

DAFTAR PUSTAKA

- 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.
- Annadurai, G., Juang, R.S., Yen, P.S., Lee, D.J., 2003. Use of thermally treated waste biological sludge as dye absorbent. *Adv. Environ. Res.* 7, 739–744.
- Artola, a, Martin, M., Balaguer, M., Rigola, M., 2000. Isotherm Model Analysis for the Adsorption of Cd (II), Cu (II), Ni (II), and Zn (II) on Anaerobically Digested Sludge. *J. Colloid Interface Sci.* 232, 64–70.
- Benaïssa, H., Elouchdi, M.A., 2011. Biosorption of copper (II) ions from synthetic aqueous solutions by drying bed activated sludge. *J. Hazard. Mater.* 194, 69–78.
- Bhatnagar, A., Minocha, A.K., 2009. Utilization of industrial waste for cadmium removal from water and immobilization in cement. *Chem. Eng. J.* 150, 145–151.
- Bhattacharya, A.K., Mandal, S.N., Das, S.K., 2006. Adsorption of Zn(II) from aqueous solution by using different adsorbents. *Chem. Eng. J.* 123, 43–51.
- Boualem, T., Debab, A., Martínez de Yuso, A., Izquierdo, M.T., 2014. Activated carbons obtained from sewage sludge by chemical activation: Gas-phase environmental applications. *J. Environ. Manage.* 140, 145–151.
- Brady, J.M., Tobin, J.M., 1995. Binding of hard and soft metal ions to *Rhizopus arrhizus* biomass. *Enzyme Microb. Technol.* 17, 791–796. -
- Calisto, V., Ferreira, C.I. a., Santos, S.M., Gil, M.V., Otero, M., Esteves, V.I., 2014. Production of adsorbents by pyrolysis of paper mill sludge and application on the removal of citalopram from water. *Bioresour. Technol.* 166, 335–344.
- Cheng, F., Luo, H., Hu, L., Yu, B., Luo, Z., Fidalgo De Cortalezzi, M., 2016. Sludge carbonization and activation: From hazardous waste to functional materials for water treatment. *J. Environ. Chem. Eng.* 4, 4574–4586.
- Chiang, H.L., Lin, K.H., Chiu, H.H., 2012. Exhaust characteristics during the

- pyrolysis of ZnCl₂ immersed biosludge. *J. Hazard. Mater.* 229–230, 233–244.
- Choi, S.B., Yun, Y.S., 2006. Biosorption of cadmium by various types of dried sludge: An equilibrium study and investigation of mechanisms. *J. Hazard. Mater.* 138, 378–383.
- Chong, K.H., Volesky, B., 1995. Description of two-metal biosorption equilibria by Langmuir-type models. *Biotechnol. Bioeng.* 47, 451–460.
- Ding, R., Zhang, P., Seredych, M., Bandosz, T.J., 2012. Removal of antibiotics from water using sewage sludge- and waste oil sludge-derived adsorbents. *Water Res.* 46, 4081–4090.
- Emami, A., Rahbar-kelishami, A., 2016. Zinc and nickel adsorption onto a low-cost mineral adsorbent: kinetic, isotherm, and thermodynamic studies. *Desalin. Water Treat.* 3994, 1–12.
- Fan, T., Liu, Y., Feng, B., Zeng, G., Yang, C., Zhou, M., Zhou, H., Tan, Z., Wang, X., 2008. Biosorption of cadmium (II), zinc (II) and lead (II) by *Penicillium simplicissimum*: Isotherms, kinetics and thermodynamics. *J. Hazard. Mater.* 160, 655–661.
- Farhan, A.M., Al-Dujaili, A.H., Awwad, A.M., 2013. Equilibrium and kinetic studies of cadmium(II) and lead(II) ions biosorption onto *Ficus carica* leaves. *Int. J. Ind. Chem.* 4, 1–8.
- Freitas, O.M.M., Martins, R.J.E., Delerue-Matos, C.M., Boaventura, R.A.R., 2008. Removal of Cd(II), Zn(II) and Pb(II) from aqueous solutions by brown marine macro algae: Kinetic modelling. *J. Hazard. Mater.* 153, 493–501.
- Fu, F., Wang, Q., 2011. Removal of heavy metal ions from wastewaters: A review. *J. Environ. Manage.* 92, 407–418.
- Gadd, G.M., White, C., 1993. Microbial treatment of metal pollution—a working biotechnology. *Bioremediation* 11, 353–359.
- Gómez-Pacheco, C. V., Rivera-Utrilla, J., Sánchez-Polo, M., López-Peñalver, J.J., 2012. Optimization of the preparation process of biological sludge adsorbents for application in water treatment. *J. Hazard. Mater.* 217–218, 76–84.
- Gupta, N., Amritphale, S.S., Chandra, N., 2010. Removal of Zn (II) from aqueous

- solution by using hybrid precursor of silicon and carbon. *Bioresour. Technol.* 101, 3355–3362.
- Gupta, S., Babu, B. V., 2009. Utilization of waste product (tamarind seeds) for the removal of Cr(VI) from aqueous solutions: Equilibrium, kinetics, and regeneration studies. *J. Environ. Manage.* 90, 3013–3022.
- Gutiérrez-Segura, E., Solache-Ríos, M., Colín-Cruz, A., Fall, C., 2012. Adsorption of cadmium by Na and Fe modified zeolitic tuffs and carbonaceous material from pyrolyzed sewage sludge. *J. Environ. Manage.* 97, 6–13.
- Hadi, P., Xu, M., Ning, C., Sze, C., Lin, K., McKay, G., 2015. A critical review on preparation, characterization and utilization of sludge-derived activated carbons for wastewater treatment. *Chem. Eng. J.* 260, 895–906.
- Henze, M., Poul, H., Cour Jansen, J. la, Erik, A., 2002. *Wastewater treatment: biological and chemical processes*, 3th ed. Springer, Verlag Berlin Heidelberg.
- Hossain, M.K., Strezov Vladimir, V., Chan, K.Y., Ziolkowski, A., Nelson, P.F., 2011. Influence of pyrolysis temperature on production and nutrient properties of wastewater sludge biochar. *J. Environ. Manage.* 92, 223–228.
- Hunsom, M., Autthanit, C., 2013. Adsorptive purification of crude glycerol by sewage sludge-derived activated carbon prepared by chemical activation with H₃PO₄, K₂CO₃ and KOH. *Chem. Eng. J.* 229, 334–343.
- Iddou, A., Ouali, M.S., 2008. Waste-activated sludge (WAS) as Cr(III) sorbent biosolid from wastewater effluent. *Colloids Surfaces B Biointerfaces* 66, 240–245.
- Ihsanullah, Al-Khaldi, F.A., Abusharkh, B., Khaled, M., Atieh, M.A., Nasser, M.S., Laoui, T., Saleh, T.A., Agarwal, S., Tyagi, I., Gupta, V.K., 2015. Adsorptive removal of cadmium(II) ions from liquid phase using acid modified carbon-based adsorbents. *J. Mol. Liq.* 204, 255–263.
- Julcour Lebigue, C., Andriantsiferana, C., N'Guessan Krou, Ayril, C., Mohamed, E., Wilhelm, A.M., Delmas, H., Le Coq, L., Gerente, C., Smith, K.M., Pullket, S., Fowler, G.D., Graham, N.J.D., 2010. Application of sludge-based carbonaceous materials in a hybrid water treatment process based on

- adsorption and catalytic wet air oxidation. *J. Environ. Manage.* 91, 2432–2439.
- Kalmykova, Y., Strömvall, A.-M., Steenari, B.-M., 2008. Adsorption of Cd, Cu, Ni, Pb and Zn on Sphagnum peat from solutions with low metal concentrations. *J. Hazard. Mater.* 152, 885–91.
- Kante, K., Qiu, J., Zhao, Z., Cheng, Y., Bandosz, T.J., 2008. Development of surface porosity and catalytic activity in metal sludge/waste oil derived adsorbents: Effect of heat treatment. *Chem. Eng. J.* 138, 155–165.
- Kargi, F., Cikla, S., 2007. Determination of model parameters for zinc (II) ion biosorption onto powdered waste sludge (PWS) in a fed-batch system. *J. Environ. Manage.* 85, 883–890.
- Khosravan, A., Lashkari, B., 2011. Adsorption of Cd(II) by Dried Activated Sludge A. Iran. *J. Chem. Eng.* 8, 41–56.
- King, P., Rakesh, N., Lahari, S.B., Kumar, Y.P., Prasad, V.S.R.K., 2008. Biosorption of zinc onto *Syzygium cumini* L. : Equilibrium and kinetic studies 144, 181–187.
- Lee, S. M., Davis, A.P., 2001. Removal Of Cu (II) And Cd (II) From Aqueous Solution By Seafood Processing Waste Sludge. *Wat. Res* 35, 534–540.
- Li, M., Li, M., Feng, C., Zeng, Q., 2014. Preparation and characterization of multi-carboxyl-functionalized silica gel for removal of Cu (II), Cd (II), Ni (II) and Zn (II) from aqueous solution. *Appl. Surf. Sci.* 314, 1063–1069.
- Liu, W., Zhang, J., Jin, Y., Zhao, X., Cai, Z., 2015. Adsorption of Pb(II), Cd(II) and Zn(II) by extracellular polymeric substances extracted from aerobic granular sludge: Efficiency of protein. *J. Environ. Chem. Eng.* 3, 1223–1232.
- Mahapatra, K., Ramteke, D.S., Paliwal, L.J., 2012. Production of activated carbon from sludge of food processing industry under controlled pyrolysis and its application for methylene blue removal. *J. Anal. Appl. Pyrolysis* 95, 79–86.
- Marques, R.R.N., Stüber, F., Smith, K.M., Fabregat, A., Bengoa, C., Font, J., Fortuny, A., Pullket, S., Fowler, G.D., Graham, N.J.D., 2011. Sewage sludge based catalysts for catalytic wet air oxidation of phenol: Preparation, characterisation and catalytic performance. *Appl. Catal. B Environ.* 101, 306–316.

- Méndez, A., Fidalgo, J.M., Guerrero, F., Gascó, G., 2009. Characterization and pyrolysis behaviour of different paper mill waste materials. *J. Anal. Appl. Pyrolysis* 86, 66–73.
- Monier, M., Abdel-Latif, D.A., 2012. Preparation of cross-linked magnetic chitosan-phenylthiourea resin for adsorption of Hg(II), Cd(II) and Zn(II) ions from aqueous solutions. *J. Hazard. Mater.* 209–210, 240–249.
- Monsalvo, V.M., Mohedano, A.F., Rodriguez, J.J., 2011. Activated carbons from sewage sludge. Application to aqueous-phase adsorption of 4-chlorophenol. *Desalination* 277, 377–382.
- Naiya, T.K., Bhattacharya, A.K., Das, S.K., 2008. Removal of Cd(II) from aqueous solutions using clarified sludge. *J. Colloid Interface Sci.* 325, 48–56.
- Nielsen, L., Zhang, P., Bandosz, T.J., 2015. Adsorption of carbamazepine on sludge/fish waste derived adsorbents: Effect of surface chemistry and texture. *Chem. Eng. J.* 267, 170–181.
- Oyaro, N., Juddy, O., Murago, E.N.M., Gitonga, E., 2007. The contents of Pb, Cu, Zn and Cd in meat in Nairobi, Kenya. *J. Food, Agric. Environ.* 5, 119–121.
- Pan, Z.H., Tian, J.Y., Xu, G.R., Li, J.J., Li, G.B., 2011. Characteristics of adsorbents made from biological, chemical and hybrid sludges and their effect on organics removal in wastewater treatment. *Water Res.* 45, 819–827.
- Phuengprasop, T., Sittiwong, J., Unob, F., 2011. Removal of heavy metal ions by iron oxide coated sewage sludge. *J. Hazard. Mater.* 186, 502–507.
- Pratiwi, D.F., Hidayat, D., Pratama, D.S., 2016. Tingkat Pencemaran Logam Kadmium (Cd) dan Kobalt (Co) Pada Sedimen di Sekitar Pesisir Bandar Lampung. *Anal. Environ. Chem.* 1, 61–68.
- Rio, S., Le Coq, L., Faur, C., Le Cloirec, P., 2006. Production of porous carbonaceous adsorbent from physical activation of sewage sludge: Application to wastewater treatment. *Water Sci. Technol.* 53, 237–244.
- Ros, A., Lillo-Ródenas, M.A., Canals-Batlle, C., Fuente, E., Montes-Morán, M.A., Martín, M.J., Linares-Solano, A., 2007. A New Generation of Sludge-Based Adsorbents for H₂S Abatement at Room Temperature. *Environ. Sci. Technol.* 41, 4375–4381.
- Ros, A., Lillo-Ródenas, M. a., Fuente, E., Montes-Morán, M. a., Martín, M.J.,

- Linares-Solano, A., 2006. High surface area materials prepared from sewage sludge-based precursors. *Chemosphere* 65, 132–140.
- Rozada, F., Otero, M., Morán, a., García, a. I., 2008. Adsorption of heavy metals onto sewage sludge-derived materials. *Bioresour. Technol.* 99, 6332–6338.
- Salmariza, S., 2012. Pemanfaatan Limbah Lumpur Proses Activated Sludge Industri Karet Remah Sebagai Adsorben. *J. Ris. Ind.* VI, 175–182.
- Salmariza, S., Lestari, I., Kurniawati, D., Aziz, H., Chaidir, Z., Zein, R., 2016. Characterization of Waste Activated Sludge of Crumb Rubber Industry (CRI-WAS) as Adsorbent of Cd(II). *Der Pharma Chem.* 8, 228–235.
- Salmariza, S., Mawardi, M., Hariyani, R., Kasman, M., 2014. Pengembangan Adsorben dari Limbah Lumpur Industri Crumb Rubber Yang Diaktivasi dengan H₃PO₄ Untuk Menyerap Ion Cr(VI). *J. Litbang Ind.* 4, 67–77.
- Samolada, M.C., Zabaniotou, A.A., 2014. Comparative assessment of municipal sewage sludge incineration, gasification and pyrolysis for a sustainable sludge-to-energy management in Greece. *Waste Manag.* 34, 411–420.
- Sen, T.K., Sarzali, M.V., 2008. Removal of cadmium metal ion (Cd²⁺) from its aqueous solution by aluminium oxide (Al₂O₃): A kinetic and equilibrium study. *Chem. Eng. J.* 142, 256–262.
- Shammas, N.K., Wang, L.K., 2014. *Water Engineering Hydraulics, Hydraulics, Distribution and Treatment*, first. ed. JohnWiley & Sons, Inc., New Jersey, USA.
- Sharma, A., Lee, B.K., 2014. Cd(II) removal and recovery enhancement by using acrylamide-titanium nanocomposite as an adsorbent. *Appl. Surf. Sci.* 313, 624–632. d
- Siswoyo, E., Mihara, Y., Tanaka, S., 2014. Determination of key components and adsorption capacity of a low cost adsorbent based on sludge of drinking water treatment plant to adsorb cadmium ion in water. *Appl. Clay Sci.* 97–98, 146–152.
- Smith, K.M., Fowler, G.D., Pullket, S., Graham, N.J.D., 2009. Sewage sludge-based adsorbents: A review of their production, properties and use in water treatment applications. *Water Res.* 43, 2569–2594.
- Soltani, D. cheshmeh, Jafari, J., Khorramabadi, S., 2009. Investigation of

- Cadmium (II) Ions Biosorption onto Pretreated Dried Activated Sludge. *Am. J. Environ. Sci.*
- Spellman, F., 2014. *Handbook of water and wastewater treatment plant operations*, third. ed. CRC Press, New York.
- Tumuluru, J.S., Sokhansanj, S., Hess, J.R., Wright, C.T., Boardman, R.D., 2011. A review on biomass torrefaction process and product properties for energy applications. *Ind. Biotechnol.* 7, 384–401.
- Tunas, E., 2009. *Teknologi pengolahan limbah cair dengan system lumpur aktif di industri karet*, first. ed. Jetro-Gapkindo, Jakarta.
- Velghe, I., Carleer, R., Yperman, J., Schreurs, S., D'Haen, J., 2012. Characterisation of adsorbents prepared by pyrolysis of sludge and sludge/disposal filter cake mix. *Water Res.* 46, 2783–2794.
- Wang, J., Chen, C., 2006. Biosorption of heavy metals by *Saccharomyces cerevisiae*: A review. *Biotechnol. Adv.* 24, 427–451.
- Wu, C., Song, M., Jin, B., Wu, Y., Huang, Y., 2013. Effect of biomass addition on the surface and adsorption characterization of carbon-based adsorbents from sewage sludge. *J. Environ. Sci. (China)* 25, 405–412.
- Wu, J., Zhang, H., He, P.J., Yao, Q., Shao, L.M., 2010. Cr(VI) removal from aqueous solution by dried activated sludge biomass. *J. Hazard. Mater.* 176, 697–703.
- Xu, G., Yang, X., Spinosa, L., 2015. Development of sludge-based adsorbents: Preparation, characterization, utilization and its feasibility assessment. *J. Environ. Manage.* 151, 221–232.
- Yang, C., Wang, J., Lei, M., Xie, G., Zeng, G., Luo, S., 2010. Biosorption of zinc(II) from aqueous solution by dried activated sludge. *J. Environ. Sci.* 22, 675–680.
- Yang, X., Xu, G., Yu, H., Zhang, Z., 2016. Preparation of ferric-activated sludge-based adsorbent from biological sludge for tetracycline removal. *Bioresour. Technol.* 211, 566–573.
- Zaini, M.A.A., Zakaria, M., Mohd.-Setapar, S.H., Che-Yunus, M.A., 2013. Sludge-adsorbents from palm oil mill effluent for methylene blue removal. *J. Environ. Chem. Eng.* 1, 1091–1098.

- Zein, R., Hidayat, D.A., Elfia, M., Nazarudin, N., Munaf, E., 2014. Sugar palm *Arenga pinnata* Merr (Magnoliophyta) fruit shell as biomaterial to remove Cr(III), Cr(VI), Cd(II) and Zn(II) from aqueous solution. *J. Water Supply Res. Technol.* 63, 553.
- Zhang, B., Xiong, S., Xiao, B., Yu, D., Jia, X., 2011. Mechanism of wet sewage sludge pyrolysis in a tubular furnace. *Int. J. Hydrogen Energy* 36, 355–363.
- Zhang, W., Mao, S., Chen, H., Huang, L., Qiu, R., 2013. Pb(II) and Cr(VI) sorption by biochars pyrolyzed from the municipal wastewater sludge under different heating conditions. *Bioresour. Technol.* 147, 545–552.
- Zhou, G., Liu, C., Tang, Y., Luo, S., Zeng, Z., Liu, Y., Xu, R., Chu, L., 2015. Sponge-like polysiloxane-graphene oxide gel as a highly efficient and renewable adsorbent for lead and cadmium metals removal from wastewater. *Chem. Eng. J.* 280, 275–282.
- Zou, J., Dai, Y., Wang, X., Ren, Z., Tian, C., Pan, K., Li, S., Abuobaidah, M., Fu, H., 2013. Structure and adsorption properties of sewage sludge-derived carbon with removal of inorganic impurities and high porosity. *Bioresour. Technol.* 142, 209–217.

