CHAPTER V
CONCLUSION AND SUGGESTIONS

V.1. Conclusions

MPN/RGO prepared from two different methods and ratio of GO (or MPN/GO) : extract did not have a significant effect on adsorption capacity over MG dye and thus, a ratio of 1:0.125 is selected as the best ratio during MPN/RGO preparation. SEM-EDX analysis showed that the % atomic weight of O and Fe in MPN/RGO method I was lower than in MPN/RGO method II. While, FTIR analysis perfomed on MPN/RGO resulted the reduction of MPN/RGO via method II was not completed. However, their adsorption capacities were comparable.

The MPN/RGO exhibited remarkable MG adsorption capability and the adsorption kinetic was found to be pseudo second-order in nature and tend to be controlled by chemisorption mechanisms. The intraparticle diffusion model shows that the adsorption process is controlled by surface adsorption. The adsorption isotherm model that is more suitable for MG adsorption by MPN/RGO method I and II is Langmuir model. The q_{max} values obtained by MPN/RGO methods I and II at 50°C were 349.4761 and 360.3766 mg/g, respectively. The results of adsorption thermodynamics indicate that the adsorption process occurs spontaneously and endothermic.

V.2. Suggestions

The adsorption of MG by MPN/RGO resulted high adsorption capacity. Therefore, the ability of this adsorbent to hold other adsorbates such metals and other dyes commonly present in wastewater can be studied further.

The repeated cycles of MPN/RGO as adsorbent for dye adsorption need to be investigated to know the stability of adsorbent in aqueous solution which in turn seek a promising candidate for dye adsorption in industrial wastewater.

XPS characterization is needed on MPN/RGO to determine the number of oxygen functional groups through the C/O ratio. The results of this analysis are used to determine the success level of GO or MPN/GO reduction.

REFERENCES

1. Srivastava, S., Sinha, R., dan Roy, D., “Toxicological effects of malachite green” *Aquat. Toxicol.* 2004, 66, 319–329.
2. Han, P., Shi, J., Nie, T., Zhang, S., Wang, X., Yang, P., Wu, H., dan Jiang, Z., “Conferring Natural-Derived Porous Microspheres with Surface Multifunctionality through Facile Coordination-Enabled Self-Assembly Process” *ACS Appl. Mater. Interfaces* 2016, 8, 8076–8085.
3. Sykam, N., Madhavi, V., dan Rao, G.M., “Rapid and efficient green reduction of graphene oxide for outstanding supercapacitors and dye adsorption applications” *J. Environ. Chem. Eng.* 2018, 6, 3223–3232.
4. Hameed, B.H. dan El-Khaiary, M.I., “Malachite green adsorption by rattan sawdust: Isotherm, kinetic and mechanism modeling” *J. Hazard. Mater.* 2008, 159, 574–579.
5. Qu, W., Yuan, T., Yin, G., Xu, S., Zhang, Q., dan Su, H., “Effect of properties of activated carbon on malachite green adsorption” *Fuel* 2019, 249, 45–53.
6. Tahir, S.S. dan Rauf, N., “Removal of a cationic dye from aqueous solutions by adsorption onto bentonite clay” *Chemosphere* 2006, 63, 1842–1848.
7. Wu, Y., Zhang, S., Guo, X., dan Huang, H., “Adsorption of chromium(III) on lignin” *Bioresour. Technol.* 2008, 99, 7709–7715.
8. Pham, T.H., Lee, B.K., dan Kim, J., “Improved adsorption properties of a nano zeolite adsorbent toward toxic nitrophenols” *Process Saf. Environ. Prot.* 2016, 104, 314–322.
9. Natale, F. Di, Lancia, A., Molino, A., dan Musmarra, D., “Removal of chromium ions form aqueous solutions by adsorption on activated carbon and char” *J. Hazard. Mater.* 2007, 145, 381–390.
10. Xu, J., Wang, L., dan Zhu, Y., “Decontamination of bisphenol A from aqueous solution by graphene adsorption” *Langmuir* 2012, 28, 8418–8425.
11. Kyzas, G.Z., Deliyanni, E.A., dan Matis, K.A., “Graphene oxide and its application as an adsorbent for wastewater treatment” *J. Chem. Technol. Biotechnol.* 2014, 89, 196–205.
12. Bhattacharya, G., Sas, S., Wadhwa, S., Mathur, A., McLaughlin, J., dan Roy, S.S., “Aloe vera assisted facile green synthesis of reduced graphene oxide for electrochemical and dye removal applications” *RSC Adv.* 2017, 7, 26680–26688.

13. Söğüt, E.G., Karataş, Y., Gülcan, M., dan Kılıç, N.Ç., "Enhancement of adsorption capacity of reduced graphene oxide by sulfonic acid functionalization: Malachite green and Zn (II) uptake" *Mater. Chem. Phys.* 2020, 256.
14. Yu, L., Wang, L., Xu, W., Chen, L., Fu, M., Wu, J., dan Ye, D., "Adsorption of VOCs on reduced graphene oxide" *J. Environ. Sci.* 2018, 67, 171–178.
15. Xue, T., Wang, Z., Weiming, G., Changmin, H., Shi, Z., Zheng, W., dan Cui, X., "Investigating the interaction of dye molecules with graphene oxide by using surface plasmon resonance technique" *RSC Adv.* 2014, 9, 677–683.
16. Jin, X., Li, N., Weng, X., Li, C., dan Chen, Z., "Green reduction of graphene oxide using eucalyptus leaf extract and its application to remove dye" *Chemosphere* 2018, 208, 417–424.
17. Sir Elkhatim, K.A., Elagib, R.A.A., dan Hassan, A.B., "Content of phenolic compounds and vitamin C and antioxidant activity in wasted parts of Sudanese citrus fruits" *Food Sci. Nutr.* 2018, 6, 1214–1219.
18. Ramanathan, S., Moorthy, S., Ramasundaram, S., Rajan, H.K., Vishwanath, S., Selvinsimpson, S., Durairaj, A., Kim, B., dan Vasanthkumar, S., "Grape Seed Extract Assisted Synthesis of Dual-Functional Anatase TiO2Decorated Reduced Graphene Oxide Composite for Supercapacitor Electrode Material and Visible Light Photocatalytic Degradation of Bromophenol Blue Dye" *ACS Omega* 2021, 6, 14734–14747.
19. Piluzza, G. dan Bullitta, S., "Correlations between phenolic content and antioxidant properties in twenty-four plant species of traditional ethnoveterinary use in the Mediterranean area" *Pharm. Biol.* 2011, 49, 240–247.
20. Lubinska-Szczygieł, M., Różańska, A., Namieśnik, J., Dymerski, T., Shafreen, R.B., Weisz, M., Ezra, A., dan Gorinstein, S., "Quality of limes juices based on the aroma and antioxidant properties" *Food Control* 2018, 89, 270–279.
21. Ayucitra, A., Irawaty, W., Jonathan, K., Hartono, C.D., dan Nugraha, A.T., "Optimization of Phenolic Compounds Extraction from Averrhoa bilimbi and Citrus hystrix peel Using Statistical Design of Experiment" *ARPN J. Eng. Appl. Sci.* 2016, 11, 13783–13789.

22. Abd Ghafar, M.F., Prasad, K.N., Weng, K.K., dan Ismail, A., "Flavonoid, hesperidine, total phenolic contents and antioxidant activities from Citrus species" *African J. Biotechnol.* 2010, 9, 326–330.
23. Gorinstein, S., Martin-Belloso, O., Lojek, A., Číž, M., Soliva-Fortuny, R., Park, Y.S., Caspi, A., Libman, I., dan Trakhtenberg, S., "Comparative content of some phytochemicals in Spanish apples, peaches and pears" *J. Sci. Food Agric.* 2002, 82, 1166–1170.
24. Chan, S.W., Lee, C.Y., Yap, C.F., Wan Aida, W.M., dan Ho, C.W., "Optimisation of extraction conditions for phenolic compounds from limau purut (Citrus hystrix) peels" *Int. Food Res. J.* 2009, 16, 203–213.
25. Zengin Kurt, B., Durmus, Z., dan Sevgi, E., "In situ reduction of graphene oxide by different plant extracts as a green catalyst for selective hydrogenation of nitroarenes" *Int. J. Hydrogen Energy* 2019, 44, 26322–26337.
26. Chen, J., Yao, B., Li, C., dan Shi, G., "An improved Hummers method for eco-friendly synthesis of graphene oxide" *Carbon N. Y.* 2013, 64, 225–229.
27. Amin, M. dan Khodabakhshi, A., "Determination of malachite green in trout tissue and effluent water from fish farms" *Int. J. Environ. Health Eng.* 2012, 1, 10.
28. Garg, V.K., Kumar, R., dan Gupta, R., "Removal of malachite green dye from aqueous solution by adsorption using agro-industry waste: A case study of Prosopis cineraria" *Dye. Pigment.* 2004, 62, 1–10.
29. Bulut, E., Özacar, M., dan Şengil, I.A., "Adsorption of malachite green onto bentonite: Equilibrium and kinetic studies and process design" *Microporous Mesoporous Mater.* 2008, 115, 234–246.
30. Dreyer, D.R., Park, S., Bielawski, C.W., dan Ruoff, R.S., "The chemistry of graphene oxide" *Chem. Soc. Rev.* 2010, 39, 228–240.
31. Nizami, M.Z.I., Takashiba, S., dan Nishina, Y., "Graphene oxide: A new direction in dentistry" *Appl. Mater. Today* 2020, 19, 100576.
32. Wijaya, R., Andersan, G., Permatasari Santoso, S., dan Irawaty, W., "Green Reduction of Graphene Oxide using Kaffir Lime Peel Extract (Citrus hystrix) and Its Application as Adsorbent for Methylene Blue" *Sci. Rep.* 2020, 10, 1–9.
33. Butryee, C., Sungpuag, P., dan Chitchumroonchokchai, C., "Effect of processing on the flavonoid content and antioxidant capacity of Citrus hystrix leaf" *Int. J. Food Sci. Nutr.* 2009, 60, 162–174.

34. He, Y.Q., Li, R.Q., Wu, D., Zhang, Y.L., Gao, J.P., dan Yan, J., "Graphene oxide reduced and dispersed by polysaccharide" *Appl. Mech. Mater.* 2013, 341–342, 233–236.
35. Lee, G. dan Kim, B.S., "Biological reduction of graphene oxide using plant leaf extracts" *Biotechnol. Prog.* 2014, 30, 463–469.
36. Mahendran, G.B., Ramalingam, S.J., Rayappan, J.B.B., Kesavan, S., Periathambi, T., dan Nesakumar, N., "Green preparation of reduced graphene oxide by Bougainvillea glabra flower extract and sensing application" *J. Mater. Sci. Mater. Electron.* 2020, 31, 14345–14356.
37. Khan, M., Al-Marri, A.H., Khan, M., Shaik, M.R., Mohri, N., Adil, S.F., Kuniyil, M., Alkhathlan, H.Z., Al-Warthan, A., Tremel, W., Tahir, M.N., dan Siddiqui, M.R.H., "Green approach for the effective reduction of graphene oxide using Salvadora persica L. root (Miswak) extract" *Nanoscale Res. Lett.* 2015, 10, 1–9.
38. B. Maddinedi, S. dan K. Mandal, B., "Biofabrication of Reduced Graphene Oxide Nanosheets using Terminalia Bellirica Fruit Extract" *Curr. Nanosci.* 2015, 12, 94–102.
39. Hou, D., Liu, Q., Cheng, H., Li, K., Wang, D., dan Zhang, H., "Chrysanthemum extract assisted green reduction of graphene oxide" *Mater. Chem. Phys.* 2016, 183, 76–82.
40. Gan, L., Li, B., Chen, Y., Yu, B., dan Chen, Z., "Green synthesis of reduced graphene oxide using bagasse and its application in dye removal: A waste-to-resource supply chain" *Chemosphere* 2019, 219, 148–154.
41. Rohaizad, A., Shahabuddin, S., Shahid, M.M., Rashid, N.M., Hir, Z.A.M., Ramly, M.M., Awang, K., Siong, C.W., dan Aspanut, Z., "Green synthesis of silver nanoparticles from Catharanthus roseus dried bark extract deposited on graphene oxide for effective adsorption of methylene blue dye" *J. Environ. Chem. Eng.* 2020, 8, 1–10.
42. Rajumon, R., Anand, J.C., Ealias, A.M., Desai, D.S., George, G., dan Saravanakumar, M.P., "Adsorption of textile dyes with ultrasonic assistance using green reduced graphene oxide: An in-depth investigation on sonochemical factors" *J. Environ. Chem. Eng.* 2019, 7, 103479.
43. Lin, Z., Weng, X., Ma, L., Sarkar, B., dan Chen, Z., "Mechanistic insights into Pb(II) removal from aqueous solution by green reduced graphene oxide" *J. Colloid Interface Sci.* 2019, 550, 1–9.

44. Ahmad, S., Ahmad, A., Khan, S., Ahmad, S., Khan, I., Zada, S., dan Fu, P., "Algal extracts based biogenic synthesis of reduced graphene oxides (rGO) with enhanced heavy metals adsorption capability" *J. Ind. Eng. Chem.* 2019, 72, 117–124.
45. Li, B., Jin, X., Lin, J., dan Chen, Z., "Green reduction of graphene oxide by sugarcane bagasse extract and its application for the removal of cadmium in aqueous solution" *J. Clean. Prod.* 2018, 189, 128–134.
46. Fathy, N., Abd El-Latif, R., Aboelenin, R., dan Khalil, L., "Green reduction of oxidized graphite to reduced graphene oxide using Zygophyllum album L.f.: Comparative adsorption studies on p-nitrophenol" *Recent Innov. Chem. Eng. (Formerly Recent Patents Chem. Eng.* 2016, 08, 1–16.
47. Juttuporn, W., Thiengkaew, P., Rodklongtan, A., Rodprapakorn, M., dan Chitprasert, P., "Ultrasound-Assisted Extraction of Antioxidant and Antibacterial Phenolic Compounds from Steam-Exploded Sugarcane Bagasse" *Sugar Tech* 2018, 20, 599–608.
48. Wijaya, Y.A., Widyadinata, D., Irawaty, W., dan Ayucitra, A., "Fractionation Of Phenolic Compounds from Kaffir Lime (Citrus hystrix) Peel Extract and Evaluation of Antioxidant Activity" *Reaktor* 2017, 17, 111.
49. Wang, X., Huang, S., Zhu, L., Tian, X., Li, S., dan Tang, H., "Correlation between the adsorption ability and reduction degree of graphene oxide and tuning of adsorption of phenolic compounds" *Carbon N. Y.* 2014, 69, 101–112.
50. Ejima, H., Richardson, J.J., dan Caruso, F., "Metal-phenolic networks as a versatile platform to engineer nanomaterials and biointerfaces" *Nano Today* 2017, 12, 136–148.
51. Ejima, H., Richardson, J.J., Liang, K., Best, J.P., Koeverden, M.P. Van, Such, G.K., Cui, J., dan Caruso, F., "One-step assembly of coordination complexes for versatile film and particle engineering" *Science (80-.).* 2013, 341, 154–157.
52. Ju, Y., Cui, J., Müllner, M., Suma, T., Hu, M., dan Caruso, F., "Engineering Low-Fouling and pH-Degradable Capsules through the Assembly of Metal-Phenolic Networks" *Biomacromolecules* 2015, 16, 807–814.
53. Ju, Y., Cui, J., Sun, H., Müllner, M., Dai, Y., Guo, J., Bertleff-Zieschang, N., Suma, T., Richardson, J.J., dan Caruso, F., "Engineered Metal-Phenolic Capsules Show Tunable Targeted Delivery to Cancer Cells" *Biomacromolecules* 2016, 17, 2268–2276.

54. Rahim, M.A., Lin, G., Tomanin, P.P., Ju, Y., Barlow, A., Björnmalm, M., dan Caruso, F., "Self-Assembly of a Metal-Phenolic Sorbent for Broad-Spectrum Metal Sequestration" *ACS Appl. Mater. Interfaces* 2020, 12, 3746–3754.
55. Bartzoka, E.D., Lange, H., Thiel, K., dan Crestini, C., "Coordination Complexes and One-Step Assembly of Lignin for Versatile Nanocapsule Engineering" *ACS Sustain. Chem. Eng.* 2016, 4, 5194–5203.
56. Ozawa, H. dan Haga, M.A., "Soft nano-wrapping on graphene oxide by using metal-organic network films composed of tannic acid and Fe ions" *Phys. Chem. Chem. Phys.* 2015, 17, 8609–8613.
57. Guo, J., Ping, Y., Ejima, H., Alt, K., Meissner, M., Richardson, J.J., Yan, Y., Peter, K., Elverfeldt, D. Von, Hagemeyer, C.E., dan Caruso, F., "Engineering multifunctional capsules through the assembly of metal-phenolic networks" *Angew. Chemie - Int. Ed.* 2014, 53, 5546–5551.
58. Duan, J., Chen, Z., Liang, X., Chen, Y., Li, H., Tian, X., Zhang, M., Wang, X., Sun, H., Kong, D., Li, Y., dan Yang, J., "Construction and application of therapeutic metal-polyphenol capsule for peripheral artery disease" *Biomaterials* 2020, 255, 120199.
59. Wang, X., Jiang, Z., Shi, J., Zhang, C., Zhang, W., dan Wu, H., "Dopamine-modified alginate beads reinforced by cross-linking via titanium coordination or self-polymerization and its application in enzyme immobilization" *Ind. Eng. Chem. Res.* 2013, 52, 14828–14836.
60. Chen, Z., Duan, J., Diao, Y., Chen, Y., Liang, X., Li, H., Miao, Y., Gao, Q., Gui, L., Wang, X., Yang, J., dan Li, Y., "ROS-responsive capsules engineered from EGCG-Zinc networks improve therapeutic angiogenesis in mouse limb ischemia" *Bioact. Mater.* 2021, 6, 1–11.
61. Liu, R.Y. dan Xu, A.W., "Byssal threads inspired ionic cross-linked narce-like graphene oxide paper with superior mechanical strength" *RSC Adv.* 2014, 4, 40390–40395.
62. Yang, Y., Li, Y., Li, Q., Wang, Y., Tan, C.H., dan Wang, R., "Rapid co-deposition of graphene oxide incorporated metal-phenolic network/piperazine followed by crosslinking for high flux nanofiltration membranes" *J. Memb. Sci.* 2019, 588, 1–10.
63. Zhang, Q., Du, Q., Jiao, T., Zhang, Z., Wang, S., Sun, Q., dan Gao, F., "Rationally designed porous polystyrene encapsulated zirconium phosphate nanocomposite for highly efficient fluoride uptake in waters" *Sci. Rep.* 2013, 3, 1–9.

64. William Kajjumba, G., Emik, S., Öngen, A., Kurtulus Özcan, H., dan Aydın, S., "Modelling of Adsorption Kinetic Processes—Errors, Theory and Application" *Adv. Sorption Process Appl.* 2019.
65. J.P., S. dan J., B., "Intraparticle diffusion-adsorption model to describe liquid/solid adsorption kinetics" *Rev. Mex. Ing. Química* 2016, 15, 161–173.
66. Mourabet, M., Boujaady, H. El, Rhilassi, A. El, Ramdane, H., Bennani-Ziatni, M., Hamri, R. El, dan Taitai, A., "Defluoridation of water using Brushite: Equilibrium, kinetic and thermodynamic studies" *Desalination* 2011, 278, 1–9.
67. Gawande, S.M., Belwalkar, N.S., dan Mane, A.A., "Adsorption and its Isotherm – Theory" *Int. J. Eng. Res.* 2017, 6, 312.
68. Wang, J. dan Guo, X., "Adsorption kinetic models: Physical meanings, applications, and solving methods" *J. Hazard. Mater.* 2020, 390, 122156.
69. Lazaridis, N.K. dan Asouhidou, D.D., "Kinetics of sorptive removal of chromium(VI) from aqueous solutions by calcined Mg-Al-CO3 hydrotalcite" *Water Res.* 2003, 37, 2875–2882.
70. Zhang, Q., Crittenden, J., Hristovski, K., Hand, D., dan Westerhoff, P., "User-oriented batch reactor solutions to the homogeneous surface diffusion model for different activated carbon dosages" *Water Res.* 2009, 43, 1859–1866.
71. Ismadji, S., Soetaredjo, F.E., dan Ayucitra, A., "The Kinetic Studies in the Adsorption of Hazardous Substances Using Clay Minerals"2015, 113–120.
72. Anirudhan, T.S. dan Radhakrishnan, P.G., "Thermodynamics and kinetics of adsorption of Cu(II) from aqueous solutions onto a new cation exchanger derived from tamarind fruit shell" *J. Chem. Thermodyn.* 2008, 40, 702–709.
73. Faniyi, I.O., Fasakin, O., Olofinjana, B., Adekunle, A.S., Oluwasusi, T. V., Eleruja, M.A., dan Ajayi, E.O.B., "The comparative analyses of reduced graphene oxide (RGO) prepared via green, mild and chemical approaches" *SN Appl. Sci.* 2019, 1, 1–7.
74. Zubir, N.A., Yacou, C., Motuzas, J., Zhang, X., dan Diniz Da Costa, J.C., "Structural and functional investigation of graphene oxide-Fe 3 O 4 nanocomposites for the heterogeneous Fenton-like reaction" *Sci. Rep.* 2014, 4, 1–8.
75. Ko, M.P. dan Huang, C.J., "A versatile approach to antimicrobial coatings via metal-phenolic networks" *Colloids Surfaces B Biointerfaces* 2020, 187, 110771.

76. Rout, D.R. dan Jena, H.M., “Removal of malachite green dye from aqueous solution using reduced graphene oxide as an adsorbent” *Mater. Today Proc.* 2021, 47, 1173–1182.
77. Psaltou, S., Kaprara, E., Kalaitzidou, K., Mitrakas, M., dan Zouboulis, A., “The effect of thermal treatment on the physicochemical properties of minerals applied to heterogeneous catalytic ozonation” *Sustain.* 2020, 12, 1–13.
78. Chakraborty, S., Chowdhury, S., dan Saha, P. Das, “Adsorption of Crystal Violet from aqueous solution onto NaOH-modified rice husk” *Carbohydr. Polym.* 2011, 86, 1533–1541.
79. Bradder, P., Ling, S.K., Wang, S., dan Liu, S., “Dye adsorption on layered graphite oxide” *J. Chem. Eng. Data* 2011, 56, 138–141.
80. Rashidi Nodeh, H., Wan Ibrahim, W.A., Ali, I., dan Sanagi, M.M., “Development of magnetic graphene oxide adsorbent for the removal and preconcentration of As(III) and As(V) species from environmental water samples” *Environ. Sci. Pollut. Res.* 2016, 23, 9759–9773.
81. Pratama, A., Destiarti, L., dan Adhitiyawarman, A., “Sintesis Titanium Oksida/Reduced Graphene Oxide (TiO2/rGO) untuk Fotokatalisis Bahan Pewarna Metilen Biru” *Positron* 2021, 11, 31.
82. Gong, Y., Li, D., Fu, Q., dan Pan, C., “Influence of graphene microstructures on electrochemical performance for supercapacitors” *Prog. Nat. Sci. Mater. Int.* 2015, 25, 379–385.
83. Rochman, R.A., Wahyuningsih, S., Ramelan, A.H., dan Hanif, Q.A., “Preparation of nitrogen and sulphur Co-doped reduced graphene oxide (rGO-NS) using N and S heteroatom of thiourea” *IOP Conf. Ser. Mater. Sci. Eng.* 2019, 509.
84. Gupta, K. dan Khatri, O.P., “Reduced graphene oxide as an effective adsorbent for removal of malachite green dye: Plausible adsorption pathways” *J. Colloid Interface Sci.* 2017, 501, 11–21.
85. Li, H., Liu, L., Cui, J., Cui, J., Wang, F., dan Zhang, F., “High-efficiency adsorption and regeneration of methylene blue and aniline onto activated carbon from waste edible fungus residue and its possible mechanism” *RSC Adv.* 2020, 10, 14262–14273.
86. Al-Kinani, A., Gheibi, M., dan Eftekhari, M., “Graphene oxide–tannic acid nanocomposite as an efficient adsorbent for the removal of malachite green from water samples” *Model. Earth Syst. Environ.* 2019, 5, 1627–1633.

87. Park, S., Lee, K.S., Bozoklu, G., Cai, W., Nguyen, S.B.T., dan Ruoff, R.S., "Graphene oxide papers modified by divalent ions - Enhancing mechanical properties via chemical cross-linking" *ACS Nano* 2008, 2, 572–578.
88. Saad, D.M.G., Cukrowska, E.M., dan Tutu, H., "Phosphonated cross-linked polyethylenimine for selective removal of uranium ions from aqueous solutions" *Water Sci. Technol.* 2012, 66, 122–129.
89. Kurniawati, D., Bahrizal, Sari, T.K., Adella, F., dan Sy, S., "Effect of Contact Time Adsorption of Rhodamine B, Methyl Orange and Methylene Blue Colours on Langsat Shell with Batch Methods" *J. Phys. Conf. Ser.* 2021, 1788.
90. Nurdila, F.A., Asri, N.S., dan Suharyadi, D.E., "Adsorpsi Logam Tembaga (Cu), Besi (Fe), dan Nikel (Ni) dalam Limbah Cair Buatan Menggunakan Nanopartikel Cobalt Ferrite" *J. Fis. Indones.* 2015, 19, 23–27.
91. Arivoli, S., Hema, M., dan Prasath, P.M.D., "Adsorption of Malachite Green Onto Carbon Prepared From Borassus Bark Adsorption of Malachite Green Onto Carbon Prepared From" *Arab. J. Sci. Eng.* 2009, 34, 31–42.
92. Önal, Y., Akmil-Başar, C., dan Sarici-Özdemir, Ç., "Investigation kinetics mechanisms of adsorption malachite green onto activated carbon" *J. Hazard. Mater.* 2007, 146, 194–203.
93. Edet, U.A. dan Ifelebuegu, A.O., "Wastewater Using Recycled Brick Waste" *Process* 2020, 8, 1–15.
94. Pholosi, A., Naidoo, E.B., dan Ofomaja, A.E., "Intraparticle diffusion of Cr(VI) through biomass and magnetite coated biomass: A comparative kinetic and diffusion study" *South African J. Chem. Eng.* 2020, 32, 39–55.
95. Zam Zam, Z., Limatahu, N.A., dan Baturante, N.J., "Nitrate Adsorption capacity of Activated Gamalama Volcanic Ash" *JKPK (Jurnal Kim. dan Pendidik. Kim.* 2021, 6, 23.
96. Do, D.D., "Fundamentals of Diffusion and Adsorption in Porous Media"ISBN 1860941303, 1998.
97. Li, Y., Du, Q., Liu, T., Sun, J., Wang, Y., Wu, S., Wang, Z., Xia, Y., dan Xia, L., "Methylene blue adsorption on graphene oxide/calcium alginate composites" *Carbohydr. Polym.* 2013, 95, 501–507.
98. Sahmoune, M.N., "Evaluation of thermodynamic parameters for adsorption of heavy metals by green adsorbents" *Environ. Chem. Lett.* 2019, 17, 697–704.

99. Emeniru, D.C., Onukwuli, O.D., Douyewodu, P., dan Okoro, B.I., "The Equilibrium and Thermodynamics of Methylene Blue Uptake onto Ekowe Clay ; Influence of Acid Activation and Calcination"2015, 17–25.
100. Liu, T., Li, Y., Du, Q., Sun, J., Jiao, Y., Yang, G., Wang, Z., Xia, Y., Zhang, W., Wang, K., Zhu, H., dan Wu, D., "Adsorption of methylene blue from aqueous solution by graphene" *Colloids Surfaces B Biointerfaces* 2012, 90, 197–203.
101. Sharma, P., Saikia, B.K., dan Das, M.R., "Removal of methyl green dye molecule from aqueous system using reduced graphene oxide as an efficient adsorbent: Kinetics, isotherm and thermodynamic parameters" *Colloids Surfaces A Physicochem. Eng. Asp.* 2014, 457, 125–133.