

## DAFTAR PUSTAKA

- Adamson, A.W., 1990, *Physical Chemistry of Surface*, John Wiley and Sons, Inc., New York.
- Adamson, A.W. and Gast, A.P., 1997, *Physical Chemistry of Surfaces*, John Wiley and Sons, Inc., New York.
- Ahmaruzzaman, M., 2011, Industrial Wastes as Low-Cost Potential Adsorbents for the Treatment of Wastewater Laden with Heavy Metals, *Adv. Colloid Interface Sci.*, 166, 36–59.
- Ali, I., 2012, New Generation Adsorbents for Water Treatment, *Chem. Rev.*, 112, 5073–5091.
- Astuti, W., Bendiyasa, I.M., Wahyuni, E.T., and Prasetya, A., 2010, The Effect of Coal Fly Ash Crystallinity toward Methyl Violet Adsorption Capacity, *ASEAN J. Chem. Eng.*, 10, 8–14.
- Atkins, P.W., 1999, *Kimia Fisika 2*, Erlangga, Jakarta.
- Bassam, R., El Alouani, M., Maissara, J., Jarmouni, N., Belhabra, M., El Mahi Chbihi, M., and Belaaouad, S., 2021, Investigation of Competitive Adsorption and Desorption of Heavy Metals from Aqueous Solution using Raw Rock: Characterization Kinetic, Isotherm, and Thermodynamic, *Mater. Today Proc.*, 1–8.
- Boughrara, L., Sebba, F.Z., Sebti, H., Choukchou-Braham, E., Bounaceur, B., Kada, S.O., and Zaoui, F., 2021, Removal of Zn(II) and Ni(II) Heavy Metal Ions by New Alginic Acid-Ester Derivatives Materials, *Carbohydr. Polym.*, 272, 1–12.
- Buhani, Narsito, Nuryono, and Kunarti, E.S., 2010, Production of Metal Ion Imprinted Polymer from Mercapto-Silica through Sol-Gel Process as Selective Adsorbent of Cadmium, *Desalination*, 251, 83–89.
- Cahyani, A.D., 2014, Pengujian Metode Spektrofotometri UV-Visible untuk Penentuan Hg(II) dalam Limbah Cair Laboratorium Kimia Analitik FMIPA UGM dengan Pereaksi Ditizon, *Skripsi*, Departemen Kimia, Universitas Gadjah Mada, Yogyakarta.
- Castelan, G.W., 1983, *Physical Chemistry*, Addison Wesley Publishing Company, London.
- Celino, A., Goncalves, O., Jacquemin, F., and Freour, S., 2014, Qualitative and Quantitative Assessment of Water Sorption in Natural Fibres using ATR-FTIR Spectroscopy, *Carbohydr. Polym.*, 101, 163–170.

- Cestari, A.R., Vieira, E.F.S., Lopes, E.C.N., and Da Silva, R.G., 2004, Kinetics and Equilibrium Parameters of Hg(II) Adsorption on Silica–Dithizone, *J. Colloid Interface Sci.*, 272, 271–276.
- Christian, G.D. and O’Reilly, J.E., 1988, *Instrumental Analysis*, Allyn and Bacon, Boston.
- Costa, A.C.S., Lopes, L., Korn, M. das G.A., and Portela, J.G., 2002, Separation and Pre-concentration of Cadmium, Copper, Lead, Nickel and Zinc by Solid-Liquid Extraction of their Cocrystallized Naphthalene Dithizone Chelate in Saline Matrices, *J. Braz. Chem. Soc.*, 13, 674–678.
- Darmayanti, L., Notodarmodjo, S., and Damanhuri, E., 2017, Removal of Copper(II) Ions in Aqueous Solutions by Sorption onto Fly Ash, *J. Eng. Technol. Sci.*, 49, 546–559.
- Davies, B.E. and Jones, L.H.P., 1988, Micronutrients and Toxic Elements, *In: Wild, A., Russell’s Soil Conditions and Plant Growth*, John Wiley and Sons, New York, 781–814.
- Deng, J., Kang, X., Chen, L., Wang, Y., Gu, Z., and Lu, Z., 2011, A Nanofiber Functionalized with Dithizone by Co-electrospinning for Lead (II) Adsorption from Aqueous Media, *J. Hazard. Mater.*, 196, 187–193.
- Emeniru, D.C., Onukwuli, O.D., Douyewodu, P.-E., and Okoro, B.I., 2015, The Equilibrium and Thermodynamics of Methylene Blue Uptake onto Ekowe Clay; Influence of Acid Activation and Calcination, *Int. J. Eng. Appl. Sci.*, 2, 17–25.
- Evangeline, C., Pragasam, V., Rambabu, K., Velu, S., Monash, P., Arthanareeswaran, G., and Banat, F., 2019, Iron Oxide Modified Polyethersulfone/Cellulose Acetate Blend Membrane for Enhanced Defluoridation Application, *Desalin. Water Treat.*, 156, 177–188.
- Evanko, C.R. and Dzombak, D.A., 1997, *Remediation of Metals-Contaminated Soils and Groundwater*, Pittsburgh, Pennsylvania.
- Gong, J., Wang, X., Shao, X., Yuan, S., Yang, C., and Hu, X., 2012, Adsorption of Heavy Metal Ions by Hierarchically Structured Magnetite-Carbonaceous Spheres, *Talanta*, 101, 45–52.
- Gultom, E.M. dan Lubis, M.T., 2014, Aplikasi Karbon Aktif dari Cangkang Kelapa Sawit dengan Aktivator H<sub>3</sub>PO<sub>4</sub> untuk Penyerapan Logam Berat Cd dan Pb, *J. Tek. Kim. USU*, 3, 5–10.
- Gupta, S. and Babu, B. V., 2009, Removal of Toxic Metal Cr(VI) from Aqueous Solutions using Sawdust as Adsorbent: Equilibrium, Kinetics and Regeneration Studies, *Chem. Eng. J.*, 150, 352–365.
- Gupta, V.K., Mittal, A., Krishnan, L., and Gajbe, V., 2004, Adsorption Kinetics and Column Operations for The Removal and Recovery of Malachite Green from Wastewater using Bottom Ash, *Sep. Purif. Technol.*, 40, 87–96.

- Hanfi, M.Y., Mostafa, M.Y.A., and Zhukovsky, M. V., 2019, Heavy Metal Contamination in Urban Surface Sediments: Sources, Distribution, Contamination Control, and Remediation, *Environ. Monit. Assess.*, 192, 1–21.
- Hendricks, N.R., 2005, The Application of High Capacity Ion Exchange Absorbent Material, Synthesized from Fly Ash and Acid Mine Drainage, for The Removal of Heavy and Trace Metals from Secondary Co-disposed Process Waters, *Thesis*, Department of Chemistry, University of Western.
- Hessley, R.K., Reasoner, J.W., and Riley, J.T., 1986, *Coal Science: An Introduction to Chemistry, Technology and Utilization*, John Wiley and Sons, Inc., New York.
- Ho, Y.S., 1995, Adsorption of Heavy Metals from Waste Streams by Peat, *Thesis*, Faculty of Engineering, University of Birmingham.
- Ho, Y.S., 2004, Citation Review of Lagergren Kinetic Rate Equation on Adsorption Reactions, *Scientometrics*, 59, 171–177.
- Ho, Y.S. and McKay, G., 1999, Pseudo-second Order Model for Sorption Processes, *Process Biochem.*, 34, 451–465.
- Huda, B.N., Wahyuni, E.T., and Mudasir, M., 2021, Eco-Friendly Immobilization of Dithizone on Coal Bottom Ash for The Adsorption of Lead(II) Ion from Water, *Results Eng.*, 10, 1–12.
- Hui, T., Sun, H.J., and Peng, T.J., 2021, Preparation and Characterization of Cordierite-based Ceramic Foams with Permeable Property from Asbestos Tailings and Coal Fly Ash, *J. Alloys Compd.*, 885, 1–11.
- Husin, G. dan Rosnelly, C.M., 2007, Studi Kinetika Adsorpsi Larutan Logam Timbal (Pb) menggunakan Karbon Aktif dari Batang Pisang, *J. Has. Penelit. Ind.*, 20, 1–10.
- Jala, S. and Goyal, D., 2006, Fly Ash as a Soil Ameliorant for Improving Crop Production-a Review, *Bioresour. Technol.*, 97, 1136–1147.
- Jellali, S., Wahab, M.A., Hassine, R. Ben, Hamzaoui, A.H., and Bousselmi, L., 2011, Adsorption Characteristics of Phosphorus from Aqueous Solutions onto Phosphate Mine Wastes, *Chem. Eng. J.*, 169, 157–165.
- Joseph, I. V., Tosheva, L., and Doyle, A.M., 2020, Simultaneous Removal of Cd(II), Co(II), Cu(II), Pb(II), and Zn(II) Ions from Aqueous Solutions Via Adsorption on FAU-type Zeolites Prepared from Coal Fly Ash, *J. Environ. Chem. Eng.*, 8, 1–9.
- Jumaeri, 1995, Studi tentang Pemanfaatan Abu Layang sebagai Adsorben Zat Warna dalam Larutan Air, *Tesis*, Departemen Kimia, Universitas Gadjah Mada, Yogyakarta.

- Kuncoro, E.P. and Fahmi, M.Z., 2013, Removal of Hg and Pb in Aqueous Solution using Coal Fly Ash Adsorbent, *Procedia Earth Planet. Sci.*, 6, 377–382.
- Li, L., Bi, R., Wang, Z., Xu, C., Li, B., Luan, L., Chen, X., Xue, F., Zhang, S., and Zhao, N., 2019, Speciation of Mercury using High-Performance Liquid Chromatography-Inductively Coupled Plasma Mass Spectrometry following Enrichment by Dithizone Functionalized Magnetite-Reduced Graphene Oxide, *Spectrochim. Acta Part B At. Spectrosc.*, 159, 1–8.
- Li, Z., Gao, X., Wu, L., Wang, K., and Kobayashi, N., 2017, Preparation of Activated Carbons from Poplar Wood by Chemical Activation with KOH, *J. Porous Mater.*, 24, 193–202.
- Li, Z., Wang, L., Qin, L., Lai, C., Wang, Z., Zhou, M., Xiao, L., Liu, S., and Zhang, M., 2021, Recent Advances in The Application of Water-stable Metal-organic Frameworks: Adsorption and Photocatalytic Reduction of Heavy Metal in Water, *Chemosphere*, 285, 1–15.
- Liu, J., Qu, R., Yan, L., Wang, L., and Wang, Z., 2016, Evaluation of Single and Joint Toxicity of Perfluorooctane Sulfonate and Zinc to *Limnodrilus Hoffmeisteri*: Acute Toxicity, Bioaccumulation and Oxidative Stress, *J. Hazard. Mater.*, 301, 342–349.
- Mahmoud, M.E., Osman, M.M., and Amer, M.E., 2000, Selective Pre-concentration and Solid Phase Extraction of Mercury(II) from Natural Water by Silica Gel-Loaded Dithizone Phases, *Anal. Chim. Acta*, 415, 33–40.
- Makhanya, B.N., Nyandeni, N., Ndulini, S.F., and Mthembu, M.S., 2021, Application of Green Microalgae Biofilms for Heavy Metals Removal from Mine Effluent, *Phys. Chem. Earth*, 124, 1–8.
- Malarvizhi, T.S. and Santhi, T., 2013, Adsorption of Zn(II) Ions from Aqueous Solution on Lignite-Fired Fly Ash, *Desalin. Water Treat.*, 51, 6777–6788.
- Marczenko, Z., 1986, *Separation and Spectrophotometric Determination of Elements*, Ellis Horwood, Chichester.
- Marwani, H.M., Albishri, H.M., Jalal, T.A., and Soliman, E.M., 2012, Activated Carbon Immobilized Dithizone Phase for Selective Adsorption and Determination of Gold(III), *Desalin. Water Treat.*, 45, 128–135.
- Masel, R.I., 1996, *Principle of Adsorption and Reaction in Solid Surfaces*, John Wiley and Sons, Inc., Toronto.
- McNeely, R.N., Nelmanis, V.P., and Dwyer, L., 1979, *Water Quality Sourcebook: A Guide to Water Quality Parameters*, Inland Waters Directorate, Water Quality Branch, Ottawa.
- Moore, J.W., 1991, *Inorganic Contaminants of Surface Water*, Springer-Verlag, New York.

- Mortada, W.I., Nabieh, K.A., Helmy, T.E., and Abou El-Reash, Y.G., 2022, Microwave-Assisted Synthesis of MCM-41 Composite with Rice Husk and its Functionalization by Dithizone for Preconcentration of Some Metal Ions from Water and Food Samples, *J. Food Compos. Anal.*, 106, 1–9.
- Mudasir, M., Baskara, R.A., Suratman, A., Yunita, K.S., Perdana, R., and Puspitasari, W., 2020, Simultaneous Adsorption of Zn(II) and Hg(II) Ions on Selective Adsorbent of Dithizone-Immobilized Bentonite in the Presence of Mg(II) Ion, *J. Environ. Chem. Eng.*, 8, 1-12.
- Mudasir, M., Karelius, K., Aprilita, N.H., and Wahyuni, E.T., 2016, Adsorption of mercury(II) on Dithizone-Immobilized Natural Zeolite, *J. Environ. Chem. Eng.*, 4, 1839–1849.
- Mufrodi, Z., Widiastuti, N., dan Kardika, R.C., 2008, Adsorpsi Zat Warna Tekstil dengan menggunakan Abu Terbang (*Fly Ash*) untuk Variasi Massa Adsorben dan Suhu Operasi, *Prosiding Seminar Nasional Teknoin 2008 Bidang Teknik Kimia dan Tekstil*, Universitas Ahmad Dahlan, Yogyakarta.
- Nair, V., Panigrahy, A., and Vinu, R., 2014, Development of Novel Chitosan-Lignin Composites for Adsorption of Dyes and Metal Ions from Wastewater, *Chem. Eng. J.*, 254, 491–502.
- Narsito, Nuryono, dan Suyanta, 2004, Kinetika Adsorpsi Zn(II) dan Cd (II) pada Silika Gel Termodifikasi Hasil Pengolahan Abu Sekam Padi, *Laporan Penelitian Dasar*, Yogyakarta.
- Nguyen, T.C., Tran, T.D.M., Dao, V.B., Vu, Q.T., Nguyen, T.D., and Thai, H., 2020, Using Modified Fly Ash for Removal of Heavy Metal Ions from Aqueous Solution, *J. Chem.*, 2020, 1–11.
- Norvia, S., Suhartana, S., dan Pardoyo, P., 2016, Dealuminasi Zeolit Alam menggunakan Asam (HCl dan H<sub>2</sub>SO<sub>4</sub>) untuk Katalis pada Proses Sintesis Biodiesel, *J. Kim. Sains dan Apl.*, 19, 72–76.
- Ntoi, L.L.A., 2016, Multiple Chromisms Associated with Dithizone, *Dissertation*, Department of Chemistry, University of the Free State.
- Oscik, J., 1982, *Adsorption*, Ellis Horwood Limited, Chichester.
- Panday, K.K., Prasad, G., and Singh, V.N., 1985, Copper(II) Removal from Aqueous Solutions by Fly Ash, *Water Res.*, 19, 869–873.
- Patel, H., 2019, Fixed-bed Column Adsorption Study: A Comprehensive Review, *Appl. Water Sci.* 2019 93, 9, 1–17.
- Pearson, R.G., 1963, Hard and Soft Acids and Bases, *J. Am. Chem. Soc.*, 85, 3533–3539. Phuengprasop, T., Sittiwong, J., and Unob, F., 2011, Removal of Heavy Metal Ions by Iron Oxide Coated Sewage Sludge, *J. Hazard. Mater.*, 186, 502–507.

- Phuengprasop, T., Sittiwong, J., and Unob, F., 2011, Removal of Heavy Metal Ions by Iron Oxide Coated Sewage Sludge, *J. Hazard. Mater.*, 186, 502–507.
- Rahmadhani, P.F., 2014, Adsorpsi Zn(II) pada Abu Dasar Batubara Terimobilisasi Dithizon, *Skripsi*, Departemen Kimia, Universitas Gadjah Mada, Yogyakarta.
- Rajkumar, R., Raman, R.K., S., S., and Swaminathan, S., 2020, Hydrodynamics and Phenol Adsorption Studies in Continuous Counter Current Liquid-Solid Settling Column, *Process Saf. Environ. Prot.*, 142, 350–358.
- Rehman, K., Fatima, F., Waheed, I., and Akash, M.S.H., 2018, Prevalence of Exposure of Heavy Metals and their Impact on Health Consequences, *J. Cell. Biochem.*, 119, 157–184.
- Renu, Agarwal, M., and Singh, K., 2017, Heavy Metal Removal from Wastewater using Various Adsorbents: A Review, *J. Water Reuse Desalin.*, 7, 387–419.
- Risdanareni, P., Puspitasari, P., Kartika, D., and Djatmika, B., 2016, Mechanical Properties of Geopolymer Paste with Fly Ash Variation, *Proceedings of the International Mechanical Engineering and Engineering Education Conferences (IMEEEEC 2016)*, Universitas Negeri Malang, Malang.
- Saikia, B.K., Hower, J.C., Islam, N., Sharma, A., and Das, P., 2021, Geochemistry and Petrology of Coal and Coal Fly Ash from a Thermal Power Plant in India, *Fuel*, 291, 1–13.
- Salih, B., Denizli, A., Kavakli, C., Say, R., and Piskin, E., 1998, Adsorption of Heavy Metal Ions onto Dithizone-Anchored Poly (EGDMA-HEMA) Microbeads, *Talanta*, 46, 1205–1213.
- Sarbak, Z. and Kramer-Wachowiak, M., 2002, Porous Structure of Waste Fly Ashes and their Chemical Modifications, *Powder Technol.*, 123, 53–58.
- Shim, Y.S., Kim, Y.K., Kong, S.H., Rhee, S.W., and Lee, W.K., 2003, The Adsorption Characteristics of Heavy Metals by Various Particle Sizes of MSWI Bottom Ash, *J. Waste Manag.*, 23, 851–857.
- Shukla, A., Zhang, Y.H., Dubey, P., Margrave, J.L., and Shukla, S.S., 2002, The Role of Sawdust in The Removal of Unwanted Materials from Water, *J. Hazard. Mater.*, 95, 137–152.
- Siska, Y., 2008, *Pengaruh Aktivasi Asam pada Zeolit Alam Turen terhadap Kapasitas Tukar Kation  $Ni^{2+}$ ,  $Co^{2+}$ ,  $Mn^{2+}$  dan  $Fe^{3+}$* , Jurusan Kimia, Universitas Brawijaya.
- Smith, L.A., Means, J.L., Chen, A., Alleman, B., Chapman, C.C., Tixie Jr., J.S., Brauning, S.E., Gavaskar, A.R., and Royer, M.D., 1995, *Remedial Options for Metals-Contaminated Sites*, Lewis Publishers, Boca Rotan, Florida.

- Soco, E. and Kalemkiewicz, J., 2015, Removal of Copper(II) and Zinc(II) Ions From Aqueous Solution by Chemical Treatment of Coal Fly Ash, *Croat. Chem. Acta*, 88, 267–279.
- Spies, A.R.L. and Wewers, F., 2020, Equilibrium, Kinetics and Thermodynamics Studies of Cd Sorption onto a Dithizone-Impregnated Amberchrom CG-300m Polymer Resin, *Arab. J. Chem.*, 13, 5050–5059.
- Stumm, W. and Morgan, J.J., 1996, *Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters*, John Wiley and Sons, Inc., Canada.
- Sulastri, S., Nuryono, N., Kartini, I., dan Kunarti, E.S., 2014, Kinetika dan Keseimbangan Adsorpsi Ion Kromium (III) dalam Larutan pada Senyawa Silika dan Modifikasi Silika Hasil Sintesis dari Abu Sekam Padi, *J. Penelit. Saintek*, 19, 33–44.
- Sun, Qi, Cai, C., Zhang, S., Tian, S., Li, B., Xia, Y., and Sun, Qingwei, 2019, Study of Localized Deformation in Geopolymer Cemented Coal Gangue-Fly Ash Backfill based on The Digital Speckle Correlation Method, *Constr. Build. Mater.*, 215, 321–331.
- Sunarti, 2008, Pembuatan Adsorben Termodifikasi dari Abu Dasar Batubara dan Aplikasinya untuk Adsorpsi Logam Berat Timbal (Pb), *Tesis*, Departemen Kimia, Universitas Gadjah Mada, Yogyakarta.
- Susanto, T., 2011, Kajian Kemampuan Adsorpsi Zeolit Alam Aktif Terimobilisasi Dithizon terhadap Limbah Ion Logam Cd(II) Terkompetisi Mg(II) dan Cu(II) secara Simultan, *J. Din. Penelit. Ind.*, 22, 41–47.
- Syahminan, 1996, Studi Distribusi Pencemaran Logam Berat di Perairan Estuari Sungai Siak, Riau, *Skripsi*, Fakultas Perikanan dan Ilmu Kelautan, Institut Pertanian Bogor, Bogor.
- Takdastan, A., Samarbaf, S., Tahmasebi, Y., Alavi, N., and Babaei, A.A., 2019, Alkali Modified Oak Waste Residues as a Cost-Effective Adsorbent for Enhanced Removal of Cadmium from Water: Isotherm, Kinetic, Thermodynamic and Artificial Neural Network Modeling, *J. Ind. Eng. Chem.*, 78, 352–363.
- Tatarchuk, T., Shyichuk, A., Sojka, Z., Gryboś, J., Naushad, M., Kotsyubynsky, V., Kowalska, M., Kwiatkowska-Marks, S., and Danyliuk, N., 2021, Green Synthesis, Structure, Cations Distribution and Bonding Characteristics of Superparamagnetic Cobalt-Zinc Ferrites Nanoparticles for Pb(II) Adsorption and Magnetic Hyperthermia Applications, *J. Mol. Liq.*, 328, 1–16.
- Wang, H., Yuan, L., and An, J., 2017, Crystallographic Characteristics of Hydroxylapatite in Hard Tissues of *Cololabis saira*, *Cryst.*, 7, 1–13.
- Weber Jr, W.J., 1972, *Physico-Chemical Processes for Water Quality Control*, Wiley Interscience, New York.

- Xie, J., Wu, S., Pang, L., Lin, J., and Zhu, Z., 2012, Influence of Surface Treated Fly Ash with Coupling Agent on Asphalt Mixture Moisture Damage, *Constr. Build. Mater.*, 30, 340–346.
- Yahaya, N.K.E.M., Latiff, M.F.P.M., Abustan, I., Bello, O.S., and Ahmad, M.A., 2011, Adsorptive Removal of Cu(II) using Activated Carbon Prepared from Rice Husk by ZnCl<sub>2</sub> Activation and Subsequent Gasification with CO<sub>2</sub>, *Int. J. Eng. Technol.*, 11, 164–168.
- Yankovych, H., Novoseltseva, V., Kovalenko, O., Marcin Behunova, D., Kanuchova, M., Vaclavikova, M., and Melnyk, I., 2021, New Perception of Zn(II) and Mn(II) Removal Mechanism on Sustainable Sunflower Biochar from Alkaline Batteries Contaminated Water, *J. Environ. Manage.*, 292, 1–11.
- Yao, Z.T., Ji, X.S., Sarker, P.K., Tang, J.H., Ge, L.Q., Xia, M.S., and Xi, Y.Q., 2015, A Comprehensive Review on the Applications of Coal Fly Ash, *Earth-Science Rev.*, 141, 105–121.
- Yu, H.M., Song, H., and Chen, M.L., 2011, Dithizone Immobilized Silica Gel On-Line Preconcentration of Trace Copper with Detection by Flame Atomic Absorption Spectrometry, *Talanta*, 85, 625–630.
- Zeng, Z., Zheng, P., Da, K., Li, Y., Li, W., Dongdong, X., Chen, W., and Pan, C., 2021, The Removal of Copper and Zinc from Swine Wastewater by Anaerobic Biological-Chemical Process: Performance and Mechanism, *J. Hazard. Mater.*, 401, 1–9.
- Zhu, C., Liu, F., Zhang, Y., Wei, M., Zhang, X., Ling, C., and Li, A., 2016, Nitrogen-doped Chitosan-Fe(III) Composite as a Dual-Functional Material for Synergistically Enhanced Co-removal of Cu(II) and Cr(VI) based on Adsorption and Redox, *Chem. Eng. J.*, 306, 579–587.