

DAFTAR PUSTAKA

- Abdullah R., Rashid U., Ibrahim M., Hakim M., Moser B., Alharthi F. (2021). Bifunctional biomass-based catalyst for biodiesel production via hydrothermal carbonization pretreatment-Synthesis, characterization and optimization. *Process Safety and Environmental Protection*. 156: 219-230. <https://doi.org/10.1016/j.psep.2021.10.007>
- ASTM D6584-13. (2022). *Standard Test Method for Determination of Total Monoglycerides, Total Diglycerides, Total Triglycerides, and Free and Total Glycerin in B-100 Biodiesel Methyl Esters by Gas Chromatography Instrument: Perkin Elmer Clarus 500 GC with FID and Auto Sampler*.
- Ajala, E. O., Ajala, M. A., Ayinla, I. K., Sonusi, A. D., dan Fanodun, S. E. (2020). Nano-synthesis of solid acid catalysts from waste-iron-filling for biodiesel production using high free fatty acid waste cooking oil. *Scientific Reports*. 10(1): 1 – 21. <https://doi.org/10.1038/s41598-020-70025-x>
- Ali, A. A., dan Abdul-Hameed, H. M. (2025). Synthesis and characterization of magnetic activated carbon manufactured from palm stones by physical activation to remove lead from aqueous solution. *Desalination and Water Treatment*. 321(100951): 1 – 14. <https://doi.org/10.1016/j.dwt.2024.100951>
- Alsultan, A. G., Asikin-Mijan, N., Ibrahim, Z., Yunus, R., Razali, S. Z., Mansir, N., Islam, A., Seenivasagam, S., dan Taufiq-Yap, Y. H. (2021). A short review on catalyst, feedstock, modernised process, current state and challenges on biodiesel production. *Catalysts*. 11(11): 1-36. <https://doi.org/10.3390/catal11111261>
- Al-Hwaiti, M., Alsbou, E., Haddad, R. M. A., Osman, A. I., Jrai, A. A., Al-Muhtaseb, A. H., Hasan, A. O., Morgan, K. T., El-Sayed, E.-S. M., Al-Fatesh, A. S., Fakeeha, A. H., Rooney, D. W., dan Al-Rawashdeh, H. (2020). Spatio-temporal analyses of extracted citrullus colocynthis seeds (Handal seed oil) as biofuel in internal combustion engine. *Renewable Energy*. 166: 234-244. <https://doi.org/10.1016/j.renene.2020.11.148>
- Abdullah, R. F., Rashid, U., Taufiq-Yap, Y. H., Ibrahim, M. L., Ngamcharussrivichai, C., dan Azam, M. (2020). Synthesis of bifunctional nanocatalyst from waste palm kernel shell and its application for biodiesel production. *RSC Advances*. 10(45): 27183. <https://doi.org/10.1039/d0ra04306k>
- Ajala, E. O., Ajala, M. A., Ayinla, I. K., Sonusi, A. D., dan Fanodun, S. E. (2020). Nano-synthesis of solid acid catalysts from waste-iron-filling for biodiesel

- production using high free fatty acid waste cooking oil. *Scientific Reports*. 10(1): 1-21. <https://doi.org/10.1038/s41598-020-70025-x>
- Anil, N., Rao, P. K., Sarkar, A., Kubavat, J., Vadivel, S., Manwar, N. R., dan Paul, B. (2024). Advancements in sustainable biodiesel production: A comprehensive review of bio-waste derived catalysts. In *Energy Conversion and Management*. 318(118884): 1-27. <https://doi.org/10.1016/j.enconman.2024.118884>
- Boro, S., Das, B., Brahma, S., Basumatary, B., Basumatary, S. F., dan Basumatary, S. (2024). Biodiesel production using areca nut (*Areca catechu* L.) leaf ash- K_2CO_3 catalyst via transesterification from an oil blend of three different feedstocks. *Sustainable Chemistry for the Environment*. 8(100164): 1 - 17. <https://doi.org/10.1016/j.senv.2024.100164>
- Brahma, S., Das, B., Nath, B., Ali, R., Das, P., Kaur, S. B., Owary, J., Daimari, R., Das, S., dan Basumatary, S. (2025). Spent mushroom substrate decorated magnetic graphene oxide (Fe_3O_4 -GO@ K_2CO_3) nanocomposite for clean fuel production from quaternary oil blend. *Bioresource Technology Reports*. 31(130076): 1-16. <https://doi.org/10.1016/j.biteb.2025.102230>
- Camilo, G. L., Queiroz, A., Ribeiro, A. E., Gomes, M. C. S., dan Brito, P. (2024). Review of biodiesel production using various feedstocks and its purification through several methodologies, with a specific emphasis on dry washing. *Journal of Industrial and Engineering Chemistry*. 136: 1-15. <https://doi.org/10.1016/j.jiec.2024.02.016>
- Chauhan, S. J., Devliya, B., Patel, B., Nagapara, J., Mevada, S., Solanki, H., dan Patel, H. D. (2025). Biodiesel production from waste cooking oil using novel heterogenous CaO - MgO - ZnO - TiO_2 nanoconjugate catalyst (CMZT-Nano Cat): A green approach towards renewable energy. *Biomass and Bioenergy*. 200(107985): 1-19. <https://doi.org/10.1016/j.biombioe.2025.107985>
- Chingakham, C., Tiwary, C., Sajith, V. (2019). Waste Animal Bone as a Novel Layered Heterogeneous Catalyst for the Transesterification of Biodiesel. *Catalysis Letters*. 149: 1100–1110. <https://doi.org/10.1007/s10562-019-02696-9>.
- Daimary, N., Eldiehy, K. S. H., Boruah, P., Deka, D., Bora, U., dan Kakati, B. K. (2022). Potato peels as a sustainable source for biochar, bio-oil and a green heterogeneous catalyst for biodiesel production. *Journal of Environmental Chemical Engineering*. 10(1): 1-12. <https://doi.org/10.1016/j.jece.2021.107108>

- Darminto, Machida, N. Cholishoh, Feby A. Perdana, Malik A. Baqiya, Mashuri, Yoyok Cahyono, and Triwikantoro. (2011). Preparing Fe_3O_4 Nanoparticles from Fe^{2+} Ions Source by Co-precipitation Process in Various pH. *AIP Conf. Proc.* 1415: 234-237.
<https://doi.org/10.1063/1.3667264>
- Direktorat Jenderal Perkebunan. (2025). *Statistik Perkebunan Jilid I 2023 – 2025*. Sekretariat Direktorat Jenderal Perkebunan: Jakarta.
- Dhawane, S. H., Kumar, T., dan Halder, G. (2016). Parametric effects and optimization on synthesis of iron (II) doped carbonaceous catalyst for the production of biodiesel. *Energy Conversion and Management*. 122: 310-320. <https://doi.org/10.1016/j.enconman.2016.06.005>
- Degfie, T., Mamo, T., Mekonnen, Y. S. (2019). Optimized Biodiesel Production from Waste Cooking Oil (WCO) using Calcium Oxide (CaO) Nanocatalyst. *Nature Scientific Report*. 9:18982.
<https://doi.org/10.1038/s41598-019-55403-4>
- Dhawane, S. H., Kumar, T., dan Halder, G. (2015). Central composite design approach towards optimization of flamboyant pods derived steam activated carbon for its use as heterogeneous catalyst in transesterification of Hevea brasiliensis oil. *Energy Conversion and Management*. 100: 277-287.
<https://doi.org/10.1016/j.enconman.2015.04.083>
- El-Bayoumy, F. I., Osman, A. I., Rooney, D. W., dan Roushdy, M. H. (2024). Utilization of iron fillings solid waste for optimum biodiesel production. *Frontiers in Chemistry*. 12(1404107): 1-19.
<https://doi.org/10.3389/fchem.2024.1404107>
- Edler, R. (2009). *The Use Of Liquid Scintillation Counting Technology For The Determination Of Biogenic Materials*. 261-267.
- Foroutan, R., Mohammadi, R., Razeghi, J., dan Ramavandi, B. (2021). Biodiesel production from edible oils using algal biochar/ $\text{CaO}/\text{K}_2\text{CO}_3$ as a heterogeneous and recyclable catalyst. *Renewable Energy*. 168: 1207–1216. <https://doi.org/10.1016/j.renene.2020.12.094>
- Foroutan, R., Mohammadi, R., Taheri, M., Ahmadi, A., dan Ramavandi, B. (2023). Edible waste oil to biofuel using reclaimable g- $\text{C}_3\text{N}_4/\text{HAp}/\text{Fe}_3\text{O}_4/\text{K}_2\text{CO}_3$ nanobiocomposite catalyst: Toxicity evaluation and optimization. *Environmental Technology and Innovation*. 32(103403): 1-15. <https://doi.org/10.1016/j.eti.2023.103403>
- Foroutan, R., Peighambaroust, S. J., Mohammadi, R., Peighambaroust, S. H., dan Ramavandi, B. (2022). Application of waste

- chalk/CoFe₂O₄/K₂CO₃ composite as a reclaimable catalyst for biodiesel generation from sunflower oil. *Chemosphere*. 289(133226): 1-11.
<https://doi.org/10.1016/j.chemosphere.2021.133226>
- Foroutan, R., Peighambardoust, S. J., Mohammadi, R., Peighambardoust, S. H., dan Ramavandi, B. (2023). Investigation of kinetics, thermodynamics, and environmental factors of biodiesel generation from sunflower and castor oil using rice husk ash/CuO/K₂CO₃ heterogeneous catalyst. *Environmental Technology and Innovation*. 32(103307): 1-15.
<https://doi.org/10.1016/j.eti.2023.103307>
- Foroutan, R., Peighambardoust, S. J., Mohammadi, R., Peighambardoust, S. H., dan Ramavandi, B. (2024). The potential of biochar derived from banana peel/Fe₃O₄/ZIF-67@K₂CO₃ as magnetic nanocatalyst for biodiesel production from waste cooking oils. *Results in Engineering*. 22(102005): 1-17. <https://doi.org/10.1016/j.rineng.2024.102005>
- Ganjoo, R., Sharma, S., Kumar, A., & Daouda, M. M. A. (2023). Activated Carbon: Fundamentals, Classification, and Properties. *The Royal Society of Chemistry*. 1–22. <https://doi.org/10.1039/bk9781839169861-00001>
- Gardy, J., Osatiashtiani, A., Céspedes, O., Hassanpour, A., Lai, X., Lee, A. F., Wilson, K., dan Rehan, M. (2018). A magnetically separable SO₄/Fe-Al-TiO₂ solid acid catalyst for biodiesel production from waste cooking oil. *Applied Catalysis B Environment and Energy*. 234: 268-278.
<https://doi.org/10.1016/j.apcatb.2018.04.046>
- Gardy, J., Rehan, M., Hassanpour, A., Lai, X., dan Nizami, A. (2019). Advances in nano-catalysts based biodiesel production from non-food feedstocks. *Journal of Environmental Management*. 249: 109316.
<https://doi.org/10.1016/j.jenvman.2019.109316>
- Hamadneh, I., Abu-Zurayk, R. A., Aqel, A., Al-Mobydeen, A., Hamadneh, L., Al-Dalahmeh, Y., Hannon, F., Albuqain, R., Alsotari, S., dan Al-Dujaili, A. H. (2022). Impact of H₃PO₄-activated carbon from pine fruit shells for paracetamol adsorption from aqueous solution. *Desalination and Water Treatment*. 264: 293–306. <https://doi.org/10.5004/dwt.2022.28589>
- Heriyadi, A. T. (2023). Sintesis Biodiesel dari Minyak jelantah Menggunakan Katalis Bentonit Teraktivasi NaOH. *Jurnal Pendidikan Tambusai*. 7(3): 21949-21958.
- Hosseini, S. A. (2022). Nanocatalysts for biodiesel production. In *Arabian Journal of Chemistry*. 15(10): 1-11.
<https://doi.org/10.1016/j.arabjc.2022.104152>

- Huda, A. K. N. A. (2023). Transisi Energi Di Indonesia : Overview & Challenges. *Buletin Pertamina Energy Institute*. 9(2) : 49 – 61.
- Hazmi, B., Rashid, U., Taufiq-Yap, Y. H., Ibrahim, M. L., dan Nehdi, I. A. (2020). Supermagnetic Nano-Bifunctional Catalyst from Rice Husk: Synthesis, Characterization and Application for Conversion of Used Cooking Oil to Biodiesel. *Catalysts*. 10(2): 225-246.
<https://doi.org/10.3390/catal10020225>
- Hanif, M., Bhatti, I. A., Zahid, M., dan Shahid, M. (2022). Production of biodiesel from non-edible feedstocks using environment friendly nano-magnetic Fe/SnO catalyst. *Scientific Reports*, 12(1): 1-14.
<https://doi.org/10.1038/s41598-022-20856-7>
- Helwani, Z., Umar, L., Neonufa, G. F., Puspawiningtyas, E., Prakoso, T., dan Lugito, G. (2020). Extraction of polyunsaturated fatty acids to reduce the iodine number of biodiesel products. *IOP Conference Series Materials Science and Engineering*. 823(1): 12022. <https://doi.org/10.1088/1757-899x/823/1/012022>
- Hatami, M., Hasanpour, M., Jing, D. (2020). Recent developments of nanoparticles additives to the consumables liquids in internal combustion engines: Part I: Nano-fuels. *Journal of Molecular Liquids*. 318(114250): 1-32. <https://doi.org/10.1016/j.molliq.2020.114250>
- Idowu, I., Pedrola, M. P., Wylie, S., Teng, K. H., Kot, P., Phipps, D., Shaw, A. (2019). Improving biodiesel yield of animal waste fats by combination of a pre-treatment technique and microwave technology. *Renewable Energy*. 142: 535-542. <https://doi.org/10.1016/j.renene.2019.04.103>
- Javed, F., William, B., Zimmerman, Fazal, T., Hafeez, A., Mustafa, M., Rashid, N., Rehman, F. (2022). Green Synthesis of Biodiesel from Microalgae Cultivated in Industrial Wastewater via Microbubble Induced Esterification using Bio-MOF-Based Heterogeneous Catalyst. *Chemical engineering research & design* . 189: 707-720.
<https://doi.org/10.1016/j.cherd.2022.12.004>
- Jayanna, V. B., Kulkarni, V. M., Krishnamurthy, K. N., Patel, G. C. , Prasad, H. S., Samuel, O. D, Linul, E. (2025). Sustainable biodiesel production from *Oenothera lamarckiana* oil using hybrid $\text{CaO@Fe}_3\text{O}_4\cdot\text{SiO}_2$ magnetic nanocatalyst: RSM-driven optimization. *Result in engineering*. 25(104359): 1 – 31. <https://doi.org/10.1016/j.rineng.2025.104359>
- Kangani, A. A., Jafari, D., Esfandyari, M., dan Mahdavi, M. (2024). Transesterification of mustard oil to biodiesel using activated carbon/ $\text{Fe}_2(\text{MoO}_4)_3/\text{K}_2\text{CO}_3$ as a novel heterogeneous nanocatalyst: Box-

- Behnken design-based optimization and Gaussian process regression. *Process Safety and Environmental Protection*. 189: 102–114.
<https://doi.org/10.1016/j.psep.2024.06.058>
- Kim, J. Y., Park, G., Choi, Y., Park, W., Koo, B., Park, K., Tsang, Y. F., Kwon, E. (2024). Strategic approach for converting fat-rich food waste into high-quality biodiesel using black soldier fly larvae for sustainable bioenergy. *Science of the Total Environment*. 951(175651): 1 – 9.
<https://doi.org/10.1016/j.scitotenv.2024.175651>
- Kumar, D., Sharma, S., Srivastava, N., Shukla, S., Gaurav, K. (2018). Advancement in the Utilization of Nanocatalyst for Transesterification of Triglycerides. *Journal Nanoscience Tech*. 4(3): 374–379.
<https://doi.org/10.30799/jnst.111.18040302>.
- Kibar, M. E., Hilal, L., Çapa, B. T., Bahçivanlar, B., dan Abdeljelil, B. Ben. (2023). Assessment of Homogeneous and Heterogeneous Catalysts in Transesterification Reaction: A Mini Review. *ChemBioEng Reviews*. 10(4): 412–422. <https://doi.org/10.1002/cben.202200021>
- Knothe, G. (2006). Analyzing Biodiesel: Standards and Other Methods. *JAOCS*. 83(10): 823-833.
- Kussuryani, Y., Chairil Anwar, Muda, dan Chairil Anwar, P. (2009). Bahan Bakar Nabati Biodiesel dan Jaminan Mutu Biodiesel. *Lembaran Publikasi Lemigas*. 43(3): 247 – 255.
- Kwiatkowski, J., Sztejna, Z. (2024). Energy Efficiency of Conifer Cones and Seed Extraction Residue Biomass Sustainability. *MDPI*. 16(7): 1-12.
- Latebo, S., Bayu, A. B., Amibo, T. A., dan Kasule, J. (2021). Optimization of Trans-esterification Process and Characterization of Biodiesel from Soapstock Using Silica Sulfuric Acid as a Heterogeneous Solid Acid Catalyst. *Journal of Engineering Research*. 10(1): 78–100.
<https://doi.org/10.36909/jer.12003>
- Lestari, I., Yohana, Farid, F., Gusti, D. R. (2021). Preparation and Characterisation of Composite Magnetite Fe₃O₄-Activated Carbon as Adsorben of Phenol. *Jurnal Riset Kimia*. 13(1): 34 – 48.
<https://doi.org/10.25077/jrk.v13i1.442>
- Liang, X., Ji, H., Ali, E., & Marzouki, R. (2024). Ultrasonic-assisted biodiesel generation from waste chicken fat utilizing a novel and reusable Ce-doped Fe₂O₃ nanocatalyst: Optimization by CCD, kinetics, and nano-additive on emissions and performance of a diesel engine. *Process Safety and Environmental Protection*. 184: 834–853.
<https://doi.org/10.1016/j.psep.2024.02.001>

- Liu, J., Niu, S., Xu, Y., Liu, S., Zhu, J., Yang, Z., Geng, J., Zhang, Y., Hao, y. (2025). Sustainable biodiesel production using acid-base bifunction supported catalysts. *Biomass and Bioenergy*. 200(108032): 1 – 11. <https://doi.org/10.1016/j.biombioe.2025.108032>
- Lempang, M., (2012). Pohon Aren dan Manfaat Produksinya Mody Lempang. *Info Teknis EBONI*. 9(1): 37 – 54.
- Legasari, L., Riandi, R., Febriani, W., dan Pratama, R. A. (2023). Analisis Kadar Air Dan Asam Lemak Bebas Pada Produk Minyak Goreng Dengan Metode Gravimetri Dan Volumetri. *Jurnal Redoks (Jurnal Pendidikan Kimia Dan Ilmu Kimia)*. 6(2): 51-60. <https://doi.org/10.33627/re.v6i2.1228>
- Liun, E. (2014). Perbandingan Harga Energi Dari Sumber Energi Baru Terbarukan Dan Fosil. *Jurnal Pengembangan Energi Nuklir*, 16(2): 119-130.
- Li X., Zuo Y., Zhang Y., Fu Y., Guo Q. (2013). In situ preparation of K_2CO_3 supported Kraft lignin activated carbon as solid base catalyst for biodiesel production. *Fuel*. 131: 435-442 <https://doi.org/10.1016/j.fuel.2013.06.008>
- Mansoorsamaei, Z., Mowla, D., Esmailzadeh, F., dan Dashtian, K. (2024). Sustainable biodiesel production from waste cooking oil using banana peel biochar- $Fe_2O_3/Fe_2K_6O_5$ magnetic catalyst. *Fuel*. 357(129821): 1-9. <https://doi.org/10.1016/j.fuel.2023.129821>
- Mawlid, O. A., Abdelhady, H. H., dan El-Deab, M. S. (2023). Highly active novel K_2CO_3 supported on $MgFe_2O_4$ magnetic nanocatalyst for low-temperature conversion of waste cooking oil to biodiesel: RSM optimization, kinetic, and thermodynamic studies. *Journal of Environmental Chemical Engineering*. 11(5): 1-19. <https://doi.org/10.1016/j.jece.2023.110623>
- Monika, Banga, S., dan Pathak, V. V. (2023). Biodiesel production from waste cooking oil: A comprehensive review on the application of heterogenous catalysts. *Energy Nexus*. 10(100209): 1-20. <https://doi.org/10.1016/j.nexus.2023.100209>
- Mohammadi, N., Ostovar, N., Niromand, R., Absala, F. (2023). Advancing biodiesel production from *Pyrus glabra* seed oil: Kinetic study and RSM optimization via microwave-assisted transesterification with biocompatible hydroxyapatite catalyst. *Sustainable Chemistry and Pharmacy*. 36(101272): 1 – 16. <https://doi.org/10.1016/j.scp.2023.101272>

- Mandari, V., dan Kumar, D. S. (2022xiao). Biodiesel Production Using Homogeneous, Heterogeneous, and Enzyme Catalysts via Transesterification and Esterification Reactions: a Critical Review. *BioEnergy Research*. 15(2): 935-961. <https://doi.org/10.1007/s12155-021-10333-w>
- Mishra, S., dan Sahu, A. (2023). A Review of Magnetically Recyclable Nanocatalysts for the Synthesis of Quinazoline and its Derivatives. *Current Organic Chemistry*. 27(11): 914 – 930. <https://doi.org/10.2174/1385272827666230911115733>
- Mairizal, A. Q., Awad, S., Priadi, C. R., Hartono, D. M., Moersidik, S. S., Tazerout, M., dan Andrès, Y. (2019). Experimental study on the effects of feedstock on the properties of biodiesel using multiple linear regressions. *Renewable Energy*. 145: 375-381. <https://doi.org/10.1016/j.renene.2019.06.067>
- Milano, J., Umar, H., Shamsuddin, A. H., Silitonga, A. S., Irfan, O. M., Sebayang, A. H., Fattah, I. M. R., dan Mofijur, M. (2021). Experimental Study of the Corrosiveness of Ternary Blends of Biodiesel Fuel. *Frontiers in Energy Research*. 9(778801): 1 – 20. <https://doi.org/10.3389/fenrg.2021.778801>
- Melo, V. M. e., Ferreira, G. F., dan Fregolente, L. V. (2024). Sustainable catalysts for biodiesel production: The potential of CaO supported on sugarcane bagasse biochar. *Renewable and Sustainable Energy Reviews*. 189(114042): 1–12. <https://doi.org/10.1016/j.rser.2023.114042>
- Mohiddin, M. N. Bin, Tan, Y. H., Kansedo, J., Mubarak, N. M., Chan, Y. S., Khalid, M., dan Lee, K. T. (2024). Transesterification of used cooking oil by palm lignocellulosic biomass magnetic biochar catalyst: Optimization and kinetic analysis. *Renewable Energy*. 229 (120750): 1-13. <https://doi.org/10.1016/j.renene.2024.120750>
- Monde, J., Kumalasari, P. I., Fauzan, A., dan Lutfi, M. (2023). Effect of blending ratio of biofuel from used cooking oil with Dexlite. *BIO Web of Conferences*. 73(5014): 1 – 8. <https://doi.org/10.1051/bioconf/20237305014>
- Meillianti. (2017). Karakteristik Karbon Aktif Dari Cangkang Buah Karet Menggunakan Aktivator H₃PO₄. *Distilasi*. 2(2): 1-9.
- Moosavi, S., Li, R. Y. M., Lai, C. W., Yusof, Y., Gan, S., Akbarzadeh, O., Chowhury, Z. Z., Yue, X. G., dan Johan, M. R. (2020). Methylene blue dye photocatalytic degradation over synthesised Fe₃O₄/ac/TiO₂ nano-catalyst: Degradation and reusability studies. *Nanomaterials*. 10(12): 1–15. <https://doi.org/10.3390/nano10122360>
- Nasikin, M dan Susanto, B.H., (2010). *Katalis Heterogen*: Jakarta.

- Nasution, M.A., (2007). Pengaruh Penggunaan Bahan Bakar Biodiesel Sawit terhadap Konsumsi dan Emisi Mobil Diesel Tipe Common Rail. *Jurnal Penelitian Kelapa Sawit*. 15(2): 91-102.
- Nirawati, Restu, M., Kuswinanti, Musa, Y., Paembonan, S. A., Millang, Syahidah dan Larekeng, S. H. (2020). Morphological Characteristics of *Arenga pinnata* Merr. From Maros and Sinjai Provenances in South Sulawesi, Indonesia, and its relationship with Brix Content. *IOP Conference Series*. 486(012080): 1-6. <https://doi.org/10.1088/1755-1315/486/1/012080>
- Nguyen, H. C., Nguyen, M. L., Su, C. H., Ong, H. C., Juan, H. Y., dan Wu, S. J. (2021). Bio-derived catalysts: A current trend of catalysts used in biodiesel production. *Catalysts*. 11(7): 812 – 830. <https://doi.org/10.3390/catal11070812>
- Oko, S., Kurniawan, A., Willain, D. (2021). Sintesis Biodiesel Dari Minyak Kedelai Melalui Reaksi Transesterifikasi Dengan Katalis CaO/NaOH. *Jurnal Teknologi*. 13(1).1-6. <https://doi.org/10.24853/jurtek>
- Oyekunle, D. T., Barasa, M., Gendy, E. A., dan Tiong, S. K. (2023). Heterogeneous catalytic transesterification for biodiesel production: Feedstock properties, catalysts and process parameters. *Process Safety and Environmental Protection*. 177: 844 – 867. <https://doi.org/10.1016/j.psep.2023.07.064>
- Opoku, B. K., Asiamah, I., Micheal, A. A., Bentum, J. K., dan Muyoma, W. P. (2021). Characterization of Chemically Activated Carbons Produced from Coconut and Palm Kernel Shells Using SEM and FTIR Analyses. *American Journal of Applied Chemistry*. 9(3): 90-112. <https://doi.org/10.11648/j.ajac.20210903.15>
- Parida, S., Singh, M., dan Pradhan, S. (2022). Biomass wastes: A potential catalyst source for biodiesel production. *Bioresource Technology Reports*. 18(101081): 1-11. <https://doi.org/10.1016/j.biteb.2022.101081>.
- Paryanto, I., Prakoso, T., Susanto, B. H., Gozan, M. (2019). The Effect of Outdoor Temperature Conditions and Monoglyceride Content on the Precipitate Formation of Biodiesel-Petrodiesel Blended Fuel (BXX). *Joint Journal of Novel Carbon Resource Sciences & Green Asia Strategy*. 6(1): 59 – 64.
- Peraturan Presiden Republik Indonesia No. 5 Tahun 2006, Tentang Kebijakan Energi Nasional, Jakarta.

- Peraturan Menteri Energi dan Sumber Daya Mineral Nomor 32 Tahun 2020, Tentang Penyediaan, Pemanfaatan Dan Tata Niaga Bahan Bakar Nabati (Bio-Fuel) Sebagai Bahan Bakar Lain. Jakarta.
- Ponnumsamay, V. K., Al-Hazmi, H. E., Shobana, S., Dharmaraja, J., Jadhav, D. A., J. R. B., Piechota, G., Igliński, B., Kumar, V., Bhatnagar, A., Chae, K. J., dan Kumar, G. (2024). A review on homogeneous and heterogeneous catalytic microalgal lipid extraction and transesterification for biofuel production. In *Chinese Journal of Catalysis*. 59: 97–117. [https://doi.org/10.1016/S1872-2067\(23\)64626-1](https://doi.org/10.1016/S1872-2067(23)64626-1)
- Piri, H., Renzi, M., dan Bietresato, M. (2023). Technical Implications of the Use of Biofuels in Agricultural and Industrial Compression-Ignition Engines with a Special Focus on the Interactions with (Bio)lubricants. *Energies*. 17(1): 129-173. <https://doi.org/10.3390/en17010129>
- Pali, H. S., Sharma, A., Kumar, N., Singh, Y. (2021). Biodiesel yield and properties optimization from Kusum oil by RSM. *Fuel*. 291(120218): 1-13. <https://doi.org/10.1016/j.fuel.2021.120218>
- Panggabean, S., Andriani, M., Sigalingging, R., dan Raju. (2021). The study of temperature variation in catalytic biodiesel production process using static mixing reactor. *IOP Conference Series: Earth and Environmental Science*. 782(2): 1-6. <https://doi.org/10.1088/1755-1315/782/2/022065>
- Prihartantyo, A., Anwar, D., Yohanna Siburian, E., dan Ida Valencia, S. (2021). Pengaruh Penggunaan Katalis Heterogen Kalium Hidroksida dengan Pendukung Karbon Aktif dan Katalis Bentonit Aktif Asam Terhadap Produksi Biodiesel dari Minyak Biji Karet. In *Journal of Applied Technology and Informatics*. 1(2): 1-2. <http://journal-jati.del.ac.id/>
- Rezki, B., Essamlali, Y., Aadil, M., Semlalc, N., Zahouily, M. (2020). Biodiesel production from rapeseed oil and low free fatty acid waste cooking oil using a cesium modified natural phosphate catalyst. *RSC Adv*. 10: 41065–41077. <https://doi.org/10.1039/d0ra07711a>
- Rajak, A. K., Zeenath, S. F., Boddula, R., Singh, S., Varshney, D., Sharma, K., Sarangi, P. K., dan Karuna, M. S. L. (2025). Efficient application of rice husk ash-derived silica combined with calcined orange peel as catalysts for biodiesel production from *Nigella sativa* seed oil within a circular economy framework. *International Journal of Biological Macromolecules*. 315(144067): 1-20. <https://doi.org/10.1016/j.ijbiomac.2025.144067>
- Sa'adah, A. F., Fauzi, A., dan Juanda, B. (2017). Peramalan Penyediaan dan Konsumsi Bahan Bakar Minyak Indonesia dengan Model Sistem Dinamik. *Jurnal Ekonomi Dan Pembangunan Indonesia*. 17(2): 118–137.

<https://doi.org/10.21002/jepi.v17i2.02>

- Sanyang, M. L., S.M. Sapuan, M. Jawaid, M. R. Ishak dan J. Sahari. (2016). "Recent Developments in Sugar Palm (*Arenga pinnata*) Based Biocomposites and Their Potential Industrial Applications. *Renewable and Sustainable Energy Reviews*. 54: 533 – 549.
- Su G, Ong H.C, Mofijur M, Mahlin T.M. I, Ok Y.S. (2022). Pyrolysis of waste oils for the production of biofuels: A critical review. *Journal of Hazardous Materials*. 424 (127396): 1–2.
<https://doi.org/10.1016/j.jhazmat.2021.127396>.
- Sanusi, N. L., Ramadhani, M. F., Nurfadhlini, N., dan Aisyah, L. (2021). Penentuan Komposisi Bahan Bakar Nabati Dalam Bahan Bakar Minyak Campuran Menggunakan Metode Direct Counting C-14. *EKSPLORIUM*. 42(2): 149-157. <https://doi.org/10.17146/eksplorium.2021.42.2.6363>
- Sholikhah, H. I., Putri, H. R., Inayati. (2021). Pengaruh Konsentrasi Aktivator Asam Fosfat (H_3PO_4) pada Pembuatan Karbon Aktif dari Sabut Kelapa terhadap Adsorpsi Logam Kromium. *EQUILIBRIUM*. 5(1): 46 – 52.
- Sa'diyah, K., Suharti, P. H., Hendrawati, N., Pratamasari, F. A., & Rahayu, O. M. (2021). Pemanfaatan Serbuk Gergaji Kayu sebagai Karbon Aktif melalui Proses Pirolisis dan Aktivasi Kimia. *CHEESA: Chemical Engineering Research Articles*. 4(2): 91-99.
<https://doi.org/10.25273/cheesa.v4i2.8589.91-99>
- Saikia, K., Das, A., Sema, A. H., Basumatary, S., Shaemningwar Moyon, N., Mathimani, T., dan Rokhum, S. L. (2024). Response surface optimization, kinetics, thermodynamics, and life cycle cost analysis of biodiesel production from *Jatropha curcas* oil using biomass-based functional activated carbon catalyst. *Renewable Energy*. 229(120473): 1 – 18.
<https://doi.org/10.1016/j.renene.2024.120743>
- Senthur Prabu, S., Asokan, M. A., Roy, R., Francis, S., & Sreelekh, M. K. (2017). Performance, combustion and emission characteristics of diesel engine fuelled with waste cooking oil bio-diesel/diesel blends with additives. *Energy*. 122: 638 – 648. <https://doi.org/10.1016/j.energy.2017.01.119>
- Saidi, M., Safaripour, M., Ameri, F. A., Jomeh, M. E. (2023). Application of sulfonated biochar-based magnetic catalyst for biodiesel production: Sensitivity analysis and process optimization. *Chemical Engineering and Processing - Process Intensification*. 190(109419): 1-14.
<https://doi.org/10.1016/j.cep.2023.109419>
- Silvaraja, J., Yahya, N. Y., Zainol, M. M., Lee, Y. S. (2025). Preliminary investigations of sustainable magnetic catalyst-based biochar derived

- spent coffee ground for biodiesel production from waste cooking oil. *Cleaner Chemical Engineering*. 11(100148): 1 – 8.
<https://doi.org/10.1016/j.clce.2025.100148>
- Sulaiman, N. F., Ramly, N. I., Mubinc, H. M. A., Lee, S. L. (2021). Transition metal oxide (NiO, CuO, ZnO)-doped calcium oxide catalysts derived from eggshells for the transesterification of refined waste cooking oil. *RSC Adv.* 11: 21781–21795. <https://doi.org/10.1039/d1ra02076e>.
- Thangavelu, K., Sundararaju, P., Srinivasan, N., Uthandi, S. (2021). Bioconversion of sago processing wastewater into biodiesel: Optimization of lipid production by an oleaginous yeast, *Candida tropicalis* ASY2 and its transesterification process using response surface methodology. *Microb Cell Fact.* 20(167): 1-18.
<https://doi.org/10.1186/s12934-021-01655-7>
- Tani D., 2023. *Pembuatan dan Karakterisasi karbon Aktif*. Penerbit NEM: Jawa Tengah.
- Tarikuzzaman, M. (2023). A Review on Activated Carbon: Synthesis, Properties, and Applications. *European Journal of Advances in Engineering and Technology*. 10(1): 114-123.
- Vasu S, Manikandan A.V, Chalapandian K, Dhasarathan P. (2024). Production of biodiesel from *Phyllanthus emblica* seeds using activated charcoal as heterogenous catalyst. *Materials today: Proceedings*. 10: 271-277.
<https://doi.org/10.1016/j.matpr.2023.05.093>
- Velusamy K, Isabel J.B, Perisamy S, Thiruvankadam A, Ravikumar H, Gupta S.K, Maldando E.A. (2024). Role of biochar as a greener catalyst in biofuel production: Production, activation, and potential utilization – A review. *Journal of the Taiwan Institute of Chemical Engineers*. 177(105731): 1-18. <https://doi.org/10.1016/j.jtice.2024.105732>
- Wang, Y., Chen, R., Zhu, F., Wang, H., Qiu, Y., Xue, B., Zhao, B., dan Zhou, T. (2025). Optimization of transesterification of sewage sludge for biodiesel production using monosaccharide-, disaccharide-, and polysaccharide-based sulfonic acid solid catalysts. *Journal of Environmental Chemical Engineering*. 13(3): 1 – 12. <https://doi.org/10.1016/j.jece.2025.116826>
- Wei, G., Wang, Y., Chong, L., Long, R., Lan, W., dan Zhang, L. (2024). Effective hydrolysis of castor oil under mild conditions catalyzed by new low-cost carbon-based solid acid: Process and mechanism, and environmental assessment. *Process Safety and Environmental Protection*. 194: 1144 – 1158. <https://doi.org/10.1016/j.psep.2024.12.077>

- Wang, J. (2024). Biodiesel production from spent coffee grounds utilizing pomegranate/orange peel biochar as a green and renewable nanocatalyst: Compression ignition engine performance and emission. *Industrial Crops and Products*. 218(118890): 1–19.
<https://doi.org/10.1016/j.indcrop.2024.118890>
- Widayat, Satriadi H., Setyojati P., Shihab D., Buchori L., Hadiyanto H., Nurushofa F. (2024). Preparation CaO/MgO/Fe₃O₄ magnetite catalyst and catalytic test for biodiesel production. *Result in engineering*. 22(102202): 1–7. <https://doi.org/10.1016/j.rineng.2024.102202>
- Wirawan, S. S., Solikhah, M. D., Setiaprja, H., & Sugiyono, A. (2024). Biodiesel implementation in Indonesia: Experiences and future perspectives. In *Renewable and Sustainable Energy Reviews*. 189(113911): 1–17.
<https://doi.org/10.1016/j.rser.2023.113911>
- Withaningsih, S., Parikesit, Iskandar, J., dan Putri, R. (2019). Socio-ecological perspective of local bio-resources based production system of palm sugar and palm flour from aren (*Arenga pinnata*): Case study of Sukaresmi Village, West Bandung, Indonesia. *Biodiversitas*. 20(7): 1990–1997. <https://doi.org/10.13057/biodiv/d200727>
- Xia, S., Tao, J., Zhao, Y., Men, Y., Chen, C., Hu, Y., Zhu, G., Chu, Y., Yan, B., dan Chen, G. (2024). Application of waste derived magnetic acid-base bifunctional CoFe/biochar/CaO as an efficient catalyst for biodiesel production from waste cooking oil. *Chemosphere*. 350(409): 1 – 10.
<https://doi.org/10.1016/j.chemosphere.2023.141104>
- Xiao, X., Chen, B., Chen, Z., Zhu, L., dan Schnoor, J. L. (2018). Insight into Multiple and Multilevel Structures of Biochars and Their Potential Environmental Applications: A Critical Review. *Environ Sci Technol*. 52(9): 5027-5047. <http://doi: 10.1021/acs.est.7b06487>.
- Xie, Y., Wang, D., Almojil, S. F., Almohana, A. I., Alali, A. F., Zhou, Y., dan Raise, A. (2023). CaO-MgFe₂O₄@K₂CO₃ as a novel and retrievable nanocatalyst for two-step transesterification of used frying oils to biodiesel. *Process Safety and Environmental Protection*. 172: 195–210.
<https://doi.org/10.1016/j.psep.2023.02.005>
- Xiong, Y., Miao, W., Wang, N., Chen, H., Wang, X., Wang, J., Tan, Q., Chen, S. (2019). Solid alcohol based on waste cooking oil: Synthesis, properties, micromorphology and simultaneous synthesis of biodiesel. *Waste Management*. 85: 295–303.
<https://doi.org/10.1016/j.wasman.2018.12.036>

- Yogin Soodesh, C., Seriyala, A. K., Navjot, Chattopadhyay, P., Rozhkova, N., Michalkiewicz, B., Chatterjee, S., dan Roy, B. (2024). Carbonaceous catalysts (biochar and activated carbon) from agricultural residues and their application in production of biodiesel: A review. *Chemical Engineering Research and Design*. 203: 759–788. <https://doi.org/10.1016/j.cherd.2024.02.002>
- Yadav, G., Yadav, N., & Ahmaruzzaman, Md. (2022). Microwave-assisted synthesis of biodiesel by a green carbon-based heterogeneous catalyst derived from areca nut husk by one-pot hydrothermal carbonization. *Scientific Reports*. 12(1): 1-14. <https://doi.org/10.1038/s41598-022-25877-w>
- Yadav, G., Yadav, N., & Ahmaruzzaman, Md. (2023). Advances in biomass derived low-cost carbon catalyst for biodiesel production: preparation methods, reaction conditions, and mechanisms. *RSC Advances*. 13(33): 1-14. <https://doi.org/10.1039/d3ra03561a>
- Yadav, G., Yadav, N., dan Ahmaruzzaman, M. (2025). Biodiesel production using a functionalized hybrid biochar catalyst: RSM-based optimization and comprehensive evaluation. *Renewable Energy*. 252(123486): 1-16. <https://doi.org/10.1016/j.renene.2025.123486>
- Yue, M., Rokhum, S. L., Ma, X., Wang, T., Li, H., Zhao, Z., Wang, Y., dan Li, H. (2024). Recent advances of biodiesel production enhanced by external field via heterogeneous catalytic transesterification system. *Chemical Engineering and Processing - Process Intensification*. 205(109997): 1 – 10. <https://doi.org/10.1016/j.cep.2024.109997>
- Zailan, Z., Tahir, M., Jusoh, M., dan Zakaria, Z. Y. (2021). A review of sulfonic group bearing porous carbon catalyst for biodiesel production. *Renewable Energy*. 175: 430–452. <https://doi.org/10.1016/j.renene.2021.05.030>
- Zhou, Y., Cao, S., Xi, C., Li, X., Zhang, L., Wang, G., dan Chen, Z. (2020). A three dimension magnetic bio-char composite-based quick, easy, cheap, effective, rugged and safe method for multi-pesticides analysis of vegetables. *Journal of Chromatography A*. 1615(460770): 1-9. <https://doi.org/10.1016/j.chroma.2019.460770>
- Zhang, S., Tao, L., Zhang, Y., Wang, Z., Gou, G., Jiang, M., Huang, C., & Zhou, Z. (2016). The role and mechanism of K₂CO₃ and Fe₃O₄ in the preparation of magnetic peanut shell based activated carbon. *Powder Technology*. 295: 152–160. <https://doi.org/10.1016/j.powtec.2016.03.034>
- 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. *Journal of Water Supply*. 63(7): 553–559. <https://doi.org/10.2166/aqua.2014.120>

Zhao, C., Lv, P., Yang, L., Xing, S., Luo, W., dan Wang, Z. (2018). Biodiesel synthesis over biochar-based catalyst from biomass waste pomelo peel. *Energy Conversion and Management*. 160: 477-485. <https://doi.org/10.1016/j.enconman.2018.01.059>