SYNTHESIS OF GRAPHENE SAND COMPOSITE BY USING *ARENGA* PALM AND TABLE SUGAR TO REMOVE METHYLENE BLUE AND NICKEL FROM AQUEOUS SOLUTION

NORUL WAHIDA BINTI KAMARUZAMAN

DOCTOR OF PHILOSOPHY

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy in Environmental Technology.

_____

(Supervisor's Signature)

Full Name : PROF. DATO' DR. ZULARISAM AB WAHID

Position : PROFESSOR

Date : MARCH 2019

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

_____

(Student's Signature)

Full Name : NORUL WAHIDA BINTI KAMARUZAMAN

ID Number : PKE 15005

Date : MARCH 2019

SYNTHESIS OF GRAPHENE SAND COMPOSITE BY USING *ARENGA* PALM AND TABLE SUGAR TO REMOVE METHYLENE BLUE AND NICKEL FROM AQUEOUS SOLUTION

NORUL WAHIDA BINTI KAMARUZAMAN

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Doctor of Philosophy

Faculty of Engineering Technology
UNIVERSITI MALAYSIA PAHANG

MARCH 2019

ACKNOWLEDGEMENTS

Alhamdulillah, I am grateful to Allah and would like to express my sincere gratitude to my supervisor Prof. Dato' Dr. Zularisam bin Ab Wahid for his germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. They have always impressed me with their outstanding professional conduct, their strong conviction for engineering, and their belief that a master program is only a start of a life-long learning experience. I appreciate their consistent support from the first day I applied to graduate program to these concluding moments. My sincere thanks go to all the UMP's Faculty of Engineering Technology lecturers especially to Associate Professor Ir. Adnan bin Zulkiple, all faculties' and laboratories' staff of Faculty of Engineering Technology, Centre of Graduate School, Bursary Department, and those who help me in many ways and make my stay at UMP unforgettable. I am gratefully acknowledged for the financial support by Ministry of Higher Education of Malaysia, (MyBrain15 Program) and Universiti Malaysia Pahang (SPB).

I am also thankful to all my friends who always give me strength, share knowledge and new information especially to Siti Norsita binti Mohd Rawi, Sharifah binti Awang, Nurmunira binti Muhammad@Atan, Nurazzimah binti Zamri, Mazlan bin Abu Seman, Mohd Nasrullah bin Zulkifli, Norbaizurah binti Rahman and Siti Aishah Puteri binti Ab Kadir. Last but not least, these special thanks goes to my parents; Kamaruzaman bin Nong and Nor Hasimah binti Dollah and my parents in-law; Ahmad Fauzi bin Hj. Ab. Rahman and Zubedah binti Mat Nor, my siblings; Azwa Hanim, Dhaiful Ikram, and Muhammad Zarrul Hakimi, not to forget my husband, Ahmad Alfian bin Ahmad Fauzi for their love, dream and sacrifice throughout my life. They consistently encouraged me to carry on my higher studies to pursue my dream. They are always giving me support and motivation to get through this tough journey; and to the most important person in my life, my baby; Aliff Nafizi bin Ahmad Alfian, thank you for being a very well-behaved boy all this while.

ABSTRAK

Pencemaran sumber air telah meningkat di beberapa kawasan di dunia disebabkan oleh pertumbuhan industri dan pelepasan efluen yang tidak dirawat, peningkatan gaya hidup urban dan tenaga intensif, kekurangan perlindungan hutan dan kesedaran alam sekitar, dan kelemahan pelaksanaan dan penguatkuasaan peraturan alam sekitar. Objektif tesis ini adalah untuk mensintesis komposit grafin dengan menggunakan gula kabung dan gula biasa sebagai sumber karbon untuk menyerap metilena biru dan nikel dari larutan akueus. Gula kabung dipilih sebagai sumber karbon kerana persamaan sifat dengan gula biasa dan tiada kajian mendalam dibuat ke atas bahan tersebut setakat ini. Proses sintesis dilakukan dengan merawat pasir melalui ayakan. Larutan gula disediakan dan dipanaskan sehingga 95 ^{o}C selama 2 jam dengan pengacauan berterusan bersama-sama dengan pasir sebelum dipanaskan di dalam relau dengan persekitaran nitrogen bagi menghasilkan 'graphene sand composite', GSC_{aps} dan GSC_{ts}. Komposit kemudiannya diaktifkan dengan menggunakan asid sulfurik pekat untuk memaksimumkan kapasiti penyerapan. Analisis karakter GSC_{aps} dan GSC_{ts} dilakukan melalui mikroskop pengimbasan pelepasan elektron (FESEM), x-ray unsur serakan (EDX), pemetaan unsur (EM) dan spektroskopi raman. Analisis pengimbasan pelepasan elektron (FESEM) menunjukkan proses salutan gula dilakukan secara seragam dengan lapisan di luar permukaan pasir. Unsur-unsur yang terbesar dalam komposit pasir grafin adalah karbon, oksigen dan silika. Terdapat juga puncak pembelauan terletak pada 26.66 ° dan 26.80 ° yang menunjukkan pembentukan hablur di permukaan GSC_{aps} dan GSC_{ts} yang yang memberi kesan kilauan kepada komposit melalui refleksi cahaya. Ujian spektroskopi raman mengesan dua puncak penting iaitu band G dan D pada 1547 cm^{-1} dan 1292 cm^{-1}. Ujian penyerapan menunjukkan bahawa 100 % daripada 1 ppm metilena biru dan nikel telah berjaya diserap dengan menggunakan 1 g GSC dengan penyerapan 50 % dan 48 % pada jam pertama. Keseimbangan penyerapan metilena biru dan nikel dicapai pada kira-kira 10-12 jam. Persamaan pseudo kedua adalah sesuai menggambarkan kinetik penyerapan metilena biru dan nikel dengan R^2 = 0.9993 dan R^2 = 0.9972 dengan menggunakan GSC_{aps} manakala R^2 = 0.9981 dan R^2 = 0.9948 dengan menggunakan GSC_{ts} secara berasingan. Data isoterma bagi penyingkiran metilena biru dan nikel adalah sesuai dengan model Langmuir dengan R^2 = 0.9999 dan R^2 = 0.9975 dengan menggunakan GSC_{aps} manakala R^2 = 0.9945 dan R^2 = 0.9962 dengan menggunakan GSC_{ts}. Penggunaan semula GSC_{aps} dan GSC_{ts} mencatatkan 87 % dan 88 % kehilangan upaya sebelum proses generasi dan berjaya mengembalikan 76 % upaya dalam menyerap metilena biru dan nikel. Kesimpulannya, ia menunjukkan bahawa kedua-dua GSC mempunyai potensi sebagai penyerap yang baik dengan 7 % peningkatan penyerapan berbanding dengan kaedah konvensional dengan menggunakan set parameter yang sama.

ABSTRACT

Pollution of water sources has increased in a number of regions of the world due to the growth of industries and its untreated effluent discharge, increasing urbanization and energy intensive life styles, loss of forest cover, lack of environmental awareness and lack of implementation of environmental rules and regulations. The aim of the thesis is to synthesis green graphene sand composite (GSC) by using arenga palm sugar and table sugar as carbon sources to remove methylene blue and nickel from aqueous solution through adsorption process. The arenga palm sugar was chosen as carbon source due to the similarity on properties with ordinary table sugar and no research has been conducted so far on this particular material. The synthesis was conducted by removing deleterious materials on sand's surfaces before sieved. The solutions of sugar were prepared and heated to 95 oC for 2 hours with constant stirring together with sand before being put in furnace with nitrogen environment to produce graphene sand composite, GSCaps and GSCts. The composites then were activated by using concentrated sulphuric acid to maximise the capacity of absorbency. The analyses on the characteristic of both GSC were conducted through field emission scanning electron microscope (FESEM), elemental dispersive x-ray (EDX), elemental mapping (EM) and raman spectroscopy. Field Emission Scanning Electron Microscope (FESEM) analyses exhibited that the sugar coating process was done uniformly as there were layers of coating sheets formation outside the sand particles' surface. It was found that the biggest elements in the composite were carbon, oxygen and silica in scattered distribution. There was also a strong diffraction peak located at 26.66 ° and 26.80 ° which indicates the formation of the crystalline of the GSCaps and GSCts respectively which give glowing effect to the composites due to the light reflection. The test on raman spectroscopy detected two important peaks namely G and D band at 1547 cm-1 and 1292 cm-1 respectively. Adsorption test showed that 100 % of 1 ppm methylene blue and nickel were successfully adsorbed by using 1 g of GSC with 50 % and 48% adsorption in the first hour of contact respectively. Complete adsorption of methylene blue and nickel was successfully achieved at 10 – 12 hours of contact. The analysis exhibited pseudo second order equation is more appropriate in describing kinetic of the methylene blue and nickel adsorption with R2=0.9993 and R2=0.9972 by using GSCaps whereas R2=0.9981 and R2=0.9948 by using GSCts respectively. The isotherm data of methylene blue and nickel removal were fitted Langmuir model best with R2=0.9999 and R2=0.9975 by using GSCaps whereas R2=0.9945 and R2=0.9962 by using GSCts respectively. The reusability of GSCaps and GSCts recorded 87 % and 88 % adsorbency capacity loss before regeneration and able to restore approximately 76 % capacity in adsorbing methylene blue and nickel. In conclusion, both GSCs have shown potentials to be acted as good adsorbent with a total of 7 % adsorption increment comparing to conventional method, by using similar parameters setting in the experiment.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

Al_2O_3	Aluminium Oxide
C	Carbon
C_e	Equilibrium concentration
C_i	Initial concentration
C_f	Final concentration
Co (II)	Cobalt (II)
Cr (VI)	Chromium (IV)
Cu (II)	Copper (II)
Fe_2O_3	Ferric (III) Oxide
Fe_3O_4	Ferroferric Oxide
g	Gram
H	Hydrogen
HCl	Hydrochloric Acid
k_1	Pseudo first order constant
k_2	Pseudo second order constant
K_F	Freundlich constant
K_L	Langmuir constant
L	Litre
mg	Miligram
MnO_2	Manganese Dioxide
$MnFe_2O_4$	Manganese Ferrite
n	Adsorption intensity
NaOH	Natrium hydroxide
Ni (II)	Nickel (II)
Pb (II)	Plumbum (II)
ppm	Parts per million
q_e	Equilibrium adsorption
q_m	Maximum adsorption
q_t	Adsorption as a factor of time
R^2	Correlation
R_L	Separation factor
t	Time

TiO_2	Titanium Dioxide
V	Volume
W	Weight
Zn (II)	Zinc (II)
^oC	Degree calcius
%	Percentage

LIST OF ABBREVIATIONS

ASTM	American Society of Testing Materials
BS	British Standard
EDX	Elemental Dispersive X-Ray
FESEM	Field Emission Scanning Electron Microscopic
GSC	Graphene Sand Composite
GSC_{aps}	Graphene Sand Composite using *Arenga* Palm Sugar
GSC_{ts}	Graphene Sand Composite using Table Sugar
IWMI	International of Water Management Institute
POFA	Palm Oil Fuel Ash
XRD	X-Ray Diffraction

REFERENCES

(en), I. 10798:2011. (2011). Nanotechnologies — Characterization of single-wall carbon nanotubes using scanning electron microscopy and energy dispersive X-ray spectrometry analysis, 1–5.

75-2078, J. (1941). *Joint Committee on Powder Diffraction Standards 75-2078 (JCPDS 75-2078)*.

A Ahmad, M Rafatullah, O Sulaiman, MH Ibrahim, R. H. (2009). Scavenging behaviour of meranti sawdust in the removal of methylene blue from aqueous solution. *Journal of Hazardous Materials*, *170*(1), 357–365.

Abdelhay, A., Al Bsoul, A., Al-Othman, A., Al-Ananzeh, N. M., Jum'h, I., & Al-Taani, A. A. (2017). Kinetic and thermodynamic study of phosphate removal from water by adsorption onto (*Arundo donax*) reeds. *Adsorption Science & Technology*, 26361741668434.

Afroz, R., Masud, M. M., Akhtar, R., & Duasa, J. B. (2014). Water pollution: Challenges and future direction for water resource management policies in malaysia. *Environment and Urbanization ASIA*, *5*(1), 63–81.

Ahmed, F., & Rodrigues, D. F. (2013). Investigation of acute effects of graphene oxide on wastewater microbial community: A case study. *Journal of Hazardous Materials*, *256–257*, 33–39.

Ahsaine, H. A., Zbair, M., Anfar, Z., Naciri, Y., El, R., Alem, N. El, & Ezahri, M. (2018). Cationic dyes adsorption onto high surface area " almond shell " activated carbon : Kinetics , equilibrium isotherms and surface statistical modeling. *Materials Today Chemistry*, *8*, 121–132.

Al-Degs, Y. S., El-Barghouthi, M. I., El-Sheikh, A. H., & Walker, G. M. (2008). Effect of solution pH, ionic strength, and temperature on adsorption behavior of reactive dyes on activated carbon. *Dyes and Pigments*, *77*(1), 16–23.

Al-Hazmi, F. S., Beall, G. W., Al-Ghamdi, A. A., Alshahrie, A., Shokr, F. S., & Mahmoud, W. E. (2016). Raman and ellipsometry spectroscopic analysis of graphene films grown directly on Si substrate via CVD technique for estimating the graphene atomic planes number. *Journal of Molecular Structure*, *1118*, 275–278.

Allen, L. J. (2017). Simulation in elemental mapping using aberration-corrected electron microscopy. *Ultramicroscopy*, *180*, 142–149.

Amin, M. T., Alazba, a a, & Manzoor, U. (2014). A Review of Removal of Pollutants from Water / Wastewater Using Different Types of Nanomaterials. *Advances in Materials Science and Engineering*, *2014*.

Andonovic, B., Ademi, A., Grozdanov, A., Paunović, P., & Dimitrov, A. T. (2015). Enhanced model for determining the number of graphene layers and their distribution from X-ray diffraction data. *Beilstein Journal of Nanotechnology*, *6*(1), 2113–2122.

Andrijanto, E., Subiyanto, G., Marlina, N., Citra, H., & Lintang, C. (2018). Preparation of Graphene Oxide Sand Composites as Super Adsorbent for Water Purification Application. *MATEC Web of Conference*, *156*(5019), 1–5.

Angelakis, A., & Snyder, S. (2015). Wastewater Treatment and Reuse: Past, Present, and Future. *Water*, *7*(9), 4887–4895. http://doi.org/10.3390/w7094887

Anh, P.T; Kroeze, S.R; Bush, A. P. . (2010). Water Pollution by Intensive Brackish Shrimp Farming in South-East Vietnam: Causes and Option for Control. *Agricultural Water Management*, *97*(6), 872–882.

Arash Asfaram, Mehrorang Ghaedi, Shilpi Agarwal, I. T. and V. K. G. (2015). Removal of basic dye Auramine-O by ZnS:Cu nanoparticles loaded on activated carbon: optimization of parameters using response surface methodology with central composite design. *RSC Advances*, *5*(24).

Arenas-Sánchez, A., Rico, A., & Vighi, M. (2016). Effects of water scarcity and chemical pollution in aquatic ecosystems: State of the art. *The Science of the Total Environment*, *572*, 390–403.

Aseel, M. Aljboree; Abbas, N. Alshirifli; Ayad, F. A. (2017). Kinetics and equilibrium study for the adsorption of textile dyes on coconut shell activated carbon Kinetics and equilibrium study for the adsorption of textile dyes on coconut shell activated carbon. *Arabian Journal of Chemistry*, *10*.

Aydogan Gokturk, P., Kakenov, N., Kocabas, C., & Suzer, S. (2017). Raman and X-Ray photoelectron spectroscopic studies of graphene devices for identification of doping. *Applied Surface Science*, *425*, 1130–1137.

Azambre, B., & Hamoud, H. I. (2017). Removal of binary dyes mixtures with opposite and similar charges by adsorption , coagulation / flocculation and catalytic oxidation in the presence of CeO 2 / H 2 O 2 Fenton-like system. *Journal of Environmental Management*, *195*, 195–207.

Bai, F., Xiong, L., & Wang, Q. (2018). Treatment of reverse-osmosis concentrate of print and dyeing wastewater by electrooxidation process with controlled oxidation-reduction potential (ORP). *Chemosphere*, 1–18.

Banerjee, S., & Chattopadhyaya, M. C. (2017). Adsorption characteristics for the removal of a toxic dye, tartrazine from aqueous solutions by a low cost agricultural by-product. *Arabian Journal of Chemistry*, *10*, S1629–S1638.

Bartczak, P., Norman, M., Klapiszewski, Ł., Karwańska, N., Kawalec, M., Baczyńska, M., … 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*.

Belaroussi, A., Labed, F., Kheni, A., Ait, R., & Bouberka, Z. (2018). Acta Ecologica Sinica A novel approach for removing an industrial dye 4GL by an Algerian Bentonite, *38*, 148–156.

Bentahar, S., Dbik, A., Khomri, M. El, Messaoudi, N. El, & Lacherai, A. (2018). Removal of a cationic dye from aqueous solution by natural clay. *Groundwater for Sustainable Development*, *6*(February), 255–262.

Biswajit, Q., & Ahamad, K. U. (2018). Ecohydrology & Hydrobiology A review on lake eutrophication dynamics and recent developments in lake modeling, (2016), 1–12.

Bourque, J. L., Biesinger, M. C., & Baines, K. M. (2016). Chemical state determination of molecular gallium compounds using XPS. *Dalton Trans.*, *45*(18), 7678–7696.

Cai, Y., Pan, Z., Liu, D., Zheng, G., Tang, S., Connell, L. D., … Zhou, Y. (2014). Effects of Pressure and Temperature on Gas Diffusion and Flow for Primary and Enhanced Coalbed Methane Recovery. *Energy Exploration & Exploitation*, *32*(4), 601–619.

Cao, Y.-L., Pan, Z.-H., Shi, Q.-X., & Yu, J.-Y. (2018). Modification of chitin with high adsorption capacity for methylene blue removal. *International Journal of Biological Macromolecules*, *114*

Carmen, Z., & Daniel, S. (2012). Textile Organic Dyes – Characteristics, Polluting Effects and Separation/Elimination Procedures from Industrial Effluents – A Critical Overview. *Organic Pollutants Ten Years After the Stockholm Convention - Environmental and Analytical Update*.

Carolin, C. F., Kumar, P. S., Saravanan, A., Joshiba, G. J., & Naushad, M. (2017). Efficient techniques for the removal of toxic heavy metals from aquatic environment: A review. *Journal of Environmental Chemical Engineering*, *5*(3), 2782–2799.

Cataldo, D; Colombo, J.C; Boltovsky, D.; Bilos, C.; Landoni, P. (2001). Environment Toxicity Assessment in the Parana River Delta Argentina: Simultaneous Evolution of Selected Pollutants and Mortality Rates of Carbicula Flumina (Bravaria) Early Juveniles. *Environment Pollution*, *112*(3), 379–389.

Chadli, H., Rahmani, A., Sbai, K., & Sauvajol, J. L. (2005). Raman active modes in carbon peapods. *Physica A: Statistical Mechanics and Its Applications*, *358*(1 SPEC. ISS.), 226–236.

Chang, H., Cheng, C., Huang, P., & Lin, S. (2014). ESEM – EDX Investigation of the Cross-sectional Microstructure and Elemental Chemical Composition of a Giant Human Cardiac Calculus, 48–53.

Changmai, M., Banerjee, P., Nahar, K., & Purkait, M. K. (2018). A novel adsorbent from carrot, tomato and polyethylene terephthalate waste as a potential adsorbent for Co (II) from aqueous solution: Kinetic and equilibrium studies. *Journal of Environmental Chemical Engineering*, *6*(1), 246–257.

Chen, A. H., & Huang, Y. Y. (2010). Adsorption of Remazol Black 5 from aqueous solution by the templated crosslinked-chitosans. *Journal of Hazardous Materials*, *177*(1–3), 668–675.

Chen, Y., Wen, X., Wang, B., & Nie, P. (2017). Agricultural pollution and regulation : How to subsidize agriculture ?, *164*, 258–264.

Cheok, Q. H. N. (2013). *Activated Carbon Manufacture: An opportunity for sustainable management of problematic waste biomass*.

Cherian, C., Kollannur, N. J., Bandipally, S., & Arnepalli, D. N. (2018). Calcium adsorption on clays: Effects of mineralogy, pore fluid chemistry and temperature. *Applied Clay Science*, (July 2017).

Chiodoni, A., Laviano, F., Gerbaldo, R., Ghigo, G., Gozzelino, L., Mezzetti, E., … Kwok, W. K. (2010). Understanding the role of heavy ion-irradiation induced surface columnar nanostructures through FESEM imaging. *Physica C: Superconductivity and Its Applications*, *470*(19), 914–917.

Class for Physics of the Royal Swedish Academy of Sciences. (2010). Class for Physics of the Royal Swedish Academy of Sciences Graphene. *Scientific Background on the Nobel Proze in Physics 2010*.

Clausell, J. V., Bastida, J., Serrano, F. J., Pardo, P., & Huertas, F. J. (2007). A new FESEM procedure for assessment of XRD microstructural data of kaolinites. *Applied Clay Science*, *37*(1–2), 127–132.

Corda, N. C., & Kini, M. S. (2018). A Review on Adsorption of Cationic Dyes using Activated Carbon. *MATEC Web of Conference*, *2022*, 1–16.

Cozzarini, C., Chiorda, B. N., Sini, C., Ph, D., Ph, D., Briganti, A., … Muzio, N. Di. (2018). Equillibrium and kinetic studies of the adsorption of antibiotics from aqueous solutions onto powdered zeolites. *Chemosphere*, 1–42.

Dakkoune, A., Vernières-Hassimi, L., Leveneur, S., Lefebvre, D., & Estel, L. (2018). Risk analysis of French chemical industry. *Safety Science*, *105*(January), 77–85.

Dao, T. D., Hong, J. E., Ryu, K. S., & Jeong, H. M. (2014). Super-tough functionalized graphene paper as a high-capacity anode for lithium ion batteries. *Chemical Engineering Journal*, *250*, 257–266.

de Abreu Domingos, R., & da Fonseca, F. V. (2018). Evaluation of adsorbent and ion exchange resins for removal of organic matter from petroleum refinery wastewaters aiming to increase water reuse. *Journal of Environmental Management*, *214*, 362–369.

De Angelis, G., Medeghini, L., Conte, A. M., & Mignardi, S. (2017). Recycling of eggshell waste into low-cost adsorbent for Ni removal from wastewater. *Journal of Cleaner Production*, *164*, 1497–1506.

de Castro Silva, F., da Silva, M. M. F., Lima, L. C. B., Osajima, J. A., & da Silva Filho, E. C. (2018). Modifying cellulose with metaphosphoric acid and its efficiency in removing brilliant green dye. *International Journal of Biological Macromolecules*, (2017).

De Gisi, S., Lofrano, G., Grassi, M., & Notarnicola, M. (2016). Characteristics and adsorption capacities of low-cost sorbents for wastewater treatment: A review. *Sustainable Materials and Technologies*, *9*, 10–40.

Demirbas, E., Kobya, M., & Sulak, M. T. (2008). Adsorption kinetics of a basic dye from aqueous solutions onto apricot stone activated carbon. *Bioresource Technology*, *99*(13), 5368–5373.

Deng, H., Hu, X., Li, H. A., Luo, B., & Wang, W. (2016). Improved pore-structure characterization in shale formations with FESEM technique. *Journal of Natural Gas Science and Engineering*, *35*, 309–319.

Desta, M. B. (2013). Batch sorption experiments: Langmuir and freundlich isotherm studies for the adsorption of textile metal ions onto teff straw (eragrostis tef) agricultural waste. *Journal of Thermodynamics*, *1*(1).

Du, X., Han, Q., Li, J., & Li, H. (2017). The behavior of phosphate adsorption and its reactions on the surfaces of Fe–Mn oxide adsorbent. *Journal of the Taiwan Institute of Chemical Engineers*, *76*, 167–175.

Dubey, R., Bajpai, J., & Bajpai, a. K. (2015). Green synthesis of graphene sand composite (GSC) as novel adsorbent for efficient removal of Cr (VI) ions from aqueous solution. *Journal of Water Process Engineering*, *5*, 83–94.

E1683-02, A. (2014). ASTM E1683-02 Standard Practice for Testing the Performance of Scanning Raman Spectrometers.

E Silva, T. L. S., & Schmal, M. (2017). Adsorption and desorption of propane on Pd (111): A van der Waals density functional study. Energy binding sites and geometries. *Surface Science*, *664*(June), 82–86.

Elbana, T. A., Magdi Selim, H., Akrami, N., Newman, A., Shaheen, S. M., & Rinklebe, J. (2018). Freundlich sorption parameters for cadmium, copper, nickel, lead, and zinc for different soils: Influence of kinetics. *Geoderma*, *324*(March), 80–88.

Esmaeili, A., Saremnia, B., & Kalantari, M. (2015). Removal of mercury(II) from aqueous solutions by biosorption on the biomass of Sargassum glaucescens and Gracilaria corticata. *Arabian Journal of Chemistry*, *8*(4), 506–511.

Fabryanty, R., Valencia, C., Soetaredjo, F. E., Putro, J. N., Santoso, S. P., Kurniawan, A., … Ismadji, S. (2017). Removal of crystal violet dye by adsorption using bentonite – alginate composite. *Journal of Environmental Chemical Engineering*, *5*(6), 5677–5687.

Feist, A., Bach, N., Rubiano, N., Danz, T., Möller, M., Priebe, K. E., … Ropers, C. (2017). Ultramicroscopy Ultrafast transmission electron microscopy using a laser-driven fi eld emitter : Femtosecond resolution with a high coherence electron beam. *Ultramicroscopy*, *176*(December 2016), 63–73.

Friel, J. J., & Lyman, C. E. (2006). M icroscopy M icroanalysis X-ray Mapping in Electron-Beam Instruments. *Microscopy and Microanalysis*, *12*, 2–25.

Galpaya, D. (2012). Recent Advances in Fabrication and Characterization of Graphene-Polymer Nanocomposites. *Graphene*, *1*(2), 30–49.

George Z. Kyzas, Eleni A. Deliyanni, Dimitrios N. Bikiaris, A. C. M. (2018). Graphene composites as dye adsorbents : Review, *129*, 75–88.

Ghaedi, M., Hajjati, S., Mahmudi, Z., Tyagi, I., Agarwal, S., Maity, a., & Gupta, V. K. (2015). Modeling of competitive ultrasonic assisted removal of the dyes – Methylene blue and Safranin-O using Fe3O4 nanoparticles. *Chemical Engineering Journal*, *268*, 28–37.

Gibson, L. T. (2014). Mesosilica materials and organic pollutant adsorption: part A removal from air. *Chemical Science Resource*, *43*(15), 5163–5172.

Goode, A. E., Porter, A. E., Kłosowski, M. M., Ryan, M. P., Heutz, S., & McComb, D. W. (2017). Analytical transmission electron microscopy at organic interfaces. *Current Opinion in Solid State and Materials Science*, *21*(2), 55–67.

Gupta, M., Gupta, H., & Kharat, D. S. (2018). Adsorption of Cu(II) by low cost adsorbents and the cost analysis. *Environmental Technology and Innovation*, *10*, 91–101.

Gupta, V. K., Agarwal, S., & Saleh, T. a. (2011). Synthesis and characterization of alumina-coated carbon nanotubes and their application for lead removal. *Journal of Hazardous Materials*, *185*(1), 17–23.

Gupta, V. K., Jain, A. K., & Shoora, S. K. (2013). Multiwall carbon nanotube modified glassy carbon electrode as voltammetric sensor for the simultaneous determination of ascorbic acid and caffeine. *Electrochimica Acta*, *93*, 248–253.

Gupta, V. K., Jain, R., Mittal, A., Saleh, T. a., Nayak, A., Agarwal, S., & Sikarwar, S. (2012). Photo-catalytic degradation of toxic dye amaranth on TiO2/UV in aqueous suspensions. *Materials Science and Engineering: C*, *32*(1), 12–17.

Gupta, V. K., Jain, R., Nayak, A., Agarwal, S., & Shrivastava, M. (2011). Removal of the hazardous dye—Tartrazine by photodegradation on titanium dioxide surface. *Materials Science and Engineering: C*, *31*(5), 1062–1067.

Gupta, V. K., Kumar, R., Nayak, A., Saleh, T. a., & Barakat, M. a. (2013). Adsorptive removal of dyes from aqueous solution onto carbon nanotubes: A review. *Advances in Colloid and Interface Science*, *193–194*, 24–34.

Gupta, V. K., & Nayak, A. (2012). Cadmium removal and recovery from aqueous solutions by novel adsorbents prepared from orange peel and Fe2O3 nanoparticles. *Chemical Engineering Journal*, *180*, 81–90.

Gupta, V. K., & Saleh, T. a. (2013). Sorption of pollutants by porous carbon, carbon nanotubes and fullerene- an overview. *Environmental Science and Pollution Research International*, *20*(5), 2828–43.

Gupta, V. K., Srivastava, S. K., Mohan, D., & Sharma, S. (1998). Original Contribution Design Parameters for Fixed Bed Reactors of Activated Carbon Developed From Fertilizer Waste for the Removal of S O M E Heavy Metal Ions. *Pergamon*, *17*(8), 517–522.

Gupta, V. K., Suhas, Nayak, A., Agarwal, S., Chaudhary, M., & Tyagi, I. (2014). Removal of

Ni (II) ions from water using scrap tire. *Journal of Molecular Liquids*, *190*, 215–222.

Gupta, S. Sen, Sreeprasad, T. S., Maliyekkal, S. M., Das, S. K., & Pradeep, T. (2012). Graphene from Sugar and its Application in Water Purification. *ACS Applied Materials and Interfaces*, *4*, 4156–4163.

Habibi, M. H., & Rahmati, M. H. (2014). Fabrication and characterization of ZnO@CdS core-shell nanostructure using acetate precursors: XRD, FESEM, DRS, FTIR studies and effects of cadmium ion concentration on band gap. *Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy*, *133*, 13–18.

Hashemifard, S. A., Matsuura, T., Ismail, A. F., Rezaei Dasht Arzhandi, M., Rana, D., & Bakeri, G. (2015). Characterization of partial pore wetting in hollow fiber gas absorption membrane contactors: An EDX analysis approach. *Chemical Engineering Journal*, *281*, 970–980.

Henry, D. G., Jarvis, I., Gillmore, G., Stephenson, M., & Emmings, J. (2018). Assessing low-maturity organic matter in shales using Raman spectroscopy: Effects of sample preparation and operating procedure. *International Journal of Coal Geology*.

Hiew, B. Y. Z., Lee, L. Y., Lee, X. J., Thangalazhy-Gopakumar, S., Gan, S., Lim, S. S., … Khiew, P. S. (2018). Review on synthesis of 3D graphene-based configurations and their adsorption performance for hazardous water pollutants. *Process Safety and Environmental Protection*, *116*, 262–286.

Ho, Y. S., & Mckay, G. (1999). Pseudo - second order model for sorption processes. *Process Biochemistry*, *34*, 451–465.

Hong, G.-B., & Wang, Y.-K. (2017). Synthesis of low-cost adsorbent from rice bran for the removal of reactive dye based on the response surface methodology. *Applied Surface Science*, *423*, 800–809.

Hossain, M. M., Ku, B.-C., & Hahn, J. R. (2015). Synthesis of an efficient white-light photocatalyst composite of graphene and ZnO nanoparticles: Application to methylene blue dye decomposition. *Applied Surface Science*, 1–11.

Hossaini, S. (2013). *Application of POLYPYRROLE and POLYPYRROLE / POLYETHYLENIMINE for the Removal of Some Heavy Metal Ions from Aqueous Solution*. Universiti Malaya.

Hosseini, S. S., Nazif, A., Alaei Shahmirzadi, M. A., & Ortiz, I. (2017). Fabrication, tuning and optimization of poly (acrilonitryle) nanofiltration membranes for effective nickel and chromium removal from electroplating wastewater. *Separation and Purification Technology*, *187*, 46–59.

Hu, B., Wang, C., Xu, X., Zhang, S., Bao, S., & Li, Y. (2016). Assessment of radioactive materials and heavy metals in the surface soil around uranium mining area of Tongliao, China, *130*, 1–11.

Iakovleva, E., Sillanpää, M., Maydannik, P., Liu, J. T., Allen, S., Albadarin, A. B., &

Mangwandi, C. (2017). Manufacturing of novel low-cost adsorbent: Co-granulation of limestone and coffee waste. *Journal of Environmental Management*, *203*, 853–860.

Ismail, N. H., Salleh, W. N. W., Sazali, N., Ismail, A. F., Yusof, N., & Aziz, F. (2018). Disk supported carbon membrane via spray coating method: Effect of carbonization temperature and atmosphere. *Separation and Purification Technology*, *195*(September 2017), 295–304.

Jabeen, H., Kemp, K. C., & Chandra, V. (2013). Synthesis of nano zerovalent iron nanoparticles - Graphene composite for the treatment of lead contaminated water. *Journal of Environmental Management*, *130*, 429–435.

Kadim Aljebori, A. M., & Alshirifi, A. N. (2012). Effect of Different Parameters on the Adsorption of Textile Dye "Maxilon Blue GRL" From Aqueous Solution by Using White Marble. *Asian Journal of Chemistry*, *24*(12), 5813–5816.

Kamranifar, M., Khodadadi, M., Samiei, V., Dehdashti, B., Noori Sepehr, M., Rafati, L., & Nasseh, N. (2018). Comparison the removal of reactive red 195 dye using powder and ash of barberry stem as a low cost adsorbent from aqueous solutions: Isotherm and kinetic study. *Journal of Molecular Liquids*, *255*, 572–577.

Kausar, A. (2015). Effect of Halloysite Nanoclay on Polymerization and. *American Journal of Polymer Science*, *5*(1), 30–34.

Kausar, A., Iqbal, M., Javed, A., Aftab, K., Nazli, Z.-H., Bhatti, H. N., & Nouren, S. (2018). Dyes adsorption using clay and modified clay: A review. *Journal of Molecular Liquids*, *256*, 395–407.

Khani, H., Rofouei, M. K., Arab, P., Gupta, V. K., & Vafaei, Z. (2010). Multi-walled carbon nanotubes-ionic liquid-carbon paste electrode as a super selectivity sensor: Application to potentiometric monitoring of mercury ion(II). *Journal of Hazardous Materials*, *183*(1–3), 402–409.

Kim, D. M., Yun, S. T., Cho, Y., Hong, J. H., Batsaikhan, B., & Oh, J. (2017). Hydrochemical assessment of environmental status of surface and ground water in mine areas in South Korea: Emphasis on geochemical behaviors of metals and sulfate in ground water. *Journal of Geochemical Exploration*, *183*, 33–45.

Kim, T. S., Song, H. J., Dar, M. A., Lee, H. J., & Kim, D. W. (2018). Fast adsorption kinetics of highly dispersed ultrafine nickel/carbon nanoparticles for organic dye removal. *Applied Surface Science*, *439*, 364–370.

Kirillin, G., Shatwell, T., & Kasprzak, P. (2013). Consequences of thermal pollution from a nuclear plant on lake temperature and mixing regime. *Journal of Hydrology*, *496*, 47–56.

Kong, J., Gu, R., Yuan, J., Liu, W., Wu, J., & Fei, Z. (2018). Ecotoxicology and Environmental Safety Adsorption behavior of Ni (II) onto activated carbons from hide waste and high-pressure steaming hide waste, *156*, 294–300.

Kumar Djamel Belaid; Kacha, Smail; Kameche, M., & Derriche, Z. (2013). Journal of

Environmental Chemical Engineering Adsorption kinetics of some textile dyes onto granular activated carbon. *Journal Od Environmental Chemical Engineering*, *1*, 496–503.

Kyzas, G. Z., Deliyanni, E. a., & Matis, K. a. (2014). Graphene oxide and its application as an adsorbent for wastewater treatment. *Journal of Chemical Technology and Biotechnology*, *89*(2), 196–205.

Lam, B., Déon, S., Morin-Crini, N., Crini, G., & Fievet, P. (2018). Polymer-enhanced ultrafiltration for heavy metal removal: Influence of chitosan and carboxymethyl cellulose on filtration performances. *Journal of Cleaner Production*, *171*, 927–933.

Le, A. B., Hoboy, S., Germain, A., Miller, H., Thompson, R., Herstein, J. J., … Lowe, J. J. (2018). A pilot survey of the U.S. medical waste industry to determine training needs for safely handling highly infectious waste. *American Journal of Infection Control*, *46*, 133–138.

Le, S. H., Chua, L. H. C., Irvine, K. N., Eikaas, H. S., Le, S. H., & Eikaas, H. S. (2017). Modeling washoff of total suspended solids in the tropics. *Journal of Environmental Management*, *200*, 263–274.

Lei, W., Zhang, X., Lou, C., Tu, Y., Yin, H., Ziehen, Z., … Chi, L. (2008). Study of the movement of electron groups near a field emission cathode. *Physics Procedia*, *1*(1), 65–70.

Li, C. W., Yu, J. H., Liang, Y. M., Chou, Y. H., Park, H. J., Choo, K. H., & Chen, S. S. (2016). Ni removal from aqueous solutions by chemical reduction: Impact of pH and pe in the presence of citrate. *Journal of Hazardous Materials*, *320*, 521–528.

Li, Z., Potter, N., Rasmussen, J., Weng, J., & Lv, G. (2018). Removal of rhodamine 6G with different types of clay minerals. *Journal of Environmental Chemical Engineering*, *202*, 127–135.

Liu, K., Li, H., Wang, Y., Gou, X., & Duan, Y. (2015). Adsorption and removal of rhodamine B from aqueous solution by tannic acid functionalized graphene. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, *477*, 35–41.

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

Liu, Y., Zhu, Y., Liu, S., Li, W., & Tang, X. (2018). Temperature effect on gas adsorption capacity in different sized pores of coal: Experiment and numerical modeling. *Journal of Petroleum Science and Engineering*, *165*(March), 821–830.

López-Cervantes, J., Sánchez-Machado, D. I., Sánchez-Duarte, R. G., & Correa-Murrieta, M. A. (2018). Study of a fixed-bed column in the adsorption of an azo dye from an aqueous medium using a chitosan–glutaraldehyde biosorbent. *Adsorption Science and Technology*, *36*(1–2), 215–232.

Machado Centenaro, G. S. N., Facin, B. R., Valério, A., de Souza, A. A. U., da Silva, A., de

Oliveira, J. V., & de Oliveira, D. (2017). Application of polyurethane foam chitosan-coated as a low-cost adsorbent in the effluent treatment. *Journal of Water Process Engineering*, *20*(July), 201–206.

Malkoc, E., & Nuhoglu, Y. (2007). Potential of tea factory waste for chromium (VI) removal from aqueous solutions : Thermodynamic and kinetic studies. *Separation and Purification Technology*, *54*, 291–298.

Manjunatha, S. G., Bobade, K. B., & Kudale, M. D. (2015). Pre-cooling technique for a thermal discharge from the Coastal Thermal Power Plant. *Procedia Engineering*, *116*(1), 358–365.

Marczewski, A. W., Seczkowska, M., Dery-Marczewska, A., & Blachnio, M. (2016). Adsorption equilibrium and kinetics of selected phenoxyacid pesticides on activated carbon: effect of temperature. *Adsorption*, *22*(4–6), 777–790.

McCarthy, F. M. G., Mertens, K. N., Ellegaard, M., Sherman, K., Pospelova, V., Ribeiro, S., … Vercauteren, D. (2011). Resting cysts of freshwater dinoflagellates in southeastern Georgian Bay (Lake Huron) as proxies of cultural eutrophication. *Review of Palaeobotany and Palynology*, *166*(1–2), 46–62.

Minkov, I. L., Manev, E. D., Sazdanova, S. V., & Kolikov, K. H. (2013). Equilibrium and dynamic osmotic behaviour of aqueous solutions with varied concentration at constant and variable volume. *The Scientific World Journal*, *2013*.

Mirmasoumi, S., Khoshbakhti Saray, R., & Ebrahimi, S. (2018). Evaluation of thermal pretreatment and digestion temperature rise in a biogas fueled combined cooling, heat, and power system using exergo-economic analysis. *Energy Conversion and Management*, *163*(October 2017), 219–238.

Mishra, A. K., & Ramaprabhu, S. (2011). Functionalized graphene sheets for arsenic removal and desalination of sea water. *Desalination*, *282*, 39–45.

Mittal, A., Mittal, J., Malviya, A., & Gupta, V. K. (2009). Adsorptive removal of hazardous anionic dye “Congo red” from wastewater using waste materials and recovery by desorption. *Journal of Colloid and Interface Science*, *340*(1), 16–26.

Moghbeli, M. R., Khajeh, A., & Alikhani, M. (2017). Nanosilica reinforced ion-exchange polyHIPE type membrane for removal of nickel ions: Preparation, characterization and adsorption studies. *Chemical Engineering Journal*, *309*, 552–562.

Montemezzani, V., Duggan, I. C., Hogg, I. D., & Craggs, R. J. (2017). Control of zooplankton populations in a wastewater treatment High Rate Algal Pond using overnight CO2 asphyxiation. *Algal Research*, *26*(March), 250–264.

Moradi, S., & Azizian, S. (2016). Preparation of nanostructured carbon covered sand for removal of methyl violet from water. *Journal of Molecular Liquids*, *219*, 909–913. http://doi.org/10.1016/j.molliq.2016.03.075

Nageeb Rashed, M. (2013). Adsorption Technique for the Removal of Organic Pollutants from Water and Wastewater. *Organic Pollutants - Monitoring, Risk and Treatment*, 167–194.

Najafi Saleh, H., Dehghani, M. H., Nabizadeh, R., Mahvi, A. H., yaghmaeian, kamyar, Hossein, Mohammadi, A. (2018). *Data in Brief*, *17*, 774–780.

Nanekar, P.P; Shah, B. K. (2003). Characterization of Material Properties. *BARC Newsletter*, (249), 25–38.

Nekouei, F., Nekouei, S., Tyagi, I., & Gupta, V. K. (2015). Kinetic, thermodynamic and isotherm studies for acid blue 129 removal from liquids using copper oxide nanoparticle-modified activated carbon as a novel adsorbent. *Journal of Molecular Liquids*, *201*, 124–133.

Nelson, D; Silvia, S. G.; Swaldo, L. A. (2014). Nanotoxicology. In *Materials, Methodologies and Assessment*. Springer.

Niazi, L., Lashanizadegan, A., & Sharififard, H. (2018). Chestnut oak shells activated carbon: Preparation, characterization and application for Cr (VI) removal from dilute aqueous solutions. *Journal of Cleaner Production*, *185*, 554–561.

Nidheesh, P. V., Zhou, M., & Oturan, M. A. (2018). An overview on the removal of synthetic dyes from water by electrochemical advanced oxidation processes. *Chemosphere*, *197*, 210–227.

Noor, Ahmad, N., Khattak, M. A., Khan, M. S., Mukhtar, A., Kazi, Khan, R. (2017). Application of Sayong Ball Clay Membrane Filtration for Ni (II) Removal from Industrial Wastewater. *Journal of Taibah University for Science*, *11*, 949–954.

Oh, W. C., Ullah, K., Zhu, L., Meng, Z. Da, Ye, S., & Sarkar, S. (2014). Photocatalytic properties under visible light with graphene based platinium selenide nanocomposites synthesized by microwave assisted method. *Materials Science in Semiconductor Processing*, *25*, 34–42.

Oyelude, E. O., & Appiah-Takyi, F. (2012). Removal of methylene blue from aqueous solution using alkali-modified malted sorghum mash. *Turkish Journal of Engineering and Environmental Sciences*, *36*(2), 161–169.

Oyelude, E. O., Awudza, J. A. M., & Twumasi, S. K. (2017). Equilibrium, Kinetic and Thermodynamic Study of Removal of Eosin Yellow from Aqueous Solution Using Teak Leaf Litter Powder. *Scientific Reports*, *7*(1), 1–10.

Pahlavan, A., Gupta, V. K., Sanati, A. L., Karimi, F., Yoosefian, M., & Ghadami, M. (2014). ZnO/CNTs nanocomposite/ionic liquid carbon paste electrode for determination of noradrenaline in human samples. *Electrochimica Acta*, *123*, 456–462.

Pandey, P. K., Sharma, S. K., & Sambi, S. S. (2010). Kinetics and equilibrium study of chromium adsorption on zeoliteNaX. *International Journal of Environmental Science & Technology*, *7*(2), 395–404.

Park, H. N., Choi, H. A., & Won, S. W. (2018). Fibrous polyethylenimine/polyvinyl chloride crosslinked adsorbent for the recovery of Pt(IV) from acidic solution: Adsorption, desorption and reuse performances. *Journal of Cleaner Production*, *176*, 360–369.

Parvathi, V. P., Umadevi, M., & Raj, R. B. (2015). Improved waste water treatment by bio-synthesized Graphene Sand Composite. *Journal of Environmental Management*, *162*, 299–305.

Pathania, D., Sharma, S., & Singh, P. (2017). Removal of methylene blue by adsorption onto activated carbon developed from Ficus carica bast. *Arabian Journal of Chemistry*, *10*, 1–6.

Paz, A., Carballo, J., Pérez, M. J., & Domínguez, J. M. (2017). Biological treatment of model dyes and textile wastewaters. *Chemosphere*, *181*, 168–177.

Pitowsky, I. (2006). On the definition of equilibrium. *Studies in History and Philosophy of Science Part B - Studies in History and Philosophy of Modern Physics*, *37*(3), 431–438.

Politi, D., & Sidiras, D. (2012). Wastewater treatment for dyes and heavy metals using modified pine sawdust as adsorbent. *Procedia Engineering*, *42*(August), 1969–1982.

Potts, J. R., Dreyer, D. R., Bielawski, C. W., & Ruoff, R. S. (2011). Graphene-based polymer nanocomposites. *Polymer*, *52*(1), 5–25.

Prasana Manikanda Kartik, Swathik H, Udayabhaskar S, & Sivamani S. (2012). Removal of Direct Red Dye by Neem Leaf Litter. *Helix*, *1*(2), 129–133.

Qiu, H., Lv, L., Pan, B., Zhang, Q. Q., Zhang, W., & Zhang, Q. Q. (2009). Critical review in adsorption kinetic models. *Journal of Zhejiang University SCIENCE A*, *10*(5), 716–724.

Qiu, Z. L., Kong, X., Yuan, J. J., Shen, Y. J., Zhu, B. ku, Zhu, L. P., … Tang, C. Y. (2018). Cross-linked PVC/hyperbranched polyester composite hollow fiber membranes for dye removal. *Reactive and Functional Polymers*, *122*(July 2017), 51–59.

R. Saito, M. Hofmann, G. Dresselhaus, A. J. & M. S. D. (2011). Raman spectroscopy of graphene and carbon nanotubes. *Journal of Advance Physics*, *60*(3), 413–550.

Rabbani, M. A. G., Howlader, M. Z. H., & Kabir, Y. (2017). Detection of multidrug resistant (MDR) bacteria in untreated waste water disposals of hospitals in Dhaka City, Bangladesh. *Journal of Global Antimicrobial Resistance*, *10*, 120–125.

Rahsepar, S., Langenhoff, A. A. M., Smit, M. P. J., van Eenennaam, J. S., Murk, A. J., & Rijnaarts, H. H. M. (2017). Oil biodegradation: Interactions of artificial marine snow, clay particles, oil and Corexit. *Marine Pollution Bulletin*, *125*(1–2), 186–191.

Rajasulochana, P., & Preethy, V. (2016). Comparison on efficiency of various techniques in treatment of waste and sewage water – A comprehensive review. *Resource-Efficient Technologies*, *2*(4), 175–184.

Ranjit Kumar, M., Meenambal, T., & Kumar, V. (2017). Macropore flow as a groundwater component in hydrologic simulation: Modelling, applications and results. *Current Science*, *112*(6), 1197–1207.

Raptis, C. E., Boucher, J. M., & Pfister, S. (2017). Assessing the environmental impacts of freshwater thermal pollution from global power generation in LCA. *Science of the Total*

Environment, *580*, 1014–1026.

Rashid, S., Shen, C., Yang, J., Liu, J., & Li, J. (2017). ScienceDirect Preparation and properties of chitosan – metal complex : Some factors influencing the adsorption capacity for dyes in aqueous solution. *Journal of Environmental Sciences*, *66*, 1–9.

Rathi, a K. a. (2002). Chemical Industry Wastewater Treatment Using Adsorption. *Industrial Research*, *61*(January), 53–60.

Reza, M., Asfaram, A., Hadipour, A., & Roosta, M. (2014). Kinetics and thermodynamic studies for removal of acid blue 129 from aqueous solution by almond shell. *Journal of Environmental Health Science and Engineering*, *12*(1), 1–7.

Riera-Torres, M., Gutiérrez-Bouzán, C., & Crespi, M. (2010). Combination of coagulation-flocculation and nanofiltration techniques for dye removal and water reuse in textile effluents. *Desalination*, *252*(1–3), 53–59.

Rincón-Silva, N. G., Moreno-Piraján, J. C., & Giraldo, L. G. (2015). Thermodynamic study of adsorption of phenol, 4-chlorophenol, and 4-nitrophenol on activated carbon obtained from eucalyptus seed. *Journal of Chemistry*, *2015*.

Rindengan, Barlina; Steivie, Karouw ;and Patrik, P. (2006). Pengaruh Sabut Kelapa terhadap Kualitas Nira Aren dan Palm Wine. *Jurnal Littri*, *12*(4), 166–171.

Rodrigues Mota, T. L., Marques de Oliveira, A. P., Nunes, E. H. M., & Houmard, M. (2017). Simple process for preparing mesoporous sol-gel silica adsorbents with high water adsorption capacities. *Microporous and Mesoporous Materials*, *253*, 177–182.

Rodríguez-Estupiñán, P., Erto, A., Giraldo, L., & Moreno-Piraján, J. C. (2017). Adsorption of Cd (II) on modified granular activated carbons: Isotherm and column study. *Molecules*, *22*(12), 1–17.

Rout, P. R., Bhunia, P., & Dash, R. R. (2017). Journal of Water Process Engineering Evaluation of kinetic and statistical models for predicting breakthrough curves of phosphate removal using dolochar-packed columns. *Journal of Water Process Engineering*, *17*, 168–180.

Ruan, G., Sun, Z., Peng, Z., & Tour, J. M. (2011). Growth of Graphene from Food, Insects, and Waste. *ACS Nano*, *5*(9), 7601–7607.

Russo, V., Tesser, R., Trifuoggi, M., Giugni, M., & Serio, M. Di. (1998). A dynamic intraparticle model for fluid – solid adsorption kinetics. *Computers and Chemical Engineering*, *74*(2015), 66–74.

Ruthven, D. M. (1984). *Principles in Adsorption and Adsorption Process*. John Wiley & Sons.

Sabirov, D. S. (2018). Information entropy changes in chemical reactions. *Computational and Theoretical Chemistry*, *1123*, 169–179.

Safinejad, A., Chamjangali, M. A., Goudarzi, N., & Bagherian, G. (2017). Synthesis and characterization of a new magnetic bio-adsorbent using walnut shell powder and its

application in ultrasonic assisted removal of lead. *Journal of Environmental Chemical Engineering*, *5*(2), 1429–1437.

Sahari, J., Sapuan, S. M., Zainudin, E. S., & Maleque, M. A. (2012). Sugar palm tree: A versatile plant and novel source for biofibres, biomatrices, and biocomposites. *Polymers from Renewable Resources*, *3*(2), 61–78.

Saleh, T.A; Gupta, V. . (2012). Column with CNT/magnesium oxide composite for lead(II) removal from water. *Environmental Science and Pollution Research*, *19*(4), 1224–1228.

Saleh, T. a., & Gupta, V. K. (2012). Photo-catalyzed degradation of hazardous dye methyl orange by use of a composite catalyst consisting of multi-walled carbon nanotubes and titanium dioxide. *Journal of Colloid and Interface Science*, *371*(1), 101–106.

Salvador, F., Martin-Sanchez, N., Sanchez-Hernandez, R., Sanchez-Montero, M. J., & Izquierdo, C. (2015). Regeneration of carbonaceous adsorbents. Part II: Chemical, Microbiological and Vacuum Regeneration. *Microporous and Mesoporous Materials*, *202*(C), 277–296.

Santhana, K. Kumar; Jiang, S.-J. Se. L. T. (2016). Effective adsorption of chromium (VI)/Cr(III) from aqueous solution using ionic liquid functionalized multiwalled carbon nanotube as a super sorbent. *Journal of Materials Chemistry A*, 1–44.

Saratale, R. G., Shin, H. S., Ghodake, G. S., Kumar, G., Oh, M. K., & Saratale, G. D. (2018). Combined effect of inorganic salts with calcium peroxide pretreatment for kenaf core biomass and their utilization for 2,3-butanediol production. *Bioresource Technology*, *258*(February), 26–32.

Schnurr, P. J., Espie, G. S., & Allen, D. G. (2013). Algae biofilm growth and the potential to stimulate lipid accumulation through nutrient starvation. *Bioresource Technology*, *136*, 337–344.

Şeker, S., & Kutlu, B. (2014). Determination of Copper (Cu) Levels for Rivers in Tunceli, Turkey. *World Environment*, *4*(4), 168–171.

Seow, T. W., & Lim, C. K. (2016). Removal of dye by adsorption: A review. *International Journal of Applied Engineering Research*, *11*(4), 2675–2679.

Serrano, L., Reina, M., Quintana, X. D., Romo, S., Olmo, C., Soria, J. M., … Pätzig, M. (2017). A new tool for the assessment of severe anthropogenic eutrophication in small shallow water bodies. *Ecological Indicators*, *76*, 324–334.

Shakir, E., Zahraw, Z., & Al-Obaidy, A. H. M. J. (2016). Environmental and health risks associated with reuse of wastewater for irrigation. *Egyptian Journal of Petroleum*, 95–102.

Sharif, F., Gagnon, L. R., Mulmi, S., & Roberts, E. P. L. (2017). Electrochemical regeneration of a reduced graphene oxide/magnetite composite adsorbent loaded with methylene blue. *Water Research*, *114*, 237–245.

Shen, T., Gao, M., Zang, W., Ding, F., & Wang, J. (2018). Architecting organo silica

nanosheets for regenerable cost-effective organics adsorbents. *Chemical Engineering Journal*, *331*, 211–220.

Shih, Y.-J., Lin, C.-P., & Huang, Y.-H. (2013). Application of Fered-Fenton and chemical precipitation process for the treatment of electroless nickel plating wastewater. *Separation and Purification Technology*, *104*, 100–105.

Simonin, J. P. (2016). On the comparison of pseudo-first order and pseudo-second order rate laws in the modeling of adsorption kinetics. *Chemical Engineering Journal*, *300*, 254–263.

Soh-Fong, Lim & Agnes, Y. W. L. (2015). Kinetic study on removal of heavy metal ions from aqueous solution by using soil. *Environmental Science and Pollution Research*, *22*(13), 10144–10158.

Song, J., Niu, X., Li, X.-M., & He, T. (2018). Selective separation of copper and nickel by membrane extraction using hydrophilic nanoporous ion-exchange barrier membranes. *Process Safety and Environmental Protection*, *113*, 1–9.

Sousa, J. C. G., Ribeiro, A. R., Barbosa, M. O., Pereira, M. F. R., & Silva, A. M. T. (2018). A review on environmental monitoring of water organic pollutants identified by EU guidelines. *Journal of Hazardous Materials*, *344*, 146–162.

Sreeprasad, T. S., Maliyekkal, S. M., Lisha, K. P., & Pradeep, T. (2011). Reduced graphene oxide-metal/metal oxide composites: Facile synthesis and application in water purification. *Journal of Hazardous Materials*, *186*(1), 921–931.

Srivastava, N. K., & Majumder, C. B. (2008). Novel biofiltration methods for the treatment of heavy metals from industrial wastewater. *Journal of Hazardous Materials*, *151*(1), 1–8.

Stobinski, L., Lesiak, B., & Malolepszy, A. (2014). Graphene oxide and reduced graphene oxide studied by the XRD, TEM and electron spectroscopy methods. *Journal of Electron Spectroscopy and Related Phenomena*, *195*, 145–154.

Sulak, M. T., & Yatmaz, H. C. (2012). Removal of textile dyes from aqueous solutions with eco-friendly biosorbent. *Desalination and Water Treatment*, *37*(January), 169–177.

Sun, L., Miznikov, E., Wang, L., & Adin, A. (2009). Nickel removal from wastewater by electroflocculation-filtration hybridization. *Desalination*, *249*(2), 832–836.

Sundramoorthy, A. K., & Gunasekaran, S. (2014). Applications of graphene in quality assurance and safety of food. *TrAC Trends in Analytical Chemistry*, *60*, 36–53.

Szatanik-Kloc, A. (2014). Application of adsorption methods to determine the effect of pH and Cu-stress on the changes in the surface properties of the roots. *International Agrophysics*, *28*(4), 511–520.

T. S. Sreeprasad, Soujit Sen Gupta, S. M. M. and, & Pradeep, T. (2013). Immobilized graphene-based composite from asphalt: Facile synthesis and application in water purification. *International Materials Reviews*, *247*, 1–19.

Talaiekhozani, A., & Rezania, S. (2017). Journal of Water Process Engineering Application of photosynthetic bacteria for removal of heavy metals , macro- pollutants and dye from wastewater : A review. *Journal of Water Process Engineering*, *19*(June), 312–321.

Teka, T., & Enyew, S. (2014). Study on Effect of Different Parameters on Adsorption Efficiency of Low Cost Activated Orange Peels for the Removal of Methyelene Blue Dye, *8*(1), 106–111.

Todor, Bulei & Heput (2018). Researches on the development of new composite materials complete / partially biodegradable using natural textile fibers of new vegetable origin and those recovered from textile waste. *IOP Conference Series: Materials Science and Engineering*, *294*, 12021.

Torres-Knoop, A., Poursaeidesfahani, A., Vlugt, T. J. H., & Dubbeldam, D. (2017). Behavior of the Enthalpy of Adsorption in Nanoporous Materials Close to Saturation Conditions. *Journal of Chemical Theory and Computation*, *13*(7), 3326–3339.

Tran, T.-K., Chiu, K.-F., Lin, C.-Y., & Leu, H.-J. (2017). Electrochemical treatment of wastewater: Selectivity of the heavy metals removal process. *International Journal of Hydrogen Energy*, *2*, 2–9.

Tuttle-Raycraft, S., Morris, T. J., & Ackerman, J. D. (2017). Suspended solid concentration reduces feeding in freshwater mussels. *Science of the Total Environment*, *598*, 1160–1168.

Umh, H. N., & Kim, Y. (2014). Sensitivity of nanoparticles' stability at the point of zero charge (PZC). *Journal of Industrial and Engineering Chemistry*, *20*(5), 3175–3178.

Uva, M., Tambasco, M., Grassi, G., Corsi, I., Protano, G., & Atrei, A. (2017). Carboxymethylcellulose hydrogels cross-linked with magnetite nanoparticles for the removal of organic and inorganic pollutants from water. *Journal of Environmental Chemical Engineering*, *5*(4), 3632–3639.

Varma, S., Sarode, D., Wakale, S., Bhanvase, B. a, & Deosarkar, M. P. (2013). Removal of Nickel from Waste Water Using Graphene Nanocomposite. *International Journal of Chemical and Physical Sciences*, *2*(March), 132–139.

Vedad, J., Mojica, E. R. E., & Desamero, R. Z. B. (2018). Raman spectroscopic discrimination of estrogens. *Vibrational Spectroscopy*, *96*, 93–100.

Vinod Kumar Gupta, Imran Ali, Tawfik A. Saleh, A. N. and S. A. (2012). Chemical treatment technologies for waste-water recycling—an overview. *RSC Advances*, (16).

Visa, M., Bogatu, C., & Duta, A. (2010). Simultaneous adsorption of dyes and heavy metals from multicomponent solutions using fly ash. *Applied Surface Science*, *256*(17), 5486–5491.

Vukelic, D., Boskovic, N., Agarski, B., Radonic, J., Budak, I., Pap, S., & Turk Sekulic, M. (2018). Eco-design of a low-cost adsorbent produced from waste cherry kernels. *Journal of Cleaner Production*, *174*, 1620–1628.

Wang, H., Qin, J., & Hu, Y. (2017). Are green roofs a source or sink of runoff pollutants ? *Ecological Engineering*, *107*, 65–70.

Wang, J., Qin, L., Lin, J., Zhu, J., Zhang, Y., Liu, J., & Van der Bruggen, B. (2017). Enzymatic construction of antibacterial ultrathin membranes for dyes removal. *Chemical Engineering Journal*, *323*, 56–63.

Wang, Q., & Yang, Z. (2016). Industrial water pollution , water environment treatment , and health risks in China. *Environment Pollution*, *218*, 358–365.

Wang, W., Huang, G., An, C., Xin, X., Zhang, Y., & Liu, X. (2017). Transport behaviors of anionic azo dyes at interface between surfactant-modified flax shives and aqueous solution: Synchrotron infrared and adsorption studies. *Applied Surface Science*, *405*, 119–128.

Wit, C. a De, Diamond, M., Molander, S., Arvidsson, R., Bergman, Å., Hauschild, M., … Zetzsch, C. (2015). Draft title : Exploring the planetary boundary for chemical pollution. *Environment International*, *78*, 8–15.

Wnuk, J. D., Rosenberg, S. G., Gorham, J. M., Van Dorp, W. F., Hagen, C. W., & Fairbrother, D. H. (2011). Electron beam deposition for nanofabrication: Insights from surface science. *Surface Science*, *605*(3–4), 257–266.

Wuana, R. A., & Okieimen, F. E. (2011). Heavy Metals in Contaminated Soils: A Review of Sources, Chemistry, Risks and Best Available Strategies for Remediation. *ISRN Ecology*, *2011*, 1–20.

Wuhrer, R., & Moran, K. (2016). X-ray Mapping Characterisation of Materials that have a Large Dynamic Compositional Range. *Microscopy and Microanalysis*, *22*(S3), 114–115.

Yang, H., Baudet, B. A., & Yao, T. (2016). Characterization of the surface roughness of sand particles using an advanced fractal approach. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Science*, *472*(2194), 20160524.

Yang, R., Li, D., Li, A., & Yang, H. (2018). Adsorption properties and mechanisms of palygorskite for removal of various ionic dyes from water. *Applied Clay Science*, *151*(July 2017), 20–28.

Yang, S., Wu, Y., Aierken, A., Zhang, M., Fang, P., & Fan, Y. (2016). Journal of the Taiwan Institute of Chemical Engineers Mono / competitive adsorption of Arsenic (III) and Nickel (II) using modified green tea waste, *60*, 213–221.

Yao, M., Chul, Y., Tijing, L. D., Choi, J., & Kyong, H. (2017). Effects of volatile organic compounds on water recovery from produced water via vacuum membrane distillation. *Desalination*.

Yari, M., Rajabi, M., Moradi, O., Yari, A., Asif, M., Agarwal, S., & Gupta, V. K. (2015). Kinetics of the adsorption of Pb(II) ions from aqueous solutions by graphene oxide and thiol functionalized graphene oxide. *Journal of Molecular Liquids*, *209*, 50–57.

Yin, P. T., Shah, S., Chhowalla, M., & Lee, K.-B. (2015). Design, Synthesis, and Characterization of Graphene–Nanoparticle Hybrid Materials for Bioapplications. *Chemical Reviews*, 22-36.

Zare, E. N., Motahari, A., & Sillanpää, M. (2018). Nanoadsorbents based on conducting polymer nanocomposites with main focus on polyaniline and its derivatives for removal of heavy metal ions/dyes: A review. *Environmental Research*, *162*(December 2017), 173–195.

Zazycki, M. A., Tanabe, E. H., Bertuol, D. A., & Dotto, G. L. (2017). Adsorption of valuable metals from leachates of mobile phone wastes using biopolymers and activated carbon. *Journal of Environmental Management*, *188*, 18–25.

Zhang, M. L., Sheng, G. P., & Yu, H. Q. (2008). Determination of proteins and carbohydrates in the effluents from wastewater treatment bioreactors using resonance light-scattering method. *Water Research*, *42*(13), 3464–3472.

Zhang, X., & Wang, X. (2015). Adsorption and desorption of Nickel(II) ions from aqueous solution by a lignocellulose/montmorillonite nanocomposite. *PLoS ONE*, *10*(2), 1–21.

Zheng, A., Zhao, K., Li, L., Zhao, Z., Jiang, L., Huang, Z., … Li, H. (2017). Quantitative comparison of different chemical pretreatment methods on chemical structure and pyrolysis characteristics of corncobs. *Journal of the Energy Institute*, 1–7.

Zhou, E., He, Y., Ma, X., Liu, G., Huang, Y., Chen, C., & Wang, W. (2017). Study of the combination of sulfuric acid treatment and thermal regeneration of spent powdered activated carbons from decolourization process in glucosamine production. *Chemical Engineering and Processing: Process Intensification*, *121*(May), 224–231.