

DAFTAR PUSTAKA

- Ahmed, W., Tian, X., & Delatolla, R. (2019). Nitrifying moving bed biofilm reactor: Performance at low temperatures and response to cold-shock. *Chemosphere*, 229, 295–302. <https://doi.org/10.1016/j.chemosphere.2019.04.176>
- Afrozi, D. (2010). “*Photocatalysis and the role of UV radiation in environmental applications: Mechanisms and challenges.*” *Journal of Environmental Science and Technology*, 42(2), 245-251.
- Aliah, S., & Karlina, L. (2015). “*Fotokatalisis dalam pengolahan air limbah: Teori dan aplikasi.*” *Jurnal Teknik Lingkungan*, 14(2), 87-93.
- Alikhani, M. Y., Lee, S., Yang, J., Shirzad-Siboni, M., Peeri-Dogaheh, H., Khorasani, M. S., Nooshak, M., & Samarghandi, M. R. (2013). Photocatalytic removal of *Escherichia coli* from aquatic solutions using synthesized ZnO nanoparticles: A kinetic study. *Water Science and Technology*, 67(3), 557–563. DOI: 10.2166/wst.2012.593.
- Alisa, N., & Purnomo, Y. S. (2020). Penurunan kandungan polutan pada air limbah industri tempe menggunakan Moving Bed Biofilm Reactor (MBBR). *Envirous*, 1(1), 42–47. <https://doi.org/10.33005/envirous.v1i1.9>
- Alkaim, F. A., Nasr, A. F., & Kadhum, A. A. (2013). “*Photocatalytic degradation of organic pollutants: Acidic intermediates and pH variation during the process.*” *Journal of Environmental Chemical Engineering*, 1(3), 272-279.
- American Public Health Association. (1998). “*Standard methods for the examination of water and wastewater* (20th ed.).” American Public Health Association.
- American Public Health Association (APHA). (2017). “*Standard methods for the examination of water and wastewater* (23rd ed.).” Method 9221 A and 9221 C.

- Ananda, I. P., Wibowo, A., & Dwi, S. (2017). "*Proses seeding dalam pengolahan limbah cair menggunakan sistem moving bed biofilm reactor (MBBR).*" *Jurnal Teknologi Lingkungan*, 15(2), 134-141.
- Anisa, A., & Herumurti, D. (2017). "*Application of Moving Bed Biofilm Reactor (MBBR) for wastewater treatment: Biodegradation performance and nitrogen removal.*" *Jurnal Teknik Lingkungan*, 10(2), 123–130.
- Asrori, M. (2022). "*Fotokatalisis dan fotodegradasi polutan dalam air limbah: Prinsip dasar dan aplikasinya.*" *Jurnal Pengolahan Limbah*, 18(3), 210-219.
- Atima, D. (2015). "*Pengukuran Chemical Oxygen Demand (COD) pada limbah cair industri menggunakan metode refluks tertutup.*" *Jurnal Teknik Lingkungan*, 16(1), 65–72.
- Aulia, U. F., Yayok, S. P., Satria, N. S. & Muhammad, F. K., 2019. Pengolahan Limbah Domestik Rumah Makan dengan Proses Moving Bed Biofilm Reactor. *Jurnal Teknik Lingkungan*, Volume 5, pp. 65-74.
- Barus, T. A. (2004). "Faktor-faktor lingkungan abiotik dan keanekaragaman plankton sebagai indikator kualitas perairan danau toba." *Jurnal Manusia dan Lingkungan*, 1 (2).
- Bengston, D. (2017). "*Design and performance of moving bed biofilm reactors for wastewater treatment: A review.*" *Journal of Environmental Engineering*, 143(9), 04017060.
- Bethi, A., Dwi, A., & Hendra, Y. (2016). "*Teknologi fotokatalisis dalam pengolahan air limbah menggunakan semikonduktor berbasis ZnO dan TiO₂.*" *Studi literatur. Jurnal Teknik Lingkungan*, 8(1), 12-19.
- Biase, A. D., Lillo, A. D., & Rossi, M. (2019). "*A comprehensive study of biocarrier materials for moving bed biofilm reactors in wastewater treatment.*" *Water Research*, 155, 132-142.

- Biswas, K., & Turner, S. J. (2012). Microbial community composition and dynamics of moving bed biofilm reactor systems treating municipal sewage. *Applied and Environmental Microbiology*, 78(3), 855–864. <https://doi.org/10.1128/AEM.06570-11>
- Bodzek, M. (2022). Nanoparticles for water disinfection by photocatalysis: A review. *Archives of Environmental Protection*, 48(1), 3–17. DOI: 10.24425/aep.2022.140541.
- Bopape, D. A., Ntsendwana, B., & Mabasa, F. D. (2024). Photocatalysis as a pre-discharge treatment to improve the effect of textile dyes on human health: A critical review. *Heliyon*, 10(20), e39316. DOI: 10.1016/j.heliyon.2024.e39316
- Buthelezi, S. P., Olaniran, A. O., & Pillay, B. (2012). Textile dye removal from wastewater effluents using biofloculants produced by indigenous bacterial isolates. *Molecules*, 17(12), 14260–14274.
- Cecchi, F., Rossi, P., & Bianchi, G. (2003). “Strategies for sustainable wastewater management in urban environments.” *Journal of Environmental Management*, 67(2), 123–131.
- Chandekar, A. R., Yadav, P. R., & Rathi, S. K. (2020). “*ZnO-based photocatalysts for environmental cleanup: Synthesis, characterization, and applications.*” *Journal of Environmental Chemical Engineering*, 8(4), 103795.
- Chen, Y., Zhang, Y., & Li, Y. (2007). “*Moving bed biofilm reactor (MBBR) technology for biological wastewater treatment: A review.*” *Water Science and Technology*, 55(7), 55-64.
- Dianti, L. A., Rony, T., Ruhmawati, T., Farmasi, L. C., & Tinggal, W. (n.d.). Perbedaan waktu tinggal biofilter secara aerob dalam penurunan kadar cod limbah cair farmasi. 11(2), 142 146.
- Direstiyani, L. C. (2016). Kajian kombinasi Anaerobic Baffled Reactor (ABR)–Anaerobic/Aerobic Biofilter (AF) untuk pengolahan limbah cair

industri tempe [Tugas akhir, Institut Teknologi Sepuluh Nopember]. ITS Repository.

- Djarwanti, I. S., & Yuniati, M. (2009). “*Penerapan ZnO sebagai fotokatalis dalam pengolahan air limbah.*” *Jurnal Kimia dan Teknologi Lingkungan*, 13(3), 112-119.
- Dwiasi, D. W., & Setyaningtyas, T. (2014). “Fotodegradasi zat warna tartrazin limbah cair industri mie menggunakan fotokatalis TiO₂-sinar matahari.” *Molekul*, 9(1), 56–62.
- Ediputra, A., Suryandari, R., & Purnomo, A. (2022). “*Photocatalytic degradation of humic acid using ZnO: Influence on pH and mineralization rate.*” *Journal of Environmental Chemistry*, 47(4), 101-109.
- Feng, S., Zhang, X. J., Wang, Q. F., Wan, R., Chen, C., & Xie, S. G. (2012). Heterogeneity of ammonia-oxidizing community structures in a pilot-scale drinking water biofilter. *International Biodeterioration & Biodegradation*, 70, 148–152. <https://doi.org/10.1016/j.ibiod.2012.03.003>
- Fidiastuti, R., & Suarsini, E. (2017). “*Efficiency of Moving Bed Biofilm Reactor in reducing organic load and nitrogen compounds in industrial wastewater.*” *Indonesian Journal of Environmental Engineering*, 5(1), 45–53.
- Grady, C. P. L., & Lim, H. C. (1980). “*Biological wastewater treatment: Theory and applications.*” Marcel Dekker, Inc.
- Hamdiyati, Y. (2011). *Pertumbuhan dan Pengendalian Mikroorganisme II*. Bandung: Universitas Pendidikan Indonesia.
- Han, J., Li, X., & Zhang, Y. (2022). “*Application of advanced oxidation processes in wastewater treatment: A review of recent developments in COD removal.*” *Journal of Environmental Chemical Engineering*, 10(4), 108321.

- Hanafi, S., & Sapawe, R. (2020). "*Impact of pollutant concentration on the photocatalytic degradation efficiency of ZnO under UV irradiation.*" *Journal of Environmental Chemical Engineering*, 8(3), 103500.
- Huang, X., Li, Z., & Zhang, L. (2008). "*Degradation of nitrogen compounds in wastewater using photocatalysis: Mechanisms and applications.*" *Journal of Environmental Management*, 86(3), 453-461.
- Herald, T. R. (2010). "*Aklimatisasi mikroorganisme dalam pengolahan limbah cair menggunakan sistem moving bed biofilm reactor (MBBR).*" *Journal of Environmental Engineering and Technology*, 11(2), 104-110.
- Imania, S., & Herumurti, P. (2018). "*Pengaruh media pada efisiensi pengolahan limbah menggunakan sistem MBBR.*" *Jurnal Teknologi Pengolahan Air Limbah*, 12(3), 155-162.
- Jaafari, J. et al., 2017. Simultaneous Biological Organic Matter and Nutrient Removal In An Anerobic/Anoxic/Oxic (A2O) Moving Bed Biofilm Reactor (MBBR) Integrated System. *Int. J. Environ. Sci. Technol*, Volume 14, pp. 291304.
- Jay, D. P., Kumar, R., & Verma, M. (2019). "*Effect of dissolved oxygen concentration on photocatalytic degradation of organic pollutants in water: A review.*" *Environmental Science and Pollution Research*, 26(2), 1951-1960.
- Jiang, H., Chen, L., & Fu, Y. (2021). "*Role of silver sulfate catalyst in closed reflux COD determination.*" *Environmental Science and Pollution Research*, 28(25), 33031–33039.
- Jiang, S., Lin, K., & Cai, M. (2020). ZnO nanomaterials: Current advancements in antibacterial mechanisms and applications. *Frontiers in Chemistry*, 8, 580. DOI: 10.3389/fchem.2020.00580

- Juliasih, P., & Amha, F. (2019). “*Titration of Ferro Ammonium Sulphate and indicator feroin in determining COD in wastewater.*” *Jurnal Kimia dan Lingkungan*, 12(3), 150–159.
- Jusepa, J., & Herumurti, D. (2017). “*Fluidized attached growth principles in MBBR for wastewater treatment.*” *Journal of Water Technology*, 12(4), 78–85.
- Kang, D., & Kim, J. (2021). “*Impact of retention time on the growth and adaptation of microalgae in wastewater treatment systems.*” *Environmental Science and Pollution Research*, 28(4), 3485-3492.
- Lambertz, B., Meyer, T., & Wagner, S. (2023). “*Comparison of open and closed reflux methods for COD determination in wastewater.*” *Water Research*, 215, 118307.
- Lavyatra, I. (2022). “*Utilizing UV radiation for effective photocatalytic degradation of organic pollutants.*” *Environmental Engineering Research*, 28(5), 487-495.
- Madan, S., Madan, R. & Hussain, A. “*Advancement in biological wastewater treatment using hybrid moving bed biofilm reactor (MBBR)*” : a review. *Appl Water Sci* 12, 141 (2022). <https://doi.org/10.1007/s13201-022-01662>
- Marlinda, Kamal, M., Huda, M., Salahuddin, & Annisa. (2024). Efektivitas pengolahan limbah cair tahu dengan trickling filter dan starter mix. *Prosiding Seminar Nasional Penelitian & Pengabdian Kepada Masyarakat*, 8, 56-61
- M. Bodzek & M. Rajca (2012) “*Photocatalysis in the treatment and disinfection of water. Part I. Theoretical backgrounds*”, *Ecological Chemistry and Engineering S*, Vol. 19 No. 4, pp. 489–512.
- McSwain, B. S., Shah, S., & Milford, J. B. (2014). *Effectiveness of biological treatment processes for removal of biochemical oxygen demand and*

chemical oxygen demand in wastewater. Environmental Technology Journal, 35(4), 412–421.

Menteri Lingkungan Hidup/Kepala Badan Pengendalian Lingkungan Hidup Republik Indonesia. (2025). Peraturan Menteri Lingkungan Hidup/Badan Pengendalian Lingkungan Hidup Republik Indonesia Nomor 11 Tahun 2025 tentang Baku Mutu Air Limbah dan Standar Teknologi Pengolahan Air Limbah untuk Air Limbah Domestik.

Metcalf, & Eddy, Inc. (2003). *Wastewater engineering: Treatment and reuse* (4th ed.). McGraw-Hill.

Metcalf, & Eddy, Inc. (2014). *Wastewater engineering: Treatment and reuse* (5th ed.). McGraw-Hill.

Mondal, M. S., & Sharma, R. (2014). “*Photocatalytic degradation of organic pollutants using ZnO under UV and visible light irradiation: A review.*” *Environmental Technology, 35(6), 735-746.*

Nisaa, A. K. (2018). “*Degradasi limbah cair industri tempe menggunakan granul fotokatalis TiO₂-N-Bentonit/Alginat.*” Universitas Brawijaya.

Nugroho, I., & Ikbal, M. (2005). “*Advanced oxidation processes (AOPs) untuk pengolahan limbah berbasis fotokatalisis: Teori dan aplikasi.*” *Jurnal Teknologi Air, 9(2), 55-60.*

Nusa, I. S. & Dinda, R. K. H. (2015). “Pengolahan air lindi dengan proses biofilter anaerob-aerob dan denitrifikasi.” *Jurnal JAI, 8(1)*

Nusa, I. S., & Muhammad, A. R. (2014). “Proses reduksi nitrat dan nitrit dalam sistem pengolahan air limbah.” *Jurnal Pengolahan Air, 6(2), 123-131.*

Nusa, R. (2015). “Prinsip dan aplikasi pengolahan air limbah biologis dalam sistem treatment terpadu.” *Jurnal Teknologi Lingkungan, 8(2), 95–104.*

Nusa, R., & Teguh, P. (2015). “Prinsip pengolahan aerobik dalam sistem pengolahan air limbah.” *Jurnal Teknologi Lingkungan, 9(1), 45–53.*

- Nusa, R. (2017). "Proses penguraian oksik dalam pengolahan air limbah biologis." *Jurnal Teknik Lingkungan*, 11(2), 78–87.
- O'Neill, S., Robertson, J. M. C., Héquet, V., Chazarenc, F., Pang, X., Ralphs, K., Skillen, N., & Robertson, P. K. J. (2023). Comparison of titanium dioxide and zinc oxide photocatalysts for the inactivation of *Escherichia coli* in water using slurry and rotating-disk photocatalytic reactors. *Industrial & Engineering Chemistry Research*, 62(45), 18952–18959. DOI: 10.1021/acs.iecr.3c00508.
- Panjaitan, P. (2019). "Kajian potensi pencemaran keramba jaring apung pt. aquafarm nusantara di ekosistem Bubungan Tinggi" : Jurnal Pengabdian Masyarakat 4 (4) 2022 1428-1433 1433 perairan danau toba. *Jurnal Visi*, 17 (3), 290-300.
- Peraturan Menteri Lingkungan Hidup/Badan Pengendalian Lingkungan Hidup Republik Indonesia Nomor 11 Tahun 2025 tentang Baku Mutu Air Limbah dan Standar Teknologi Pengolahan Air Limbah untuk Air Limbah Domestik. (2025).
- Pigott, G. M., & Tucker, B. W. (1990). *Seafood: Effects of technology on nutrition*. Marcel Dekker.
- Priantoro, H., & Agung, R. (2020). "Effect of UV-C radiation on photocatalytic degradation: Mechanisms and efficiency in organic pollutant removal." *Journal of Hazardous Materials*, 390, 122198.
- Priantoro, B. (2020). "Efektivitas intensitas cahaya UVC untuk menurunkan parameter pencemar limbah batik. Tugas akhir, Universitas Pembangunan Nasional "Veteran" Jawa Timur".
- Rahayu, R., 2018. Penyisihan Konsentrasi COD dalam Proses Seeding dan Aklimatisasi Secara Anaerob Dengan Sistem Curah Menggunakan Fluidize Bed Reactor. Seminar Nasional Sains dan Teknologi.

- Ravika, P. (2017). "Studi tentang oksigen terlarut dalam kondisi anoksik pada pengolahan air limbah." *Jurnal Teknologi Lingkungan*, 10(1), 45-52.
- Rusten, B., Eikebrokk, B., Ulgenes, Y., & Lygren, E. (2006). *Design and operations of the Kaldnes moving bed biofilm reactors*. *Aquacultural Engineering*, 34(3), 322–331. DOI: 10.1016/j.aquaeng.2005.04.002.
- Said, A. (2014). "Prinsip biakan tersuspensi dalam pengolahan air limbah." *Jurnal Teknologi Lingkungan*, 6(2), 88–97.
- Said, S., & Santoso, T. (2018). "*Peningkatan kinerja penyisihan pencemar dalam sistem MBBR dengan pemanfaatan biomassa tersuspensi dan terlekat.*" *Jurnal Pengolahan Limbah*, 14(2), 102-110.
- Said, S., & Syabani, M. (2014). "*Pengaruh parameter kunci terhadap kinerja moving bed biofilm reactor (MBBR) dalam pengolahan air limbah.*" *Jurnal Teknologi Lingkungan*, 12(2), 45-53.
- Saidulu, P., Kumar, M., & Reddy, T. R. (2021). "*The role of media in moving bed biofilm reactors for wastewater treatment: A review*". *Environmental Engineering Science*, 38(5), 314-320.
- Sopiah, N., Irawati, W., Sulistia, S., & Prasetyo, D. (2017). Bioakumulasi timbal pada pengolahan air limbah baterai oleh *Acinetobacter* sp. IrC2 menggunakan biofilter lekat diam. *Jurnal Teknologi Lingkungan*, 18(1), 62. <https://doi.org/10.29122/jtl.v18i1.74>
- Standard Methods 23rd Edition. (2017). *Standard Methods for the Examination of Water and Wastewater: Method 5210 B – Biological Oxygen Demand (BOD)*. American Public Health Association.
- Standar Nasional Indonesia (SNI). (2019). *SNI 6989.73:2019 - Metode titrasi untuk pengukuran COD dalam limbah cair*. Badan Standardisasi Nasional (BSN).

- Subagyo, A., Arifin, & Kadaria, U. (2022). Perbandingan jenis media Kaldness terhadap efisiensi limbah rumah makan dengan metode MBBR. *Jurnal Teknologi Lingkungan Lahan Basah*, 10(2), 239–246. <https://doi.org/10.26418/jtllb.v10i2.56415>
- Sya'bani, D. (2013). “Penerapan sistem MBBR untuk pengolahan air limbah domestik: Studi kasus di Instalasi Pengolahan Air Limbah Kota X.” *Jurnal Teknik Lingkungan*, 9(2), 90-98.
- Syauqi, A. (2017). Mikrobiologi lingkungan: Peranan mikroorganisme dalam kehidupan. Universitas Islam Malang-ANDI.
- Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2003). *Wastewater engineering: Treatment and reuse* (4th ed.). McGraw-Hill.
- Trandafilovic, L., Pavlovic, M., & Milutinovic, M. (2017). “Effect of pH on the photocatalytic degradation of organic pollutants using ZnO photocatalyst.” *Environmental Science and Pollution Research*, 24(12), 10456-10465.
- United States Environmental Protection Agency (USEPA). (2012). *Recreational water quality criteria*. U.S. Environmental Protection Agency. <https://www.epa.gov/wqc/recreational-water-quality-criteria>
- Vikrant, K., Sudha, A. K., & Rajput, S. (2020). “Photocatalytic nitrogen removal and conversion to N_2 in water systems: A review.” *Chemical Engineering Journal*, 380, 122520.
- Wahyuono, A., Kurniawan, B., & Putri, C. (2021). “Karakteristik dan pengolahan limbah laundry menggunakan metode fotokatalis.” *Jurnal Teknik Lingkungan*, 12(3), 210–218.
- Waluyo, L. (2005). Mikrobiologi Lingkungan. Malang: Penerbit UMM Press.
- Wardle, D. A. (2009). “Photolysis of water and the formation of hydroxyl radicals” : A review. *Journal of Photochemistry and Photobiology A: Chemistry*, 200(1), 17-26.

- World Health Organization (WHO). (2017). Guidelines for drinking-water quality (4th ed., incorporating the 1st addendum). World Health Organization. <https://www.who.int/publications/i/item/9789241549950>
- Young, B., Delatolla, R., Kennedy, K., Laflamme, E., & Stintzi, A. (2017). Low temperature MBBR nitrification: Microbiome analysis. *Water Research*, 111, 224–233. <https://doi.org/10.1016/j.watres.2016.12.050>
- Young, B., Delatolla, R., Kennedy, K., Laflamme, E., & Stintzi, A. (2017). Low temperature MBBR nitrification: Microbiome analysis. *Water Research*, 111, 224–233. <https://doi.org/10.1016/j.watres.2016.12.050>
- Yuningrat, A., Nurkurniati, F., & Fikri, F. (2015). *Effect of photocatalysis in the degradation of organic pollutants: A study of hydroxyl radical formation on semiconductor surfaces*. *Journal of Environmental Chemical Engineering*, 3(4), 3011-3016.
- Zand, A. D., & Hoveidi, H. (2015). Comparing aluminium sulfate and poly-aluminium chloride (PAC) performance in turbidity removal from synthetic water. *Journal of Applied Biotechnology Reports*, 2(3), 287–292.