ismail Z. (2015). Wasted cockle shell (Anadara granosa) as a natural adsorbent for treating polluted river water in the fabricated column model (FCM). 16395-16403.

Mojiri, A., Aziz, H. A., Zaman, N. Q., Aziz, S. Q. & Zahed, M. A. (2014). Powdered ZELIAC augmented sequencing batch reactors (SBR) process for co-treatment of landfill leachate and domestic wastewater. *Journal of Environmental Management*, 139, 1-14.

Mojiri, A., Aziz, H. A., Zaman, N. Q., Aziz, S. Q. & Zahed, M. A. (2016). Metals removal from municipal landfill leachate and wastewater using adsorbents combined with biological method. *Desalination and Water Treatment*, 57(6), 2819-2833.

Monsalvo, V. M., Mohedano, A. F., & Rodriguez, J. J. (2012). Adsorption of 4-chlorophenol by inexpensive sewage sludge-based adsorbents. Chemical Engineering Research and Design, 90(11), 1807-1814.

Montalvo, S., Guerrero, L., Borja, R., Sánchez, E., Milán, Z., Cortés, I. & Delala Rubia, M. A. (2012). Application of natural zeolites in anaerobic digestion processes: A review. *Applied Clay Science*, 58(2012), 125-133.

Motling, S, Mukherjee, S. N. & Dutta, A. (2014). Removal of phenolic compound and cod from landfill leach ate by commercial activated carbon. International *Journal of Engineering Research & Technology*, 3(2), 2880-2888.

N.A.A. Rahman, M.I.M. Said, S. Azman, Carbonized green mussel shell as heavy metal removal, Malays. J. Civ. Eng., 29 (2017) 56–68.

Na, Q., Xiangyang, S., Xinhui, Q. & Zhou, Y. (2016). Effects of peat and mushroom residues on removing ammonia-nitrogen and total phosphorus in wastewater. *Nature Environment and Pollution Technology*, 15(4), 1373-1380.

Nor Nazrieza, M. S., Siti Rohana, M. Y., Subramaniam, K., Hazilia, H. & Amir Herberd, A. (2015). Characterization of leachate from Panchang Bedena landfill, Batang Padang landfill and Matang landfill: A comparative study. *Malaysian Journal of Science*, 34 (1), 69-77.

Nguyen, P. T., Nguyen, T. A., Bhandari, B. & Prakash, S. (2016). Comparison of solid substrates to differentiate the lubrication property of dairy fluids by tribological measurement. *Journal of Food Engineering*, 185, 1-8.

Nurazim, I., Hanidi, A. A. & Mohd, S. Y. (2017). Adsorption of UV254 in Kerian River water onto Zeliac^{TM}: Analysis using linear and non-linear forms of isotherm models. *Global NEST Journal*, 19(1), 74-81.

Oboh, I. O., Aluyor, E. O. & Audu, T. O. K. (2013). Second-order kinetic model for the adsorption of divalent metal ions on Sida acuta leaves. *International Journal of Physical Sciences*, 8(34), 1722-1728.

Okada, K., Ono, Y., Kameshima, Y., Nakajima, A. & MacKenzie, K. J. D. (2007). Simultaneous uptake of ammonium and phospate ions by compounds prepared from paper sludge ash. Journal of Hazardous Materials, 141(3), pp. 622 - 629.

Olorunfemi, I. E., Ogunrinde, T. A. & Fasinmirin, J. T. (2014). Soil hydrophobicity: an overview. *Journal of Scientific Research & Reports*, 3(8), 1003-1037.

Öman, C. B. & Junestedt, C. (2008). Chemical characterization of landfill leachates – 400 parameters and compounds. *Waste Management*, 28(10), 1876-1891.

Orge, Faria, Pereira (2017). Photocatalytic ozonation of aniline with TiO2-carbon composite materials. Journal of Environmental Management. Volume 195, Part 2, 15 June 2017, Pages 208-215

Othman, E., Yusoff, M. S., Aziz, H. A., Adlan, M. N., Bashir, M. J. K. & Hung, Y. - T. (2010). The effectiveness of silica sand in semi-aerobic stabilized landfill leachate treatment. *Water*, 2(4), 904-915.

Park, S-. J. & Kim, B-. J. (2005). Ammonia removal of activated carbon fibers produced by oxyfluorination. *Journal of Colloid and Interface Science*, 291(2), 597-599.

Perkin Elmer SCIEX. (2005). *ELAN 9000 ICP-MS.* Shelton, CT.

Perkin Elmer (2005). *Spectrum 100 Series User's Guide*. UK.

Pizarro, C., Rubio, M. A., Escudey, M., Albornoz, M. F., Munoz, D., Denardin, J. & Fabris, J. D. (2015). Nanomagnetite-zeolite composites in the removal arsenate from aqueous systems. *Journal of the Brazilian Chemical Society*, 26(9), 1887-1896.

Qiu, H., Lu, L., Pan, B-. C., Zhang, Q-. J., Zhang, W-. M. & Zhang, Q-. X. (2009). Critical review in adsorption kinetic models. *Journal of Zheijiang University SCIENCE A*, 10(5), 716-724.

Raghab, S. M., El-Meguid, A. M. A. & Hegazi, H. A. (2013). Treatment of leachate from municipal solid waste landfill. *HBRC Journal*, 9(2), 187-192.

Rahmani, A. R., Samadi, M. T. & Ehsani, H. R. (2009). Investigation of clinoptilolite natural zeolite regeneration by air stripping followed by ion exchange for removal of ammonium from aqueous solutions. *Iranian Journal Of Environmental Health Science & Engineering*, 6(3), 167-172.

Rangel-Mendez, J. R., Barrios, V. A. E., & Davila-Rodriguez, J. L. (2010). Chitin based biocomposites for removal of contaminants from water: A case study of fluoride adsorption. In Biopolymers. InTech.

Rodriguez, J., Castrillon, L., Maranon, E., Sastre, H. & Fernandez, E. (2004). Removal of non-biodegradable organic matter from landfill leachate by adsorption. *Water Research*, 38(14-15), 3297-3303.

Rosli M. A. (2017), Potensi Tanah Gambut, Batu Kapur, Zeolit dan Karbbon Teraktif sebagai Penjerap Komposit Untuk Merawat Larut resapan Thesis.

Rout, P. R., Dash, R. R. & Bhunia, P. (2014). Modelling and packed bed column studies on adsorptive removal of phosphate from aqueous solutions by a mixture of ground burnt patties and red soil. *Advances in Environmental Research*, 3(3), 231-251.

Sadegh, H., Yari, M., Ghoshekandi, R. S., Ebrahimiasl, S., Maazinejad, B., Jalili, M. & Chahardori, M. (2014). Dioxins: a review of its environmental risk. *Pyrex Journal of Research in Environmental Studies*, 1(1), 1-7.

Sartaj. M and Fernandes L. (2015). Adsorption of boron from landfill leachate by peat and the effect of environmental factors. Journal of Environmental Engineering and Science. Volume 4. Issue 1. ISSN 1496-2551.

Sartaj.M, Ahmadifar. M., Ayub K.J. (2010) . Assessment of in-situ aerobic treatment of municipal landfill leachate at laboratory scale. Iranian Journal of Science and Technology Transaction B: Engineering 34(1):107-116

Sayed, Y. E. & Bandosz, T. J. (2004). Adsorption of valeric acid from aqueous solution onto activated carbons: role of surface basic sites. *Journal of Colloid and Interface Science*, 273(1), 64-72.

Saviour A. U. (2012). Coconut coir dust as a low cost adsorbent for the removal of cationic dye from aqueous solution. Journal of Saudi Chemical Society 77(S1).

Seco. A, Carmen. G, Marzal. P and Antonio A. (1999). Effect of pH, cation concentration and sorbent concentration on cadmium and copper removal by a granular activated carbon. Chemical Technology and Biotechnology. https://doi.org/10.1002/(SICI)1097-4660(199909)74:9<911.

Şchiopu, A. M. & Ghinea, C. (2013). Municipal solid waste management and treatment of effluents resulting from their landfilling. *Environmental Engineering and Management Journal*, 12(8), 1699-1719.

Segui, P., Aubert, J. E., Husson, B. & Measson, M. (2012). Characterization of wastepaper sludge ash for its valorization as a component of hydraulic binders. Applied Clay Science, 57, pp. 79 – 85.

Shahril Effendi A. Rahman (2019). Rawatan Larut resapan Menggunakan Penjerap Media Komposit Karbon Teraktif, Zeolit, Batu Kapur Dan Enapcemar Sisa Kertas Thesis.

Sharifah & Latifah (2013). The challenge of future landfill: A case study of Malaysia. Journal of Toxicology and Environmental Health Sciences. Vol. 5(6), pp. 86-96.

Schroeder J. P, Croot P. L D.V. B & Hanel R. (2011). Potential and limitations of ozone for the removal of ammonia, nitrite, and yellow substances in marine recirculating aquaculture systems. Volume 45. 35-41

Shukla, P. R., Wang, S., Ang, H. M. & Tade, M. O. (2009). Synthesis, characterisation, and adsorption evaluation of carbon-natural-zeolite composites. *Advanced Powder Technology*, 20(3), 245-250.

Singh, S., Srivastava, V. C. & Mall, I. D. (2009). Fixed-bed study for adsorptive removal of furfural by activated carbon. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 332(1), 50-56.

Siswoyo, E. & Tanaka, S. (2013). Development of eco-adsorbent based on solid waste of paper industry to adsorb cadmium ion in water. Journal of Clean Energy Technologies, 1(3), pp. 198 - 201.

Sivakumar, D. (2013). Adsorption study on municipal solid waste leachate using Moringa oleifera seed. *Journal of Environmental Science and Technology*, 10(1), 113-124.

Sothern Waste Management Sdn.Bhd. (2005), Clean Enviromental for Healthy Living The Better, Waste Management Company

Steenhuis, T. S., Rivera, J. C., Hernández, C. J. M., Walter, M. T., Bryant, R. B. & Nektarios, P. (2001). Water repellency in New York State soils. *International Turfgrass Society Research Journal*, 9, 624-628.

Stoeckli, F. & Cleary, D. H. (2001). On the mechanisms of phenol adsorption by carbons. *Russian Chemical Bulletin*, 50(11), 2060-2063.

Suliman, W., Harsh, J. B., Lail, N. I. A., Fortuna, A. M., Dallmeyer, I. & Perez, M. G. (2016). Influence of feedstock source and pyrolysis temperature on biochar bulk and surface properties. *Biomass and Bioenergy*, 84(2016), 37-48.

Sumrit M., Phansiri M., Wanwimon P. , Sataporn K. (2015). Characterization and Properties of Activated Carbon Prepared from Tamarind Seeds by KOH Activation for Fe(III) Adsorption from Aqueous Solution. ScientificWorld Journal. 2015; 10.1155/2015/415961.

Suzuki, M. (1990). *Adsorption Engineering.* Kodansha-Tokyo: Elsevier Science.

Świątek, M. Z. & Malińska, K. (2010). Removal of ammonia by clinoptilolite. *Global NEST Journal*, 12(3), 256-261.

Syafalni, S., Abustan, I., Dahlan, I., Wah, C. K. & Umar, G. (2012). Treatment of dye wastewater using granular activated carbon and zeolite filter. *Modern Applied Science*, 6(2), 37-51.

Tchobanoglous, G., Theisen, H. Dan Vigil, S.A. (1993) Integrated Solid Waste Management. Engineering Principles and Management Issues. International Edition New York: Mcgraw Hill Inc.

Temel, F. A. & Kuleyin, A. (2016). Ammonium removal from landfill leachate using natural zeolite: kinetic, equilibrium, and thermodynamic studies. *Desalination and Water Treatment*, 57(50), 23873-23892.

Thomas, G. W. (1982). *Exchangeable cations*. In A.L. Page (ed.). Methods of soil analysis, Part 2, Second Edition, Agronomy Monograph 9, American Society of Agronomy, Madison, WI.

Thomas, H. C. (1944). Heterogeneous Ion Exchange in a Flowing System. *Journal of the American Chemical Society*, 66(10), 1664-1666.

Thomas, J. M. dan Thomas, W. J. (1997). *Principle and Practice of Heterogeneous Catalysis.* Weinheim: VCH.

Torres, A. L., Correa, E. M. C., González, C. F., Franco, M. F. A. & Serrano, V. G. (2012). On the use of a natural peat for the removal of Cr(VI) from aqueous solutions. *Journal of Colloid and Interface Science*, 386(1), 325-332.

Toretta, V., Ferronato, N., Katsoyiannis, I. A., Tolkou, A. K. & Airoldi, M. (2016). Novel and conventional technologies for landfill leachates treatment: a review. *Sustainablity*, 9(9), 1-39.

Tyrell, S.F.Leeds-Harrison, P.B. Dan Harrison, K.S. (2002) Removal Of Ammonical Nitrogen From Landfill Leachate By Rogation Into Vegetated Treatment Plant. Water Research. Vol.36, 291-299

USACE (U.S. Army Corps of Engineers), (2011). Adsorption Design Guide, Engineering And Design. [Online] Department Of The Army DG 1110-1-2. Capaian maklumat pada 18 Mei 2019 dari http: //www.publications.usace.army.mil/USACEPublications/EngineerDesign Guides.aspx

Valsaraj, K. T. & Melvin, E. M. (2009). *Elements of Environmental Engineering: Thermodynamics and Kinetics*. Edisi Ketiga, New York: CRC Press.

Villafranco, E. Z., Quintal, I. D. B., Salazar, S. G., Quintal, M. B., Correa, H. E. S. & Rodríguez, J. M. S. (2014). Adsorption kinetics of matter contained in a leachate using eggshell and activated carbon. *Journal of Environmental Protection*, 5(7), 608-619.

Wang, S., Zhu, Z. H., Coomes, A., Haghseresht, F. & Lu, G. Q. (2005). The physical and surface chemistry characteristic of activated carbon and the adsorption of methylene blue from wastewater. *Journal of Colloid and Interface Science*, 284(2), 440-446.

Wajima, T. & Rakovan, J. F. (2013). Removal behavior of phosphate from aqueous solution by calcined paper sludge. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 435, pp. 132 - 138.

Weber, W. J. & Morris, J. C. (1963). Kinetics of adsorption on carbon from solution. *Journal of the Sanitary Engineering Division, American Society of Civil Engineering*, 89(1), 31-60.

Widiastuti, N., Wu, H., Ang, M. & Zhang, D. (2011). Removal of ammonium from greywater using natural zeolite. *Desalination*, 277(1-3), 15-23.

Winarna, Murtilaksono, K., Sabiham, S., Sutandi, A & Sutarta, E. S. (2016). Hydrophobicity of Tropical Peat Soil from an Oil Palm Plantation in North Sumatra, *Journal of Agronomy*, 15(3), 114-121.

Worch, E. (2012). *Adsorption Technology in Water Treatment: Fundamentals, Processes, and Modeling*. Berlin/Boston: Walter de Gruyter GmbH and Co. KG.

Worrell, W. A. & Vesilind, P. A. (2012). *Solid Waste Engineering*. Edisi Kedua. Cengage Learning, Stamford.

Yao, P. (2017). Perspectives on technology for landfill leachate treatment. *Arabian Journal of Chemistry*, 10(2), 2567-2574.

Yao, Z., Xia, M., Li, H., Chen, T., Ye, Y., & Zheng, H. (2014). Bivalve shell: not an abundant useless waste but a functional and versatile biomaterial. Critical Reviews in Environmental Science and Technology, 44(22), 2502-2530.

Yoon, Y. H. & Nelson, J. H. (1984). Application of gas adsorption kinetics: Part 1, A theoretical model for respirator cartridge service time. *American Industrial Hygiene Association Journal*, 45(8), 509-516.

Yu, R., Hu, X., Ding, Z., & Zhang, Y. (2016). Biosorption of lead (ii) from aqueous solutions using adsorbents prepared from peanut hulls, soybean shells and grape fruit peels. Environmental Engineering & Management Journal (EEMJ), 15(11).

Yuan, Y. & Lee, T. R. (2013). *Contact Angle and Wetting Properties*. Springer Series in Surface Sciences.

Zakaria, N. F., Majid, Z. A., Ramli, Z., Jaafar, J., Aris, A., Talib, J. & Ali, R. (2016). Adsorbent from waste and natural deposits for paraquat removal in water. *Malaysian Journal of Analytical Sciences*, 20(3), 469-476.

Zawawi Daud, Hamidi Abdul Azizi Dan Mohd. Nordin Adlan, (2007a) Appropriate Combination Of Physical-Chemical Treatment (Coagulation-Flocculation And Filtration) For The Efficient Treatment Of Semi-Aerobic Leachate, Proceeding Of International Conference On Natural Resources And Enviromental Management. Kuching Sarawak, Malaysia, 22-29 Nov. 2007

Zehra, T, Lim, L. B. L. & Priyantha, N. (2015). Removal behavior of peat collected from Brunei Darussalam for Pb(II) ions from aqueous solution: equilibrium isotherm, thermodynamics, kinetics and regeneration studies. *Environmental Earth Sciences*, 74(3), 2541-2551.

Zendelska, A., Golomeova, M., Blazev, K., Krstev, B., Golomeov, B. & Krstev, A. (2014). Kinetic studies of zinc ions removal from aqueous solution by adsorption on natural zeolite. *International Journal of Science Environment*, 3(4), 1303-1318.

Zin, N. S. M., Aziz, H. A., Adlan, M. N., Ariffin, A., Yusoff, M. S. & Dahlan, I. (2014). Treatability study of partially stabilized leachate by composite coagulant (prehydrolyzed iron and tapioca flour). *International Journal of Scientific Research in Knowledge*, 2(7), 313-319.

Zuo, Y., Zhan, J., & Costa, N. (2001, February). Use of shell chitin extracted from seafood processing waste in recycling of industrial wastewater. In Environmentally Conscious Manufacturing (Vol. 4193, pp. 403-413). International Society for Optics and Photonics

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