

REFERENCES

- Aka, R. J. N., Hossain, Md. M., Nasir, A., Zhan, Y., Zhang, X., Zhu, J., Wang, Z.-W., & Wu, S. (2024). Enhanced nutrient recovery from anaerobically digested poultry wastewater through struvite precipitation by organic acid pre-treatment and seeding in a bubble column electrolytic reactor. *Water Research*, 252, 121239. <https://doi.org/10.1016/j.watres.2024.121239>
- APHA, American Water Works Association, & Water Environment Federation. (2017). Standard Methods for the Examination of Water and Wastewater – Section 2130 Turbidity. In Lipps WC, Baxter TE, & Braun-Howland E (Eds.), *Standard Methods for the Examination of Water and Wastewater*. APHA Press.
- Battaz, S., Djazi, F., Allal, H., Trabelsi, I., Abdellah, Z., Benrabaa, R., & Hamzaoui, A. H. (2024). Phosphorus recovery as struvite from wastewater by using seawater, brine and natural brine. *Desalination and Water Treatment*, 317, 100082. <https://doi.org/10.1016/j.dwt.2024.100082>
- Cahyani, M. R., Zuhaela, I. A., Saraswati, T. E., Raharjo, S. B., Pramono, E., Wahyuningsih, S., Lestari, W. W., & Widjonarko, D. M. (2021). Pengolahan Limbah Tahu dan Potensinya. *Proceeding of Chemistry Conferences*, 6, 27. <https://doi.org/10.20961/pcc.6.0.55086.27-33>
- Cerrillo, M., Palatsi, J., Comas, J., Vicens, J., & Bonmatí, A. (2015). Struvite precipitation as a technology to be integrated in a manure anaerobic digestion treatment plant – removal efficiency, crystal characterization and agricultural assessment. *Journal of Chemical Technology & Biotechnology*, 90(6), 1135–1143. <https://doi.org/10.1002/jctb.4459>
- Chen, Y., Long, J., Chen, S., Xie, Y., Xu, Z., Ning, Z., Zhang, G., Xiao, T., Yu, M., Ke, Y., Peng, L., & Li, H. (2022). Multi-step purification of electrolytic manganese residue leachate using hydroxide sedimentation, struvite precipitation, chlorination and coagulation: Advanced removal of manganese, ammonium, and phosphate. *Science of The Total Environment*, 805, 150237. <https://doi.org/10.1016/j.scitotenv.2021.150237>
- Corona, F., Hidalgo, D., Martín-Marroquín, J. M., & Antolín, G. (2021). Study of the influence of the reaction parameters on nutrients recovering from digestate by struvite crystallisation. *Environmental Science and Pollution Research*, 28(19), 24362–24374. <https://doi.org/10.1007/s11356-020-08400-4>
- Doyle, J. D., & Parsons, S. A. (2002). Struvite formation, control and recovery. *Water Research*, 36(16), 3925–3940. [https://doi.org/10.1016/S0043-1354\(02\)00126-4](https://doi.org/10.1016/S0043-1354(02)00126-4)

- Fosso-Kankeu, E. , N. , M. E. , M. V. , and HWJP. N. (2020). Impact of magnesium source on the yield and structure of struvite. *18th JOHANNESBURG Int'l Conference on Science, Engineering, Technology & Waste Management (SETWM-20) Nov. 16-17, 2020 Johannesburg (SA)*.
https://www.researchgate.net/publication/346388464_Impact_of_magnesium_source_on_the_yield_and_structure_of_struvite?enrichId=rgreq-2f3be42f0540f2559b98ddb838761fae-XXX&enrichSource=Y292ZXJQYWdlOzM0NjM4ODQ2NDtBUzo5NjIwNDczODI2NTUwMDZAMTYwNjM4MTM3ODk5Nw%3D%3D&el=1_x_2&_esc=publicationCoverPdf
- Farghali, M., Chen, Z., Osman, A. I., Ali, I. M., Hassan, D., Ihara, I., Rooney, D. W., & Yap, P.-S. (2024). Strategies for ammonia recovery from wastewater: a review. *Environmental Chemistry Letters*, 22(6), 2699–2751. <https://doi.org/10.1007/s10311-024-01768-6>
- González Morales, C., Camargo-Valero □, A., Molina Pérez, F. J., & Fernández, B. (2019). Effect of the stirring speed on the struvite formation using the centrate from a WWTP Efecto de la velocidad de agitación en la formación de estruvita usando el centrado de una PTAR. *Revista Facultad de Ingeniería Universidad de Antioquia*, 92, 42–50. <https://doi.org/10.17533/udea.redin.20190518>
- González-Morales, C., Fernández, B., Molina, F. J., Naranjo-Fernández, D., Matamoros-Veloza, A., & Camargo-Valero, M. A. (2021). Influence of pH and Temperature on Struvite Purity and Recovery from Anaerobic Digestate. *Sustainability*, 13(19), 10730. <https://doi.org/10.3390/su131910730>
- Ha, T. H., Mahasti, N. N. N., Ha, H. Q., Liao, P. L., Huang, Y. H., & Lu, M. C. (2024). Recovery of nitrogen as struvite from swine wastewater: Comparison study of batch and continuous fluidized-bed crystallization process. *Separation and Purification Technology*, 351. <https://doi.org/10.1016/j.seppur.2024.128045>
- Ha, T.-H., Mahasti, N. N. N., Ha, H.-Q., Liao, P.-L., Huang, Y.-H., & Lu, M.-C. (2024). Recovery of nitrogen as struvite from swine wastewater: Comparison study of batch and continuous fluidized-bed crystallization process. *Separation and Purification Technology*, 351, 128045. <https://doi.org/10.1016/j.seppur.2024.128045>
- Ha, T.-H., Mahasti, N. N. N., Lu, M.-C., & Huang, Y.-H. (2023). Ammonium-nitrogen recovery as struvite from swine wastewater using various magnesium sources. *Separation and Purification Technology*, 308, 122870. <https://doi.org/10.1016/j.seppur.2022.122870>

- Henderson, R. K., Parsons, S. A., & Jefferson, B. (2010). The impact of differing cell and algogenic organic matter (AOM) characteristics on the coagulation and flotation of algae. *Water Research*, 44(12), 3617–3624. <https://doi.org/10.1016/j.watres.2010.04.016>
- Huang, H., Guo, G., Zhang, P., Zhang, D., Liu, J., & Tang, S. (2017). Feasibility of physicochemical recovery of nutrients from swine wastewater: Evaluation of three kinds of magnesium sources. *Journal of the Taiwan Institute of Chemical Engineers*, 70, 209–218. <https://doi.org/10.1016/j.jtice.2016.10.051>
- Jarvis, P., Jefferson, B., & Parsons, S. A. (2005). Breakage, Regrowth, and Fractal Nature of Natural Organic Matter Flocs. *Environmental Science & Technology*, 39(7), 2307–2314. <https://doi.org/10.1021/es048854x>
- Kim, D., Kim, J., Ryu, H.-D., & Lee, S.-I. (2009). Effect of mixing on spontaneous struvite precipitation from semiconductor wastewater. *Bioresource Technology*, 100(1), 74–78. <https://doi.org/10.1016/j.biortech.2008.05.024>
- Kim, D., Min, K. J., Lee, K., Yu, M. S., & Park, K. Y. (2016). Effects of pH, molar ratios and pre-treatment on phosphorus recovery through struvite crystallization from effluent of anaerobically digested swine wastewater. *Environmental Engineering Research*, 22(1), 12–18. <https://doi.org/10.4491/eer.2016.037>
- Kolb, A., Gebhardt, T., & Dockhorn, T. (2025). Struvite Precipitation from Centrate—Identifying the Best Balance Between Effectiveness and Resource Efficiency. *Resources*, 14(4), 56. <https://doi.org/10.3390/resources14040056>
- Laridi, R., Auclair, J.-C., & Benmoussa, H. (2005). Laboratory and Pilot-scale Phosphate and Ammonium Removal by Controlled Struvite Precipitation Following Coagulation and Flocculation of Swine Wastewater. *Environmental Technology*, 26(5), 525–536. <https://doi.org/10.1080/09593332608618533>
- Lavanya, A., & Ramesh, S. K. T. (2021). Crystal seed-enhanced ammonia nitrogen and phosphate recovery from landfill leachate using struvite precipitation technique. *Environmental Science and Pollution Research*, 28(43), 60569–60584. <https://doi.org/10.1007/s11356-021-14950-y>
- Le Corre, K. S., Valsami-Jones, E., Hobbs, P., & Parsons, S. A. (2009). Phosphorus Recovery from Wastewater by Struvite Crystallization: A Review. *Critical Reviews in Environmental Science and Technology*, 39(6), 433–477. <https://doi.org/10.1080/10643380701640573>
- Li, D.-Y., Cho, Y.-C., Hsu, M. H., & Lin, Y.-P. (2022). Recovery of phosphate and ammonia from wastewater via struvite precipitation using spent

refractory brick gravel from steel industry. *Journal of Environmental Management*, 302, 114110. <https://doi.org/10.1016/j.jenvman.2021.114110>

- Li, G., Zheng, B., Zhang, W., Liu, Q., Li, M., & Zhang, H. (2024). Phosphate Removal Efficiency and Life Cycle Assessment of Different Anode Materials in Electrocoagulation Treatment of Wastewater. *Sustainability (Switzerland)*, 16(9). <https://doi.org/10.3390/su16093836>
- Liu, X., Hu, Z., Zhu, C., Wen, G., Meng, X., & Lu, J. (2013). Influence of process parameters on phosphorus recovery by struvite formation from urine. *Water Science and Technology*, 68(11), 2434–2440. <https://doi.org/10.2166/wst.2013.514>
- Liu, Y., Kwag, J.-H., Kim, J.-H., & Ra, C. (2011). Recovery of nitrogen and phosphorus by struvite crystallization from swine wastewater. *Desalination*, 277(1–3), 364–369. <https://doi.org/10.1016/j.desal.2011.04.056>
- Luu, T. A., Nguyen, G. C., Truong, M. T., Le, V. G., & Bui, X. T. (2025). Recovery of high-quality struvite fertilizer product from swine wastewater using fluidized bed homogeneous crystallization. *RSC Advances*, 15(30), 24122–24136. <https://doi.org/10.1039/d5ra03370e>
- Marshal, F. F. (2024). *Recovery Amonium dan Fosfat dari Air Limbah Artifisial Menggunakan Sistem Presipitasi Struvite dengan Sumber Magnesium dari Air Laut* [Undergraduate Thesis]. Andalas University.
- Mavhungu, A., Mbaya, R., Masindi, V., Foteinis, S., Muedi, K. L., Kortidis, I., & Chatzisyneon, E. (2019). Wastewater treatment valorisation by simultaneously removing and recovering phosphate and ammonia from municipal effluents using a mechano-thermo activated magnesite technology. *Journal of Environmental Management*, 250, 109493. <https://doi.org/10.1016/j.jenvman.2019.109493>
- Mehta, C. M., & Batstone, D. J. (2013). Nucleation and growth kinetics of struvite crystallization. *Water Research*, 47(8), 2890–2900. <https://doi.org/10.1016/j.watres.2013.03.007>
- Morse, G. K., Brett, S. W., Guy, J. A., & Lester, J. N. (1998). Review: Phosphorus removal and recovery technologies. *Science of the Total Environment*, 212(1), 69–81. [https://doi.org/10.1016/S0048-9697\(97\)00332-X](https://doi.org/10.1016/S0048-9697(97)00332-X)
- Ohlinger, K. N., Young, T. M., & Schroeder, E. D. (1998). Predicting struvite formation in digestion. *Water Research*, 32(12), 3607–3614. [https://doi.org/10.1016/S0043-1354\(98\)00123-7](https://doi.org/10.1016/S0043-1354(98)00123-7)

- Otero, M., Freire, L., Gómez-Cuervo, S., & Ávila, C. (2024). Ammonium Removal in Wastewater Treatments by Adsorbent Geopolymer Material with Granite Wastes: Full-Scale Validation. *Clean Technologies*, 6(1), 339–364. <https://doi.org/10.3390/cleantechnol6010017>
- Peng, C., Chai, L., Tang, C., Min, X., Ali, M., Song, Y., & Qi, W. (2017). Feasibility and enhancement of copper and ammonia removal from wastewater using struvite formation: a comparative research. *Journal of Chemical Technology & Biotechnology*, 92(2), 325–333. <https://doi.org/10.1002/jctb.5009>
- Perwitasari, D. S., Muryanto, S., Jamari, J., & Bayuseno, A. P. (2018). Kinetics and morphology analysis of struvite precipitated from aqueous solution under the influence of heavy metals: Cu²⁺, Pb²⁺, Zn²⁺. *Journal of Environmental Chemical Engineering*, 6(1), 37–43. <https://doi.org/10.1016/j.jece.2017.11.052>
- Pesonen, J., Janssens, F., Hu, T., Lassi, U., & Tuomikoski, S. (2022). Precipitation of struvite using MgSO₄ solution prepared from sidestream dolomite or fly ash. *Heliyon*, 8(12), e12580. <https://doi.org/10.1016/j.heliyon.2022.e12580>
- Ping, Q., Li, Y., Wu, X., Yang, L., & Wang, L. (2016). Characterization of morphology and component of struvite pellets crystallized from sludge dewatering liquor: Effects of total suspended solid and phosphate concentrations. *Journal of Hazardous Materials*, 310, 261–269. <https://doi.org/10.1016/j.jhazmat.2016.02.047>
- Prywer, J., Sieroń, L., & Czystkowska, A. (2019). Struvite Grown in Gel, Its Crystal Structure at 90 K and Thermoanalytical Study. *Crystals*, 9(2), 89. <https://doi.org/10.3390/cryst9020089>
- Rahman, Md. M., Salleh, M. A. Mohd., Rashid, U., Ahsan, A., Hossain, M. M., & Ra, C. S. (2014). Production of slow release crystal fertilizer from wastewaters through struvite crystallization – A review. *Arabian Journal of Chemistry*, 7(1), 139–155. <https://doi.org/10.1016/j.arabjc.2013.10.007>
- Rayshouni, H., & Wazne, M. (2022). Effects of Calcium on the Removal of Ammonium from Aged Landfill Leachate by Struvite Precipitation. *Water*, 14(12), 1933. <https://doi.org/10.3390/w14121933>
- Ronteltap, M., Maurer, M., Hausherr, R., & Gujer, W. (2010). Struvite precipitation from urine – Influencing factors on particle size. *Water Research*, 44(6), 2038–2046. <https://doi.org/10.1016/j.watres.2009.12.015>
- Satria Fajar Nugroho, G., Prastiwa Melania, R., Handayani, W., & Sulistyningrum, R. (2019). Issue 2 Article 2 12-31-2019 Part of the

Social and Behavioral Sciences Commons Recommended Citation
Recommended Citation Nugroho, Gefa Satria Fajar. *INDONESIA. Journal of Environmental Science and Sustainable Development*, 2(2), 127–138. <https://doi.org/10.7454/jessd.v2i2.1021>

- Seodigeng, R. C. F., Tshilenge, J. K., & Rutto, H. L. (2021). Struvite crystallisation of synthetic urine using magnesium nitrate: Effect of parameters on crystal size distribution. *Chemical Engineering Transactions*, 86, 1465–1470. <https://doi.org/10.3303/CET2186245>
- Septifani, R., Suhartini, S., & Perdana, I. J. (2021). Cleaner production analysis of tofu small scale enterprise. *IOP Conference Series: Earth and Environmental Science*, 733(1). <https://doi.org/10.1088/1755-1315/733/1/012055>
- Setiawan, A., Firdatul Jannah, F., Ramadani, T. A., & Dewi, T. U. (2022). Penyisihan Fosfat dan Amonium pada Air Limbah Menggunakan Presipitasi Struvite dengan Penambahan Bittern Removal of Phosphate and Ammonium in Wastewater Using Struvite Precipitation with Addition of Bittern. *Jurnal Pengendalian Pencemaran Lingkungan (JPPL)*, 4(1). <https://ejournal.pnc.ac.id/index.php/jppl>
- Shaddel, S., Grini, T., Andreassen, J.-P., Østerhus, S. W., & Ucar, S. (2020). Crystallization kinetics and growth of struvite crystals by seawater versus magnesium chloride as magnesium source: towards enhancing sustainability and economics of struvite crystallization. *Chemosphere*, 256, 126968. <https://doi.org/10.1016/j.chemosphere.2020.126968>
- Shaddel, S., Grini, T., Ucar, S., Azrague, K., Andreassen, J.-P., & Østerhus, S. W. (2020). Struvite crystallization by using raw seawater: Improving economics and environmental footprint while maintaining phosphorus recovery and product quality. *Water Research*, 173, 115572. <https://doi.org/10.1016/j.watres.2020.115572>
- Shalaby, M. S., & El-Rafie, S. (2015). Struvite Precipitation and Phosphorous Removal from Urine Synthetic Solution: Reaction Kinetic Study. *Bulletin of Chemical Reaction Engineering & Catalysis*, 10(1), 88–97. <https://doi.org/10.9767/bcrec.10.1.7172.88-97>
- Shu, J., Liu, R., Liu, Z., Chen, H., & Tao, C. (2016). Simultaneous removal of ammonia and manganese from electrolytic metal manganese residue leachate using phosphate salt. *Journal of Cleaner Production*, 135, 468–475. <https://doi.org/10.1016/j.jclepro.2016.06.141>
- Shu, J., Wu, H., Chen, M., Peng, H., Li, B., Liu, R., Liu, Z., Wang, B., Huang, T., & Hu, Z. (2019). Fractional removal of manganese and ammonia nitrogen from electrolytic metal manganese residue leachate using

carbonate and struvite precipitation. *Water Research*, 153, 229–238. <https://doi.org/10.1016/j.watres.2018.12.044>

- Simanjuntak, N. A. M. B., Zahra, N. L., & Suryawan, I. W. K. (2021). Tofu Wastewater Treatment Planning with Anaerobic Baffled Reactor (ABR) and Activated Sludge Application. *Jurnal Ilmu Alam Dan Lingkungan*, 12(1), 21–27. <https://journal.unhas.ac.id/index.php/jai2>
- Sitasari, A. N., & Khoironi, A. (2021). Evaluasi Efektivitas Metode dan Media Filtrasi pada Pengolahan Air Limbah Tahu. *Jurnal Ilmu Lingkungan*, 19(3), 565–575. <https://doi.org/10.14710/jil.19.3.565-575>
- Tarragó, E., Puig, S., Rusalleda, M., Balaguer, M. D., & Colprim, J. (2016). Controlling struvite particles' size using the up-flow velocity. *Chemical Engineering Journal*, 302, 819–827. <https://doi.org/10.1016/j.cej.2016.06.036>
- Trang, N. T. T., Yen, L. T. H., Hanh, L. T. H., & Thanh, B. X. (2018). Struvite Formation from Wastewater: Affecting Factors and Nutrient Recovery. *GeoScience Engineering*, 64(1), 9–13. <https://doi.org/10.2478/gse-2018-0002>
- Triger, A., Pic, J.-S., & Cabassud, C. (2012). Determination of struvite crystallization mechanisms in urine using turbidity measurement. *Water Research*, 46(18), 6084–6094. <https://doi.org/10.1016/j.watres.2012.08.030>
- Usman, M. O., Aturagaba, G., Ntale, M., & Nyakairu, G. W. (2022). A review of adsorption techniques for removal of phosphates from wastewater. In *Water Science and Technology* (Vol. 86, Issue 12, pp. 3113–3132). IWA Publishing. <https://doi.org/10.2166/wst.2022.382>
- Wahyuningsih, S., Amara, V. D., Rinawati, Sehusman, Sabarella, & Komalasari, W. B. (2024). Buletin Konsumsi Pangan. *Buletin Konsumsi Pangan*, 15(2).
- Wang, F., Fu, R., Lv, H., Zhu, G., Lu, B., Zhou, Z., Wu, X., & Chen, H. (2019). Phosphate Recovery from Swine Wastewater by a Struvite Precipitation Electrolyzer. *Scientific Reports*, 9(1), 8893. <https://doi.org/10.1038/s41598-019-45085-3>
- Wang, Y., Mou, J., Liu, X., & Chang, J. (2021). Phosphorus recovery from wastewater by struvite in response to initial nutrients concentration and nitrogen/phosphorus molar ratio. *Science of The Total Environment*, 789, 147970. <https://doi.org/10.1016/j.scitotenv.2021.147970>
- Weralupitiya, C., Wanigatunge, R., Joseph, S., Athapattu, B. C. L., Lee, T. H., Kumar Biswas, J., Ginige, M. P., Shiung Lam, S., Senthil Kumar, P., & Vithanage, M. (2021). Anammox bacteria in treating ammonium rich

wastewater: Recent perspective and appraisal. In *Bioresource Technology* (Vol. 334). Elsevier Ltd. <https://doi.org/10.1016/j.biortech.2021.125240>

Wu, J., Li, Y., Xu, B., Li, M., Wang, J., Shao, Y., Chen, F., Sun, M., & Liu, B. (2022). Effects of Physicochemical Parameters on Struvite Crystallization Based on Kinetics. *International Journal of Environmental Research and Public Health*, 19(12), 7204. <https://doi.org/10.3390/ijerph19127204>

Yan, Y., Kallikazarou, N. I., Nisiforou, O., Shang, Q., Fu, D., Antoniou, M. G., & Fotidis, I. A. (2025). Phosphorus recovery through struvite crystallization from real wastewater: Bridging gaps from lab to market. *Bioresource Technology*, 427, 132408. <https://doi.org/10.1016/j.biortech.2025.132408>

Yudhistira, B., Andriani, M., Utami, R., Pangan, T., & Pertanian, F. (2016). KARAKTERISASI: LIMBAH CAIR INDUSTRI TAHU DENGAN KOAGULAN YANG BERBEDA (ASAM ASETAT DAN KALSIUM SULFAT). In *Caraka Tani-Journal of Sustainable Agriculture* (Vol. 31, Issue 2).

Zahrina, I., Yenier, E., & Eriyati. (2022). Application Of Wastewater Treatment Technology In Tofu Industry, Pekanbaru City. *International Journal Of Community Service*, 2(2), 223–229. <https://doi.org/10.51601/ijcs.v2i2.88>

Zarebska, A., Romero Nieto, D., Christensen, K. V., Fjerrbæk Søtoft, L., & Norddahl, B. (2015). Ammonium Fertilizers Production from Manure: A Critical Review. *Critical Reviews in Environmental Science and Technology*, 45(14), 1469–1521. <https://doi.org/10.1080/10643389.2014.955630>

