

DAFTAR PUSTAKA

- Abdellaoui, I., Islam, M.M., Sakurai, T., Hamzaoui, S., and Akimoto, K., 2018, Impurities removal process for high-purity silica production from diatomite, *Hydrometallurgy*, 179, 207–214.
- Anonim. (2021). *Peraturan Pemerintah Republik Indonesia Nomor 22 Tahun 2021 tentang Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup*. Jakarta: Sekretariat Negara Republik Indonesia.
- Anthony, E.B., 2016, Introduction to Silicates, *Ganoksin*.
- Bahfie, F., Manaf, A., Astuti, W., Nurjaman, F., and Herlina, U., 2021, Tinjauan teknologi proses ekstraksi bijih nikel laterit, *J. Teknol. Miner. dan Batubara*, 17, 135–152.
- Batool, F., Akbar, J., Iqbal, S., Noreen, S., dan Bukhari, S. N. A., 2018. Study of isothermal, kinetic, and thermodynamic parameters for adsorption of cadmium: An overview of linear and nonlinear approach and error analysis. *Bio. In. Chem. App.*, 2018, 1–11.
- Brinker, C.J., dan Scherer, G.W., 1990, Sol-gel science: the physics and chemistry of sol-gel processing, Boston: Academic Press.
- Buxton, S., Garman, E., Heim, K.E., Lyons-darden, T., Schlekat, C.E., Taylor, M.D., and Oller, A.R., 2019, Concise Review of Nickel Human Health Toxicology and Ecotoxicology, *Inorganics*, 7, 89.
- Cahyaningsih, L.D.R., 2012, Pengaruh pH terhadap sintesis silika gel dari abu sekam padi menggunakan metode modifikasi sol gel.
- Charazińska, S., Burszta-Adamiak, E., and Lochyński, P., 2022. Recent trends in Ni(II) sorption from aqueous solutions using natural materials. *Reviews in Environmental Science and Bio/Technology*, 21(1), 105–138.
- Çiçekçi, A., Sevim, F., Sevim, M., and Kavcı, E., 2025. Adsorption capacity, reaction kinetics and thermodynamic studies on Ni(II) removal with GO@Fe₃O₄@Pluronic-F68 nanocomposite. *Polymers*, 17(15), 2141
- Coman, V., Robotin, B., & Ilea, P., 2013. Nickel recovery/removal from industrial wastes: A review. *Resources, Conservation and Recycling*, 73, 229–238
- Desta, M. B., 2013. Batch sorption experiments: Langmuir and Freundlich isotherm studies for the adsorption of textile metal ions onto teff straw (*Eragrostis tef*) agricultural waste. *Journal of Thermodynamics*, 2013, Article ID 375830, 1.

- Ellerbrock, R., Stein, M., and Schaller, J. 2022. Comparing amorphous silica, short-range-ordered silicates and silicic acid species by FTIR. *Scientific Reports*, 12, 11708.
- Ezzeddine, Z., Batonneau-Gener, I., Ghssein, G., dan Pouilloux, Y., 2025. Recent Advances in Heavy Metal Adsorption via Organically Modified Mesoporous Silica: A Review. *Water*, 17(5), 669
- Firdaus, M.L., Madina, F.E., F, S.Y., Elvia, R., Soraya, N., Eddy, D.R., and Cid-andres, A.P., 2020, Silica extraction from beach sand for dyes removal: isotherms, kinetics and thermodynamics, 13, 249–254.
- Gupta, A. A., Sharma, V., Sharma, K., Kumar, V., Choudhary, S., Mankotia, P., Kumar, B., Mishra, H., Moulick, A., Ekielski, A., & Mishra, P. K. and 2021. A Review of Adsorbents for Heavy Metal Decontamination: Growing Approach to Wastewater Treatment. *Materials*, 14(16), 4702.
- Hafiz, S.Y. Al and Badi'ah, N.I. Al, 2025, Dampak Hilirisasi Nikel Terhadap Lingkungan Dan Masyarakat, *Iqtishaduna J. Ilm. Mhs. Huk. Ekon. Syariah*, 6, 748–755.
- Hamza, T. A., Sherif, A. H., & Abdalla, E. A., 2017. A novel approach to reinforce provisional material using silica gel powder. *Stomatological Disease and Science*, 1, 3–7
- Hannachi, Y., and Hafidh, A., 2020. Preparation and characterization of novel bi-functionalized xerogel for removal of methylene blue and lead ions from aqueous solution in batch and fixed-bed modes: RSM optimization, kinetic and equilibrium studies. *Journal of Saudi Chemical Society*, 24(7), 505–519.
- Hellal, M. S., Rashad, A. M., Kadimpati, K. K., Attia, S. K., and Fawzy, M. E., 2023. Adsorption characteristics of nickel (II) from aqueous solutions by Zeolite Scony Mobile-5 (ZSM-5) incorporated in sodium alginate beads. *Scientific Reports*, 13, Article 19601
- Hidajat, D., Tilana, F. G., dan Kusuma, I. G. B. S. A., 2023. Dampak Polusi Udara Terhadap Kesehatan Kulit. *Jurnal Kedokteran Unram*, 12(4), 371–378.
- 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, 100221.
- Hosseinhali, N., Hasanov, M., and Abbasi, M., 2021. Heavy metals' removal from aqueous environments using silica sulfuric acid. *Water Reuse*, 11(3), 508–519.
- Ho, Y. S., and McKay, G., 1999. Pseudo-second order model for sorption processes. *Process Biochemistry*, 34(5), 451–465.

- Ince, M. and Ince, O.K., 2017, An Overview of Adsorption Technique for Heavy Metal Removal from Water / Wastewater: A Critical Review, *Int. J. Pure Appl. Sci.*, 3, 10–19.
- Irzon, R., 2018, Komposisi Kimia Pasir Pantai di Selatan Kulon Progo dan Implikasi terhadap Provenance, *J. Geol. dan Sumberd. Miner.*, 19, 31–45.
- Kubicki, J.D. and Heaney, P.J., 2003, Molecular orbital modeling of aqueous organosilicon complexes : Implications for silica biomineralization, *Geochim. Cosmochim. Acta*, 67, 4113–4121.
- Lin, C. and Tseng, J., 2012, Green technology for improving process manufacturing design and storage management of organic peroxide, *Chem. Eng. J.*, 180, 284–292.
- Maria, S., Guelli, D.A., Souza, U. De, Angela, K., Bonilla, S., Augusto, A., and Souza, U. De, 2010, Removal of COD and color from hydrolyzed textile azo dye by combined ozonation and biological treatment, *J. Hazard. Mater.*, 179, 35–42.
- Maulana, M. R., Tanjung, D., & Hasibuan, M. H. M., 2024. Analisis Penggunaan Pasir Pantai Pondok Permai di Kecamatan Pantai Cermin Kabupaten Serdang Berdagai sebagai Agregat Halus terhadap Kuat Tekan Beton. *Konstruksi: Publikasi Ilmu Teknik, Perencanaan Tata Ruang dan Teknik Sipil*, 2(2).
- Meftah, N., Hani, A., and Merdas, A., 2023. Extraction and physicochemical characterization of highly-pure amorphous silica nanoparticles from locally available dunes sand. *Chemistry Africa*, 6, 3039–3048.
- Mudasir, M., Karelius, K., Aprilita, N. H., and Wahyuni, E. T., 2016. Adsorption of mercury(II) on dithizone-immobilized natural zeolite. *Journal of Environmental Chemical Engineering*, 4(2), 1839–1849.
- Munfidzah, 2010, Pembuatan Silika Gel dari Natrium Silikat Teknis Dengan Berbagai Konsentrasi Asam Dan Uji Daya Serapnya Terhadap Ion Logam Pb (II), *Skripsi*, Universitas Negeri Yogyakarta.
- Murbakhsy, Y.A., Mudasir, dan Natsir, T.A., 2024, Sintesis Silika Gel Terimobilisasi Ditizon dari Abu Dasar Batubara dan Aplikasinya untuk Adsorpsi Ion Logam Zn(II), *Skripsi*, FMIPA, Universitas Gadjah Mada.
- Musah, M., Azeh, Y., Mathew, J., Umar, M., Abdulhamid, Z., and Muhammad, A., 2022. Adsorption Kinetics and Isotherm Models: A Review. *Caliphate Journal of Science and Technology*, 4(1), 20–26..
- Mustafa, S., Dilara, B., Naeem, A., Rehana, N., and National, K.N., 2003, Temperature and pH Effect on the Sorption of Divalent Metal Ions by Silica Gel, *Adsorpt. Sci. Technol.*, 21, 297–307.

- Naat, J.N., 2022, Adsorpsi Ion Pb (II) Menggunakan Silika Berbasis Pasir Alam [Ion Pb (II) Adsorption Using Silica from Natural Sand of Takari-NTT], *KOVALEN J. Ris. Kim.*, 8, 266–279.
- Ngwenya, L., Banza, M., & Seodigeng, T., 2025. Adsorption of Nickel (II) from Aqueous Solution Using Recyclable Three-Dimensional Cellulose Nanocrystal Hydrogel: A Central Composite Design. *Engineering Proceedings*, 87(1), 99.
- Nurfaidah, A.Y., Lestari, D.P., Azzahra, R.T., and Suminar, R., 2020, Terhadap proses pemisahan nikel dari logam pengotor menggunakan metode leaching, *J. Fluida Vol.*, 13, 81–92.
- Nursari, E., Ningrum, W., Yunata, E.E., Suaebah, E., and Firdaus, R.A., 2025, Review: sintesis nanopartikel silika dari beberapa material dengan metode sol-gel, 14, 115–123.
- Pratama, W.M., Aprilita, N.H., and Mudasir, M., 2022, Dithizone-Immobilized Nickel Slag for Removing Lead (II) Ion, *J. Mater. Environ. Sci.*, 13, 1127–1136.
- Rachmawati, D. O., Gunadi, G. A., & Risha, N., 2025. Analisa Kandungan Mineral Pasir Hitam di Pantai Bali Barat. *Jurnal Teori dan Aplikasi Fisika*, 13(2), 61–68.
- Rahmadani, A., 2024, Analisis Kandungan Mineral Pasir Besi Pantai Boe Kabupaten Takalar, Sulawesi Selatan Menggunakan Metode X-Ray Diffraction (XRD), Skripsi, Universitas Hasanuddin.
- Rahman, I.A. and Padavettan, V., 2012, Synthesis of Silica Nanoparticles by Sol-Gel : Size-Dependent Properties , Surface Modification , and Applications in Silica-Polymer Nanocomposites — A Review, 2012, .
- Raji, Z., Karim, A., Karam, A., and Khalloufi, S., 2023, Adsorption of Heavy Metals : Mechanisms , Kinetics , and Applications of Various Adsorbents in Wastewater Remediation — A Review, *Waste*, 1, 775–805.
- Reinho, P., Sanam, R., Pote, L.L., and Latumakulita, G., 2022, Synthesis and Characterization of Silica Gel of Waste Agate From The Nian Village of Timor Tengah Utara Regency Using Sol Gel Method, *Indones. J. Chem. Res.*, 7, 9–17.
- Saad, E. and Sayed, A.E.H., 2023, Effects of black sand on *Oreochromis niloticus* : insights into the biogeochemical impacts through an experimental study, 11, 1–12.
- Septiawan, M.R., Asnawi, I., Rahman, F.R., and Ramadhan, A., 2023, Studi Khelasi Logam Timbal (Pb) Pada sampel air, *J. Teknol. Kim. Miner.*, 2, 11–

16.

Setyorini, A., Suhartana, and Pardoyo., 2018, Natural Zeolite Modification using Dithizone and Its Application as Adsorbent of Cu (II), *J. Kim. Sains dan Apl.*, 21, 98–101.

Sofiyanah., 2014. *Immobilisasi Dithizon pada Silika Gel Teraktivasi HCl dan Aplikasinya terhadap Adsorpsi Ion Logam Pb(II) dan Cu(II)* [Skripsi, Universitas Islam Negeri Sunan Kalijaga.

Stuart, B. H., 2004. *Infrared Spectroscopy: Fundamentals and Applications*. John Wiley & Sons.

Sumari, Prakasa, Y. F., Asrori, M. R., dan Rachmadika, D., 2020. Analisis Kandungan Mineral Pasir Pantai Bajul Mati Kabupaten Malang Menggunakan XRF dan XRD. *Fullerene Journal of Chemistry*, 5(2), 58–62.

Susiana, C.A., Rusdiarso, B., and Mudasir, M., 2024, Enhanced Capacity and Easily Separable Adsorbent of Dithizone-immobilized Magnetite Zeolite for Pb(II) Adsorption, *Indones. J. Chem.*, 24, 1058–1070.

Sutal, Y., Pingak, R. K., Ahab, A. S., and Baunsele, S. D., 2019. Kajian awal ekstraksi silika dari pasir Noeltoko menggunakan X-Ray Fluorescence. *Prosiding Seminar Nasional Sains dan Teknik FST UNDANA (SAINSTEK)*, Kupang, 25 Oktober 2019, 75–78

Taleb, M. A., Kumar, R., Barakat, M. A., Almeelbi, T., Seliem, M. K., & Ahmad, A., 2024. Recent advances in heavy metals uptake by tailored silica-based adsorbents. *Science of the Total Environment*, 955, 177093.

Thordardottir, U.L. Extraction of High-Purity Silica from Industrial Biomass Ash using Low- Cost Hydrometallurgical Methods,.

Widayatno, T., Yuliawati, T., dan Susilo, A.A., 2017, Adsorpsi logam berat (pb) dari limbah cair dengan adsorben arang bambu aktif, *J. Teknol. Bahan Alam*, 1, 17–23.

Wogo, H. E., Segu, J. O., and Ola, P., 2013. *Sintesis Silika Gel Terimobilisasi Dithizon melalui Proses Sol-Gel*. *Jurnal Sains dan Terapan*, 5, 84–95.

Youssif, M. M., El-Attar, H. G., and Wojnicki, M., 2024. Recent Developments in the Adsorption of Heavy Metal Ions from Aqueous Solutions Using Various Nanomaterials. *Materials*, 17(21), 5141.

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(1), 625–630.

Yudo, S., dan Said, N. I., 2005. Pengolahan Air Limbah Industri Kecil Pelapisan Logam. *Jurnal Air Indonesia*, 1(1), 17–29.