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REMOVAL OF CADMIUM IONS VIA THE MAGNETIC BIOCHAR SYNTHESISED FROM SUGARCANE BAGASSE: FACTORS AFFECTING YIELD AND ADSORPTION CAPABILITY

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Abstract

The sugarcane bagasse (SCB) was a precursor in synthesising magnetic biochar using a modified single-stage electric muffle furnace to remove Cd2+ ions in industrial wastewater. Nickel (II) oxide (NiO2) was added to boost the efficiency of yield and the removal of heavy metals. The magnetic biochar (MBN3) was optimally synthesised at 500 °C for 30 min with an IR of 0.4 to evaluate its performance in adsorption capability. Analyses of Field Emission Scanning Electronic Microscopy indicated that pores in the magnetic biochar enlarged after the impregnation and decomposition with an average diameter of 3.2 nm (MBN3) and surface area of 63.5 m2g-1. The highest removal for Cd2+ onto MBN3 was 87.6%, reaching pH 6.0 and an agitation speed of 125 rpm for 60 min. The maximum adsorption capacity (qm) for the adsorption of Cd2+ onto MBN3 was 47.9 mgg-1. The adsorbent followed the pseudo-second-order kinetic model and the Langmuir-Freundlich isotherm model with R2 = 0.9853 (Langmuir) and R2 = 0.9538 (Freundlich), suggesting that the surface of MBN3 might be heterogeneous with different classes of active sites, heavy metals were adsorbed on some classes of active sites only, rather than on all active sites © Penerbit UMT

Author Keywords

adsorption; biomass; Carbon materials; magnetic materials; water remediation

References

- Abioye, A. M., Ani, F. N.
  Advancement in the production of activated carbon from biomass using microwave heating
  (2017) *Jurnal Teknologi*, 79 (3), pp. 79-88.
- Amphlett, J. T., Choi, S., Parry, S. A., Moon, E. M., Sharrad, C. A., Ogden, M. D.
  Insights on uranium uptake mechanisms by ion exchange resins with chelating functionalities: Chelation vs. anion exchange
  (2020) *Chemical Engineering Journal*, 392, p. 123712.
- Andas, J., Rahman, M. L. A., Yahya, M. S. M.
  Preparation and characterization of activated carbon from palm kernel shell
  (2017) *IOP Conference Series: Materials Science and Engineering*, 226 (1), p. 012156.
- Aneyo, I. A., Doherty, F. V, Adebesin, O. A., Hammed, M. O.
  Biodegradation of pollutants in wastewater from pharmaceutical, textile and local dye effluent in Lagos, Nigeria
  (2016) *Journal of Health and Pollution*, 6 (12), pp. 34-42.
- Bag, O., Tekin, K., Karagoz, S.
  Microporous activated carbons from lignocellulosic biomass by KOH activation
  (2020) *Fullerenes, Nanotubes and Carbon Nanostructures*, 28 (12), pp. 1030-1037.
- Chakraborty, R., Asthana, A., Singh, A. K., Jain, B., Susan, A. B. H.
  Adsorption of heavy metal ions by various lowcost adsorbents: A review

(2022) *International Journal of Environmental Analytical Chemistry*, 102 (2), pp. 342-379.

- Chen, T., Zhou, Z., Han, R., Meng, R., Wang, H., Lu, W.
  Adsorption of cadmium by biochar derived from municipal sewage sludge: Impact factors and adsorption mechanism
  (2015) *Chemosphere*, 134, pp. 286-293.

- Collard, F. X., Blin, J., Bensakhria, A., Vaiette, J.
  Influence of impregnated metal on the pyrolysis conversion of biomass constituents
  (2012) *Journal of Analytical Applied Pyrolysis*, 95, pp. 213-226.

- Cullity, B. D.
  (1956) *Elements of X-ray diffraction*,
  (2nd ed). Addison-Wesley Publishing Company, Inc

- Ding, Y., Jing, D., Gong, H., Zhou, L., Yang, X.
  Biosorption of aquatic cadmium (II) by unmodified rice straw
  (2012) *Bioresources Technology*, 114, pp. 20-25.

- Engwa, G. A., Ferdinand, P. U., Nwalo, F. N., Unachukwu, M. N.
  Mechanism and health effects of heavy metal toxicity in humans
  (2019) *Poisoning in the modern world-new tricks for an old dog? IntechOpen*,
  Karcioglu, Ô. & B. Arslan (Eds)

- Ferlay, J., Colombet, M., Soerjomataram, I, Mathers, C, Parkin, D.M, Pineros, M, Znaor, A, Bray, F.
  Estimating the global cancer incidence and mortality in 2018: GLOBOCON sources and methods
  (2019) *International Journal of Cancer*, 144 (8), pp. 1941-1953.

- Foo, K. Y., Hameed, B. H.
  Mesoporous activated carbon from wood sawdust by K2CO3 activation using microwave heating
  (2012) *Bioresources Technology*, 111, pp. 425-432.

- Foo, K. Y., Hameed, B. H.
  Preparation, characterization and evaluation of adsorptive properties of orange peelbased activated carbon via microwave-induced K2CO3 activation
  (2012) *Bioresources Technology*, 104, pp. 679-686.

- Foo, K.Y., Hameed, B.H.
  Coconut husk derived activated carbon via microwave-induced activation: effects of activation agents, preparation parameters and adsorption performance
  (2012) *Chemical Engineering Journal*, 184, pp. 57-65.

- Grassi, M., Kaykioglu, G., Belgiorno, V, Lofrano, G.
  Removal of emerging contaminants from water and wastewater by adsorption process
  (2012) *Emerging Compounds Removal from Wastewater Natural and Solar Based Treatments*, pp. 15-37.
  Lofrano, G. (Eds), Netherlands: Springer

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

- Li, H., Awadh, S., Mahyoub, A., Liao, W., Xia, S., Zhao, H., Guo, M.
  Effect of pyrolysis temperature on characteristics and aromatic contaminants adsorption behavior of magnetic biochar derived from pyrolysis oil distillation

residue
(2017) *Bioresources Technology*, 223, pp. 20-26.

- Li, H., Dong, X., da Silva, E. B., de Oliveira, L. M., Chen, Y., Ma, L. Q.
Mechanisms of metal sorption by biochars: Biochar characteristics and modifications
(2017) *Chemosphere*, 178, pp. 466-478.

- Lu, H., Zhang, W., Yang, Y., Huang, X., Wang, S., Qiu, R.
Relative distribution of pb2+ sorption mechanisms by sludge-derived biochar
(2012) *Water Research*, 46, pp. 854-862.

- Manjuladevi, M., Anitha, R., Manonmani, S.
Kinetic study on adsorption of Cr (VI), Ni (II), Cd (II) and Pb (II) ions from aqueous solutions using activated carbon prepared from Cucumis melo peel
(2018) *Applied Water Science*, 8 (1), pp. 1-8.

- Moubarik, A., Grimi, N.
Valorization of olive stone and sugarcane bagasse byproducts as bio sorbents for the removal of cadmium from aqueous solution
(2014) *Food Research International*, 73, pp. 169-175.

- Mubarak, N. M., Kundu, A., Sahu, J. N., Abdullah, E. C., Jayakumar, N. S.
Synthesis of palm oil empty fruit bunch magnetic pyrolytic char impregnating with FeCq by microwave heating technique
(2014) *Biomass and Bioenergy*, 61, pp. 265-275.

- Peng, J., Liu, X., Bao, Z.
Pyrolysis behaviour of basswood by TG
(2019) *IOP Conference Series: Materials Science and Engineering*, 490 (2), p. 022051.

- Richardson, Y., Motuzas, J., Julbe, A., Vblle, G., Blin, J.
Catalytic investigation of in situ generated Ni metal nanoparticles for tar conversion during biomass pyrolysis
(2013) *The Journal of Physical Chemistry C*, 117, pp. 23812-23831.

- Saleh, T. A., Mustaqeem, T., Khaled, M.
Water treatment technologies in removing heavy metal ions from wastewater: A review
(2022) *Environmental Nanotechnology, Monitoring & Management*, 17, p. 100617.

- Saleh, T. A., Sari, A., Tuzen, M.
Simultaneous removal of polyaromatic hydrocarbons from water using polymer modified carbon
(2022) *Biomass Conversion and Biorefinery*,

- Shafie, S. M., Mahlia, T. M. I., Masjuki, H. H., Andriyana, A.
Current energy usage and sustainable energy in Malaysia: A Review
(2011) *Renewable & Sustainable Energy Reviews*, 15 (9), pp. 4370-4377.

- Sun, K., Ro, K., Guo, M., Novak, J., Mashayekhi, H., Xing, B.
Sorption of bisphenol A, 17a-ethinyl estradiol and phenanthrene on thermally and hydrothermally produced biochars
(2011) *Bioresources Technology*, 102, pp. 5757-5763.

- Tan, C., Yaxin, Z., Hongtao, W., Wenjing, L., Zeyu, Z., Yuancheng, Z., Lulu, R.
Influence of pyrolysis temperature on characteristics and heavy metal adsorptive performance of biochar derived from municipal sewage sludge
(2014) *Bioresources Technology*, 164, pp. 47-54.

- Tungal, R., Shende, R. V, Christopher, L. P.
Nickel catalyzed high-pressure hydrothermal processing of biomass for H2 production
(2011) *Journal of Energy and Power Engineering*, 5, pp. 504-514.

- Unugul, T., Nigiz, F. U.
Preparation and characterization of an active carbon adsorbent from waste mandarin peel and determination of adsorption behaviour on the removal of synthetic dye solutions
(2020) *Water, Air, & Soil Pollution*, 231 (11), pp. 1-14.

- Wang, Y., Wang, X., Wang, X., Liu, M., Wu, Z., Yang, L., Xia, S., Zhao, J.
Adsorption of Pb (II) from aqueous solution to Ni-doped bamboo charcoal
(2013) *Journal of Industrial and Engineering Chemistry*, 19, pp. 353-359.

- Wang, Z., Han, L., Sun, K., Jin, J., Ro, K. S., Libra, J. A., Liu, X., Xing, B.
Sorption of four hydrophobic organic contaminants by biochar's derived from maize straw, wood dust and swine manure at different pyrolytic temperatures
(2016) *Chemosphere*, 144, pp. 285-291.

- Wang, Z., Liu, G., Zheng, H., Li, F., Ngo, H. H., Guo, W., Liu, C., Xing, B.
Investigating the mechanisms of biochar's removal of lead from solution
(2015) *Bioresources Technology*, 177, pp. 308-317.

- Wu, L., Liu, X., Lv, G., Zhu, R., Tian, L., Liu, M., Li, Y, Liao, L.
Study on the adsorption properties of methyl orange by natural one-dimensional nano-mineral materials with different structures
(2021) *Scientific Reports*, 11, p. 10640.

- Yu, J. X., Wang, L. Y., Chi, R. A., Zhang, Y. F., Xu, Z. G., Guo, J.
Competitive adsorption of Pb2+ and Cd2+ on magnetically modified sugarcane bagasse prepared in two simple steps
(2013) *Applied Surface Science*, 268, pp. 163-170.

- Zhang, M., Gao, B., Varnoosfaderani, S., Hebard, A., Yao, Y., Inyang, M.
Preparation and characterization of novel magnetic biochar for arsenic removal
(2013) *Bioresources Technology*, 130, pp. 457-462.

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