

BAB V

KESIMPULAN DAN SARAN

V.1. Kesimpulan

1. Pembuatan komposit GO-bentonit:ekstrak (1:1) memperoleh kapasitas adsorpsi tertinggi yaitu sebesar 179,4 mg/g pada rasio grafit:bentonit(1:1). Komposit GO-bentonit:ekstrak (1:2) memperoleh kapasitas adsorpsi tertinggi pada rasio grafit:bentonit(1:1) sebesar 151,14 mg/g. Komposit GO-bentonit:ekstrak (1:3) memperoleh kapasitas adsorpsi tertinggi pada rasio grafit:bentonit(3:1) sebesar 182,78 mg/g dan komposit GO-bentonit:ekstrak (1:4) memperoleh kapasitas adsorpsi tertinggi pada rasio grafit:bentonit(3:1) sebesar 183,37 mg/g.
2. Kinetika adsorpsi, isoterm adsorpsi dan besaran termodinamika proses adsorpsi komposit rGO-bentonit terhadap metilen biru belum dapat dipelajari karena memerlukan data lanjutan.

V.2. Saran

1. Komposit rGO-bentonit dapat melakukan proses adsorpsi dengan baik namun belum secara maksimal. Oleh karena itu, perlu dilakukan lebih lanjut dengan aktivasi bentonit terlebih dahulu menggunakan aktivasi kimia maupun fisika.
2. Perlunya pengulangan percobaan untuk memastikan data-data yang telah diperoleh.
3. Perlunya lanjutan pengambilan data percobaan sehingga kinetika adsorpsi, isoterm adsorpsi dan besaran termodinamika proses adsorpsi komposit rGO-bentonit terhadap metilen biru belum dapat dipelajari.

DAFTAR PUSTAKA

1. Zaharia, C. and D. Suteu, "Coal fly ash as adsorptive material for treatment of a real textile effluent: operating parameters and treatment efficiency" *Environmental Science and Pollution Research International* 2012, **20**(4), 2226–2235.
2. Siddique, K., et al., "Textile wastewater treatment options: a critical review" 2017, 183-207.
3. Erickson, K., et al., "Determination of the local chemical structure of graphene oxide and reduced graphene oxide" *Advanced Material* 2010, **22**(40), 4467-4472.
4. Robati, D., et al., "Kinetics and thermodynamics of malachite green dye adsorption from aqueous solutions on graphene oxide and reduced graphene oxide" *Journal of Molecular Liquids* 2016, **214**: p, 259-263.
5. Maddineni, S.b. and B. Mandal, "Biofabrication of reduced graphene oxide nanosheets using terminalia bellirica fruit extract" *Curr. Nanosci.* 2016, **12**(1), 94-102.
6. Darmadinata, M., J. Jumaeri, and T. Sulistyarningsih, "Pemanfaatan bentonit teraktivasi asam sulfat sebagai adsorben anion fosfat dalam air" *Indonesian Journal of Chemical Science* 2019, **8**(1), 1-8.
7. Vezentsev, A.I., et al., "Adsorption of methylene blue on the composite sorbent based on bentonite-like clay and hydroxyapatite" *Indonesian Journal of Chemistry* 2018, **18**(4), 733-741.
8. Hariani, P., et al., "Adsorption of phenol pollutants from aqueous solution using ca-bentonite/chitosan composite" *Jurnal Manusia dan Lingkungan* 2015, **22**(2), 233-239.
9. Laysandra, L., et al., "Adsorption and photocatalytic performance of bentonite-titanium dioxide composites for methylene blue and rhodamine b decoloration" *Heliyon* 2017, **3**(12), e00488.
10. Chen, J., et al., "An improved Hummers method for eco-friendly synthesis of graphene oxide" *Carbon* 2013, **64**, 225-229.
11. Wick, P., et al., "Classification framework for graphene-based materials" *Angew Chem.Int.Ed. Engl.* 2014, **53**(30), 7714-8.
12. Hummers, W.S. and R.E. Offeman, "Preparation of Graphitic Oxide" *Journal of the American Chemical Society* 1958, **80**(6), 1339-1339.
13. Nugrahenny, A., et al., "Preparation and application of reduced graphene oxide as the conductive material for capacitive deionization" *Carbon Letters* 2014, **15**(1), 38-44.

14. Paranthaman, V., et al., "Investigation on the performance of reduced graphene oxide as counter electrode in dye sensitized solar cell applications" *Physica Status Solidi (a)* 2018, **215**(18), 1800298.
15. Zhou, X., et al., "In situ synthesis of metal nanoparticles on single-layer graphene oxide and reduced graphene oxide surfaces" *Journal of Physical Chemistry C - J.Phys.Chem.C.* 2009, **113**(25), 10842–10846.
16. Dimiev, A., "Mechanism of formation and chemical structure of graphene oxide: fundamentals and applications" 2016, 36-84.
17. Dreyer, D., et al., "The chemistry of graphene oxide" *Chem.Soc.Rev.* 2010, **39**(1), 228-240.
18. Aunkor, M.T.H., et al., "The green reduction of graphene oxide" *RSC Advances* 2016, **6**(33), 27807-27828.
19. Gourav Bhattacharya, et al., "Aloe vera assisted facile green synthesis of reduced graphene oxide for electrochemical and dye removal applications" 2017, **7**, 26680-26688.
20. Wijaya, R., et al., "Green reduction of graphene oxide using kaffir lime peel extract (*citrus hystrix*) and its application as adsorbent for methylene blue" *Scientific Reports* 2020, **10**(1), 667.
21. Gan, L., et al., "Green synthesis of reduced graphene oxide using bagasse and its application in dye removal: a waste-to-resource supply chain" *Chemosphere* 2018, **219**, 148-154.
22. Jin, X., et al., "Green reduction of graphene oxide using eucalyptus leaf extract and its application to remove dye" *Chemosphere* 2018, **208**, 417-424.
23. Upadhyay, R., et al., "Grape extract assisted green synthesis of reduced graphene oxide for water treatment application" *Materials Letters* 2015, **160**, 355-358.
24. Puttegowda, M., et al., "15-potential of natural/synthetic hybrid composites for aerospace applications, in Sustainable Composites for Aerospace Applications" *M. Jawaid and M. Thariq, Editors* 2018, Woodhead Publishing, 315-351.
25. Todor, M.P., et al., "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* 2018, **294**, 012021.
26. Linh, H., et al., "Fast and Effective Route for Removing Methylene Blue from Aqueous Solution by Using Red Mud-Activated Graphite Composites" *Journal of Chemistry* 2019, **2019**, 1-7.

27. El-Sharkaway, E.A., et al., "Removal of methylene blue from aqueous solutions using polyaniline/graphene oxide or polyaniline/reduced graphene oxide composites" *Environmental Technology* 2019, 1-9.
28. Dehghani, M.H., et al., "Removal of methylene blue dye from aqueous solutions by a new chitosan/zeolite composite from shrimp waste: Kinetic and equilibrium study" *Korean Journal of Chemical Engineering* 2017, **34**(6), 1699-1707.
29. Shi, H., et al., "Methylene blue adsorption from aqueous solution by magnetic cellulose/graphene oxide composite: equilibrium, kinetics, and thermodynamics" *Industrial & Engineering Chemistry Research* 2014, **53**(3), 1108-1118.
30. Xu, W., et al., "Fabrication of graphene oxide/bentonite composites with excellent adsorption performances for toluidine blue removal from aqueous solution" *Advanced Powder Technology* 2019, **30**(3): p. 493-501.
31. Ourari, A., et al., "Bentonite modified carbon paste electrode as a selective electrochemical sensor for the detection of cadmium and lead in aqueous solution" *International Journal of Electrochemical Science* 2018, **13**(2), 1683-1699.
32. Thales, J., et al., "Hybrid materials based on bentonite functionalized with amine groups via the hydrolytic sol-gel method" *Journal of the Brazilian Chemical Society* 2016, **27**(5). 933-940.
33. Králik, M., "Adsorption, chemisorption, and catalysis" *Chemical Papers* 2014, **68**(12), 1625-1638.
34. Patel, H., "Fixed-bed column adsorption study: a comprehensive review" *Applied Water Science* 2019, **9**(3), 45.
35. Azizi, A., et al., "Adsorption performance of modified graphene oxide nanoparticles for the removal of toluene, ethylbenzene, and xylenes from aqueous solution" *Desalination and Water Treatment* 2016, **57**(59), 28806-28821.
36. Aisyahlika, S.Z., M.L. Firdaus, and R. Elvia, "Kapasitas adsorpsi arang aktif cangkang bintaro (cerbera odollam) terhadap zat warna sintetis reactive red-120 dan reactive blue-198" 2018, **2** (2), 149.
37. Saha, D. and H.A. Grappe, "5-adsorption properties of activated carbon fibers, in Activated Carbon Fiber and Textiles" J.Y. Chen, Editor 2017, Woodhead Publishing: Oxford, 143-165.
38. Wu, S., et al., "Adsorption properties of doxorubicin hydrochloride onto graphene oxide: equilibrium, kinetic and thermodynamic studies" *Materials (Basel, Switzerland)* 2013, **6**(5), 2026-2042.

39. Keno, D., et al., "Correspondence: kinetic, sorption isotherms, pseudo-first-order model and pseudo-second-order model studies of Cu(II) and Pb(II) using defatted Moringa oleifera seed powder" 2016, **5**: p. 71-78.
40. Gehlot, G., S. Verma, and N.M. Sarita Sharma, "Adsorption isotherm studies in the removal of malachite green dye from aqueous solution by using coal fly ash" 2015, **3**(2), 42-44.
41. Hidayat, A., S. Setiadji, and E. Hadisantoso, "sintesis oksida grafena tereduksi (rGO) dari arang tempurung kelapa (cocos nucifera)" *Al-Kimiya* 2019, **5**, 68-73.
42. Irawaty, W., et al., "Design of kaffir lime peel extract tablets by direct compression: Effects of filler-binder on rheological properties" 2014, **8**(4), 85-89.
43. Adhytiawan and A. Azmy, "Pengaruh variasi waktu tahan hidrotermal terhadap sifat kapasitif superkapasitor material graphene" *Jurnal Teknik ITS*, 2013, **2**(1), 45-50.
44. Sykam, N., V. Madhavi, and M. Gowravaram, "Rapid and efficient green reduction of graphene oxide for outstanding supercapacitors and dye adsorption applications" *Journal of Environmental Chemical Engineering* 2018, **6**(2), 3223-3232.
45. Ma, Y.-X., et al., "One-step fabrication of β -cyclodextrin modified magnetic graphene oxide nanohybrids for adsorption of Pb(II), Cu(II) and methylene blue in aqueous solutions" *Applied Surface Science* 2018, **459**, 544-553.
46. Gurushantha, K., et al., "New green synthesized reduced graphene oxide-ZrO₂ composite as high performance photocatalyst under sunlight" *RSC Adv.* 2017, **7**, 12690-12703.
47. Bhattacharya, G., et al., "Aloe vera assisted facile green synthesis of reduced graphene oxide for electrochemical and dye removal applications" *RSC Advances* 2017, **7**(43), 26680–26688.
48. P C, N., et al., "Spinach assisted green reduction of graphene oxide and its antioxidant and dye absorption properties" *Ceramics International* 2015, **41**, 4810-4813.
49. C Gowda, U., N. Bhushana, and S. Sharma, "Clove extract mediated facile green reduction of graphene oxide, its dye elimination and antioxidant properties" *Materials Letters* 2015, **142**, 4-6.
50. Bradder, P., et al., *Dye adsorption on layered graphite oxide*. Journal of Chemical & Engineering Data, 2011. **56**(1). 138-141.
51. Arias Arias, F., et al., *The adsorption of methylene blue on eco-friendly reduced graphene oxide*. Nanomaterials (Basel), 2020. **10**(4). 681.

52. Chang, Y.S., et al., *Adsorption of Cu(II) and Ni(II) ions from wastewater onto bentonite and bentonite/GO composite*. Environmental Science and Pollution Research, 2020.
53. Gupta, K. and O.P. Khatri, *Reduced graphene oxide as an effective adsorbent for removal of malachite green dye: Plausible adsorption pathways*. Journal of Colloid and Interface Science, 2017. **501**. 11-21.
54. Ribeiro Dos Santos, F., H.C. de Oliveira Bruno, and L. Zelayaran Melgar, *Use of bentonite calcined clay as an adsorbent: equilibrium and thermodynamic study of Rhodamine B adsorption in aqueous solution*. Environ Sci Pollut Res Int, 2019. **26**(28). 28622-28632.
55. Chen, L., et al., *Adsorption of methylene blue in water by reduced graphene oxide: Effect of functional groups*. Materials Express, 2013. **3**(4). 281-290.
56. Susilawati, S. and N. Nurul Alam, *Chemical activation of bentonite clay and its adsorption properties of methylene blue*. Jurnal Natural Unsyiah, 2014. **14**(2). 7-11.
57. Amari, A., et al., *Effect of structure and chemical activation on the adsorption properties of green clay minerals for the removal of cationic dye*. Applied Sciences, 2018. **8**(11). 2302.
58. Istighfar, N., *Improved cooking oil with adsorption method using bentonite-activated carbon moringa seeds*. Malang: UIN. Indoensian, 2010.
59. Suarya, P., *Adsorpsi pengotor minyak daun cengkeh oleh lempung teraktivasi asam*. Jurnal Kimia (Journal of Chemistry), 2008. **2**(1). 19-24.
60. Naswir, M., et al., *The development of nanotechnology bentonite as adsorbent of metal Cadmium (Cd)*. Journal of Physics: Conference Series, 2018. **1116**(4). 042026.
61. C.R, M., et al., *Adsorption behaviour of reduced graphene oxide towards cationic and anionic dyes: Co-action of electrostatic and $\pi-\pi$ interactions*. Materials Chemistry and Physics, 2017. **194**. 243-252.
62. Xiao, J., et al., *Environmentally friendly reduced graphene oxide as a broad-spectrum adsorbent for anionic and cationic dyes via $\pi-\pi$ interactions*. Journal of Materials Chemistry A, 2016. **4**(31). 12126-12135.
63. Nugraha, M.S., F.W. Mahatmanti, and T. Sulistyaningsih, *Pemanfaatan bentonit teraktivasi hcl sebagai adsorben ion logam Cd(II)*. Indonesian Journal of Chemical Science, 2017. **6**(3). 196-201.
64. Pusch, R., *Bentonite clay : environmental properties and applications*. 2015. 360.

65. Zaki, A.B., et al., *Kinetics and mechanism of the sorption of some aromatic amines onto amberlite ira-904 anion-exchange resin*. Journal of Colloid and Interface Science, 2000. **221**(1). 58-63.
66. Hong, S., et al., *Adsorption thermodynamics of methylene blue onto bentonite*. Journal of Hazardous Materials, 2009. **167**(1). 630-633.
67. Gupta, V.K., S.K. Srivastava, and D. Mohan, *Equilibrium uptake, sorption dynamics, process optimization, and column operations for the removal and recovery of malachite green from wastewater using activated carbon and activated slag*. Industrial & Engineering Chemistry Research, 1997. **36**(6). 2207-2218.