

DAFTAR PUSTAKA

- Ahmad, N., Dayana, S. A. S., Abnisa, F., and Mohd, W. A., 2018, Natural rubber, a potential alternative source for the synthesis of renewable fuels via Hydrous Pyrolysis, *Materials Science and Engineering.*, 334, 012004.
- Akbas, A., and Yuhana, N. Y., 2021, Recycling of rubber wastes as fuel and its additives, *Recycling.*, 6, 78.
- Alam, S. S., and Khan, A. H., 2024, Microwave-assisted pyrolysis for waste plastic recycling: a review on critical parameters, benefits, challenges, and scalability perspectives, *International Journal of Environmental Science and Technology.*, 21, 5311-5330.
- Alisha, G. D., Trisunaryanti, W., Syoufian, A., and Larasati, S., 2023, Synthesis of high stability Mo/SiO₂ catalyst utilizing Parangtritis beach sand for hydrocracking waste palm oil into biofuel, *Biomass Conversion and Biorefinery.*, 13, 11041-11055.
- Amin, A. K., Wijaya, K., and Trisunaryanti, W., 2020. Physico-chemical properties of nickel promoted sulfated zirconia powder prepared using different procedures, *Asian J. Chem.*, 32, 555-560.
- Anekwe, I. M. S., Chetty, M., Khotseng, L., Kiambi, S. L., Maharaj, L., Oboirien, B., & Isa, Y. M., 2024, Stability, deactivation and regeneration study of a newly developed HZSM-5 and Ni-doped HZSM-5 zeolite catalysts for ethanol-to-hydrocarbon conversion, *Catalysis Communications.*, 186, 106802.
- Athala, AP., Fitri, Y., Meka, W., Ridwan, A., Mahendra, RA., Rezeki, TN., Widara, LS., Hamzah, M., 2022, Analisa eksperimental terhadap distribusi produk co-pyrolysis limbah sarung tangan medis dan limbah biomassa, *J Tek Kim.*, 28, 116–125.
- Bangjang, T., Kaewchada, A., and Jaree, A., 2021, Hydroprocessing of palm oil using Rh/HZSM-5 for the production of biojet fuel in a fixed bed reactor, *Can. J. Chem. Eng.*, 99, 435–446.
- Chandrasekaran, A., Ramachandran, S., and Subbiah, S., 2017, Determination of kinetic parameters in the pyrolysis operation and thermal behavior of *Prosopis juliflora* using thermogravimetric analysis, *Bioresource technology.*, 233, 413-422.
- Chen, L., Janssens, T. V., Skoglundh, M., and Grönbeck, H., 2019, Interpretation of NH₃-TPD profiles from Cu-CHA using first-principles calculations, *Topics in Catalysis.*, 62, 93-99.
- Chintakanan, P., Vitidsant, T., Reubroycharoen, P., Kuchonthara, P., Kida, T., and Hinchiranan, N., 2021, Bio-jet fuel range in biofuels derived from hydroconversion of palm olein over Ni/zeolite catalysts and freezing point of biofuels/Jet A-1 blends, *Fuel.*, 293, 120472.

- Chittella, H., Yoon, L. W., Ramarad, S., and Lai, Z. W., 2021, Rubber waste management: A review on methods, mechanism, and prospects, *Polymer Degradation and Stability.*, 194, 109761.
- Corma, A., González-Alfaro, V., & Orchilles, A. V., 1995, Catalytic cracking of alkanes on MCM-22 zeolite. Comparison with ZSM-5 and beta zeolite and its possibility as an FCC cracking additive, *Applied Catalysis A: General.*, 129, 203-215.
- Cui, Y., Chen, B., Xu, L., Chen, M., Wu, C. E., Qiu, J., and Hu, X., 2023, CO₂ methanation over the Ni-based catalysts supported on the hollow ZSM-5 zeolites: Effects of the hollow structure and alkaline treatment, *Fuel.*, 334, 126783.
- Cui, Y., Zhang, Y., Cui, L., Liu, Y., Li, B., and Liu, W., 2023, Assisted pyrolysis of polypropylene plastic for liquid oil production, *Journal of Cleaner Production.*, 411, 137303.
- Dagle, R. A., Lizarazo-Adarme, J. A., Dagle, V. L., Gray, M. J., White, J. F., King, D. L., and Palo, D. R., 2014, Syngas conversion to gasoline-range hydrocarbons over Pd/ZnO/Al₂O₃ and ZSM-5 composite catalyst system, *Fuel processing technology.*, 123, 65-74.
- Dai, Y., Lu, P., Cao, Z., Campbell, C.T., and Xia, Y., 2018, The physical chemistry and materials science behind sinter-resistant catalysts, *Chem. Soc. Rev.*, 47, 4314–4331.
- Damjanović, L., and Auroux, A., 2009, Determination of acid/base properties by temperature programmed desorption (TPD) and adsorption calorimetry, In A. W. Chester & E. G. Derouane (Eds.), *Zeolite characterization and catalysis: A tutorial*, Springer Netherlands., 07–167.
- Danon, B., Van Der Gryp, P., Schwarz, C. E., and Görgens, J. F., 2015, A review of dipentene (D-limonene) production from waste tire pyrolysis, *Journal of Analytical and Applied Pyrolysis.*, 112, 1-13.
- Darwanta, D., Trisunaryanti, W., Wijaya, K., and Purwono, S., 2023, Synthesis and Catalytic Performance of Ni/Silica Pillared Clay on HDPE Plastic Hydrocracking to Produce Liquid Hydrocarbons as Fuel, *Iran. J. Catal.*, 13, 135–155.
- De Sousa, F. P., Cardoso, C. C., and Pasa, V. M., 2016, Producing hydrocarbons for green diesel and jet fuel formulation from palm kernel fat over Pd/C, *Fuel processing technology.*, 143, 35-42.
- De, S., Zhang, J., Luque, R., and Yan, N., 2016, Ni-based bimetallic heterogeneous catalysts for energy and environmental applications, *Energy Environ. Sci.*, 9, 3314–3347.
- Du, Z., Li, Y., Wang, X., Wan, Y., Chen, Q., Wang, C., and Ruan, R., 2011, Microwave-assisted pyrolysis of microalgae for biofuel production,

Bioresource technology., 102, 4890-4896.

- El-Kemary, M., Nagy, N., and El-Mehasseb, I., 2013, Nickel oxide nanoparticles: Synthesis and spectral studies of interactions with glucose, *Materials Science in Semiconductor Processing*, 16, 1747-1752.
- Felix, M.D.S., Hagare, D., Tahmasebi, A., Sathasivan, A., Arora, M., 2024, Microwave pyrolysis of polypropylene, and high-density polyethylene, and catalytic gasification of waste coffee pods to hydrogen-rich gas, *Waste Management.*, 187, 306–316.
- Figueiredo, A. L., Araujo, A. S., Linares, M., Peral, Á., García, R. A., Serrano, D. P., and Fernandes Jr, V. J., 2016, Catalytic cracking of LDPE over nanocrystalline HZSM-5 zeolite prepared by seed-assisted synthesis from an organic-template-free system, *Journal of analytical and applied pyrolysis.*, 117, 132-140.
- Fitria, R. A., Prasetyo, N., Saviola, A. J., Trisunaryanti, W., Syoufian, A., Amin, A. K., and Wijaya, K., 2025, Synthesis of cobalt-dispersed sulfated zirconia nanocatalyst for the hydroconversion of used palm cooking oil into bio-jet fuel, *Case Studies in Chemical and Environmental Engineering.*, 11, 101052.
- Ghanbari, B., Kazemi Zangeneh, F., Taheri Rizi, Z., and Aghaei, E., 2020, High-impact promotional effect of Mo impregnation on aluminum-rich and alkali-treated hierarchical zeolite catalysts on methanol aromatization, *ACS omega.*, 5, 11971-11986.
- Grzybek, G., Góra-Marek, K., Tarach, K., Pyra, K., Patulski, P., Greluk, M., and Kotarba, A., 2022, Tuning the properties of the cobalt-zeolite nanocomposite catalyst by potassium: Switching between dehydration and dehydrogenation of ethanol, *Journal of Catalysis.*, 407, 364-380.
- Guzman-Bucio, D. M., Gomez-Sosa, G., Cabrera-German, D., Torres-Ochoa, J. A., Bravo-Sanchez, M., Cortazar-Martinez, O., Carmona-Carmona, A. J., and Herrera-Gomez, A., 2023, Detailed peak fitting analysis of the Ni 2p photoemission spectrum for metallic nickel and initial oxidation, *Journal of Electron Spectroscopy and Related Phenomena*, 262, 147284.
- Hachemi, I., Kumar, N., Mäki-Arvela, P., Roine, J., Peurla, M., Hemming, J., Salonen, J., and Murzin, D.Y., 2017, Sulfur-free Ni catalyst for production of green diesel by hydrodeoxygenation, *J. Catal.*, 347, 205–221.
- Hall, W. J., Zakaria, N., and Williams, P. T., 2009, Pyrolysis of latex gloves in the presence of Y-zeolite, *Waste Management.*, 29, 797-803.
- Hamidzadeh, M., Ghassemzadeh, M., Tarlani, A., and Sahebdehfar, S., 2018, The effect of hydrothermal impregnation of Ni, Co, and Cu on HZSM-5 in the nitrogen oxide removal, *International Journal of Environmental Science and Technology.*, 15, 93-104.
- Hassan, SN., Sani, YM., Abdul, Aziz AR., Sulaiman, NMN., Daud WMAW., 2015,

Biogasoline: an out-of-the-box solution to the food-for-fuel and land-use competitions., *Energy Convers Manag.*, 89,349–367.

Hayashi, H., Ueda, A., Suino, A., Hiro, K., and Hakuta, Y., 2009, Hydrothermal synthesis of yttria stabilized ZrO₂ nanoparticles in subcritical and supercritical water using a flow reaction system, *Journal of Solid State Chemistry.*, 182, 2985-2990.

Hoang, A. T., Nižetić, S., Ong, H. C., Mofijur, M., Ahmed, S. F., Ashok, B., and Chau, M. Q., 2021, Insight into the recent advances of microwave pretreatment technologies for the conversion of lignocellulosic biomass into sustainable biofuel, *Chemosphere.*, 281, 130878.

Hongloi, N., Prapainainar, P., Seubsai, A., Sudsakorn, K., and Prapainainar, C., 2019, Nickel catalyst with different supports for green diesel production, *Energy.*, 182, 306–320.

Hsu, P.J., Jiang, J.W., and Lin, Y.C., 2018, Does a Strong Oxophilic Promoter Enhance Direct Deoxygenation? A Study of NiFe, NiMo, and NiW Catalysts in p-Cresol Conversion, *ACS Sustain. Chem. Eng.*, 6, 660–667.

Hunsiri, W., Chaihad, N., Ngamcharussrivichai, C., Tungasmita, D.N., Reubroycharoen, P., and Hinchiranan, N., 2023, Branched-chain biofuels derived from hydroisomerization of palm olein using Ni/modified beta zeolite catalysts for biojet fuel production, *Fuel Process. Technol.*, 248, 107825.

Hu, X., Ma, D., Zhang, G., Ling, M., Hu, Q., Liang, K., and Zheng, Y., 2023, Microwave-assisted pyrolysis of waste plastics for their resource reuse: A technical review, *Carbon Resources Conversion.*, 6, 215-228.

Hu, Z., Ma, X., and Chen C., 2012, A study on experimental characteristic of microwave assisted pyrolysis of microalgae, *Bioresource Technology.*, 107:487–93.

Ibrahim, M. S., Trisunaryanti, W., and Triyono, T., 2022, Nickel supported parangtritis beach sand (PP) catalyst for hydrocracking of palm and Malapari oil into biofuel., *Bulletin of Chemical Reaction Engineering and Catalysis*, 17, 638-649.

Iliopoulou, E. F., Stefanidis, S. D., Kalogiannis, K. G., Delimitis, A., Lappas, A. A., and Triantafyllidis, K. S., 2012, Catalytic upgrading of biomass pyrolysis vapors using transition metal-modified ZSM-5 zeolite, *Applied Catalysis B: Environmental.*, 127, 281-290.

Islam, K. O., Ahmad, N., Ummer, A. C., Ahmed, U., Siddiqui, M. N., Millan, M., and Jameel, A. G. A., 2025, Microwave-Assisted Pyrolysis of Waste Plastics: A Comprehensive Review on Process Parameters, *Catalysts, and Future Prospects.*, Results in Engineering, 105571.

Januszewicz, K., Kazimierski, P., Kosakowski, W., and Lewandowski, W. M., 2020, Waste tyres pyrolysis for obtaining limonene, *Materials.*, 13, 1359.

- Jeništová, K., Hachemi, I., Mäki-Arvela, P., Kumar, N., Peurla, M., Čapek, L., Wärnå, J., and Murzin, D.Y., 2017, Hydrodeoxygenation of stearic acid and tall oil fatty acids over Ni-alumina catalysts: Influence of reaction parameters and kinetic modelling, *Chem. Eng. J.*, 316, 401–409.
- Kamaluddin, H. S., Gong, X., Ma, P., Narasimharao, K., Chowdhury, A. D., and Mokhtar, M., 2022, Influence of zeolite ZSM-5 synthesis protocols and physicochemical properties in the methanol-to-olefin process, *Materials Today Chemistry.*, 26, 101061.
- Kostyniuk, A., Bajec, D., Djinović, P., and Likozar, B., 2020, Allyl alcohol production by gas phase conversion reactions of glycerol over bifunctional hierarchical zeolite-supported bi-and tri-metallic catalysts, *Chemical Engineering Journal.*, 397, 125430.
- Kumaran, G. M., Garg, S., Soni, K., Prasad, V. V. D. N., Sharma, L. D., and Dhar, G. M., 2006, Catalytic functionalities of H-β-zeolite-supported molybdenum hydrotreating catalysts, *Energy & fuels.*, 20, 1784-1790.
- Kumari, J., Rahul, and Agarwal, P., 2025, Impact of heat treatment on properties of molybdenum oxide thin films and performance of MoO_{3-x}-based c-Si solar cells, *Materials Today Communications*, 43, 111603.
- Lahijani, P., Mohammadi, M., Mohamed, A.R., Ismail, F., Lee, K.T., and Amini, G., 2022, Upgrading biomass-derived pyrolysis bio-oil to bio-jet fuel through catalytic cracking and hydrodeoxygenation: A review of recent progress, *Energy Convers. Manag.*, 268, 115956.
- Laghezza, M., Fiore, S., and Berruti, F., 2024., A review on the pyrolytic conversion of plastic waste into fuels and chemicals, *Journal of Analytical and Applied Pyrolysis.*, 179, 106479.
- Lee, C.W., Lin, P.Y., Chen, B.H., Kukushkin, R.G., and Yakovlev, V.A., 2021, Hydrodeoxygenation of palmitic acid over zeolite-supported nickel catalysts, *Catal. Today.*, 379, 124–131.
- Lei, H., Ren, S., Julson, J., 2009, The effects of reaction temperature and time and particle size of corn stover on microwave pyrolysis, *Energy Fuels.*, 23, 3254–3261.
- Liao, J., Liu, Z., Ling, Y., Zhang, Q., Qiu, S., Gu, J., Li, J., Dong, H., Song, J., and Wang, T., 2023, Electronic and surface engineering of Mo doped Ni@C nanocomposite boosting catalytic upgrading of aqueous bio-ethanol to bio-jet fuel precursors, *Chem. Eng. J.*, 461, 141888.
- Li, J., Lin, L., Ju, T., Meng, F., Han, S., Chen, K., and Jiang, J., 2024, Microwave-assisted pyrolysis of solid waste for production of high-value liquid oil, syngas, and carbon solids: A review, *Renewable and Sustainable Energy Reviews.*, 189, 113979.
- Liu, S., Zhu, Q., Guan, Q., He, L., and Li, W., 2015, Bio-aviation fuel production

from hydroprocessing castor oil promoted by the nickel-based bifunctional catalysts, *Bioresource technology.*, 183, 93-100.

Lopez, G., Artetxe, M., Amutio, M., Bilbao, J., Olazar, M., 2017, Thermochemical routes for the valorization of waste polyolefinic plastics to produce fuels and chemicals, A review, *Renew Sustain. Energy Rev.*, 73, 346–368.

Luo, T., Zhou, W., Wang, Y., Jiang, H., Wu, J., Hu, J., Wang, M., Wang, W., Wang, Q., Hu, Y., and Fan, L., 2024, Integrating microwave pyrolysis and hydrotreating for converting low-density polyethylene into jet fuel, *Renew. Energy.*, 236, 121432.

Maluf, S.S., and Assaf, E.M., 2009, Ni catalysts with Mo promoter for methane steam reforming, *Fuel.*, 88, 1547–1553.

Ma, Z., Meng, X., Liu, N., and Shi, L., 2018, Pd-Ni doped sulfated zirconia: study of hydrogen spillover and isomerization of N-hexane, *Molecular Catalysis.*, 449, 114-121.

Meng, B., Ren, S., Zhang, X., Chen, K., Wei, W., Guo, Q., and Shen, B., 2022, Enhancement of the strong Brønsted acidity and mesoporosity: Zr⁴⁺ promoted framework modification of Zeolite Y, *Microporous and Mesoporous Materials.*, 335, 111849.

Miandad, R., Barakat, M. A., Aburiazaiza, A. S., Rehan, M., and Nizami, A. S., 2016, Catalytic pyrolysis of plastic waste: A review, *Process Safety and Environmental Protection.*, 102, 822-838.

Mishra, R. K., Iyer, J. S., and Mohanty, K. (2019). Conversion of waste biomass and waste nitrile gloves into renewable fuel, *Waste Management*, 89, 397-407.

Mishra, R. K., and Mohanty, K., 2020, Co-pyrolysis of waste biomass and waste plastics (polystyrene and waste nitrile gloves) into renewable fuel and value-added chemicals, *Carbon Resources Conversion.*, 3, 145-155.

Mohan, D., Pittman Jr, C. U., and Steele, P. H., 2006, Pyrolysis of wood/biomass for bio-oil: a critical review, *Energy and fuels.*, 20, 848-889.

Moonsrikaew, W., Akkarawatkhoosith, N., Tongtummachat, T., Kaewchada, A., Lin, K.Y.A., Evgeny, R., and Jaree, A., 2023, Bio-jet fuel production from crude palm kernel oil under hydrogen-nitrogen atmosphere in a fixed-bed reactor by using Pt/C as catalyst, *Energy Convers. Manag. X.*, 20, 100471.

Motasemi, F. and Afzal, M.T., 2013, A review on the microwave-assisted pyrolysis technique, *Renew. Sustain. Energy Rev.*, 28, 317–330.

Munawar, S., Khalid, M. H., Anwar, H., and Jamil, Y., 2025, Absorption and fluorescence properties of transition metal compounds. In *Modern Luminescence from Fundamental Concepts to Materials and Applications*, Woodhead Publishing., 3-29.

Nishihara, H., Ohtake, F., Castro-Muñiz, A., Itoi, H., Ito, M., Hayasaka, Y., and

- Kyotani, T., 2018, Enhanced hydrogen chemisorption and spillover on non-metallic nickel subnanoclusters, *Journal of Materials Chemistry A.*, 6, 12523-12531.
- Nishiyama, Y., Kumagai, S., Motokucho, S., Kameda, T., Saito, Y., Watanabe, A., Nakatani, H., Yoshioka, T., 2020, Temperature-dependent pyrolysis behavior of polyurethane elastomers with different hard- and soft-segment compositions, *Journal of Analytical and Applied Pyrolysis.*, 145, 104754.
- Ochoa, A., Bilbao, J., Gayubo, A. G., and Castaño, P., 2020, Coke formation and deactivation during catalytic reforming of biomass and waste pyrolysis products: A review, *Renewable and Sustainable Energy Reviews.*, 119, 109600.
- Park, J., Choi, I., Lee, M. J., Kim, M. H., Lim, T., Park, K. H., and Kim, J. J., 2014, Effect of fluoroethylene carbonate on electrochemical battery performance and the surface chemistry of amorphous MoO₂ lithium-ion secondary battery negative electrodes, *Electrochimica Acta.*, 132, 338-346.
- Patrawoot, S., Tran, T., Arunchaiya, M., Somsongkul, V., Chisti, Y., and Hansupalak, N., 2021, Environmental impacts of examination gloves made of natural rubber and nitrile rubber, identified by life-cycle assessment, *SPE polymers.*, 2, 179-190.
- Pinto-Salamanca, C. E., Rigail-Cedeño, A. F., and Oliveros, M. E. M., 2020, Synthesis and characterization of natural rubber/clay nanocomposite to develop electrical safety gloves, *Materials Today: Proceedings.*, 33, 1949-1953.
- Qi, L., Tang, X., Wang, Z., & Peng, X., 2017, Pore characterization of different types of coal from coal and gas outburst disaster sites using low temperature nitrogen adsorption approach, *International Journal of Mining Science and Technology.*, 27, 371-377.
- Qu, W., Zhou, Q.A., Wang, Y.Z., Zhang, J., Lan, W.W., Wu, Y.H., Yang, J.W., Wang, D.Z., 2006. Pyrolysis of waste tire on ZSM-5 zeolite with enhanced catalytic activities, *Polymer Degradation and Stability.*, 91, 2389–2395.
- Qu, X., Li, Y., Zhang, X., and Li, R., 2024, Comprehensive analysis of pyrolysis in medical rubber gloves: pyrolysis characteristics, kinetics, thermodynamics, volatile products, and pathways, *Waste Disposal and Sustainable Energy.*, 6, 297-308.
- Ramadhani, A. N., Abdullah, I., and Krisnandi, Y. K., 2022, Effect of Physicochemical Properties of Co and Mo Modified Natural Sourced Hierarchical ZSM-5 Zeolite Catalysts on Vanillin and Phenol Production from Diphenyl Ether, *Bulletin of Chemical Reaction Engineering and Catalysis.*, 17, 225-239.
- Ramírez, S., Martínez, J., and Ancheyta, J., 2013, Kinetics of thermal

hydrocracking of heavy oils under moderate hydroprocessing reaction conditions, *Fuel.*, 110, 83-88.

Restelatto, D., Bortoluz, J., Sartori, P., Guerra, N. B., Cid, C. C., Cruz, R. C., and Crespo, J. S., 2024, Cosmetic gloves from natural rubber latex for upper limb prostheses: preparation and physicochemical, mechanical and biological characterization, *Biomedical Engineering Advances.*, 7, 100126.

Ruslan, R., Sardi, B., Khairuddin, K., Sumarni, N.K., Tiro, W., Magfira, Z.P., Ainun, N., and Mahfud, M., 2025, Microwave pyrolysis of low-rank coal: Enhancing liquid fuel yield and quality using Fe-TiO₂ and Fe-HZSM-5 catalysts, *J. Energy Inst.*, 119, 101942.

Sana, S., Reddy, K.R., Rajanna, K.C., Venkateswarlu, M., and Ali, M.M., 2012, Mortar-Pestle and Microwave Assisted Regioselective Nitration of Aromatic Compounds in Presence of Certain Group V and VI Metal Salts under Solvent Free Conditions, *Int. J. Org. Chem.*, 02, 233-247.

Sarker, A., Rabbi, A. S., Nadi, N. A., Rahman, A. L., Momin, A. A., Ahmed, K. S., & Simol, H. A., 2024, Structural and transport properties of newly synthesized ZSM-5 sourcing silica from coconut shell ash, *Results in Chemistry.*, 11, 101810.

Schroeder, C., and Sanchez-Sanchez, M., 2024, Unlocking the potential for pseudo-molecular catalysts via understanding the activity of transition metal ionic species in zeolites, *Chem Catalysis.*, 4.

Shi, J., Sun, L., Yan, H., and Wang, J., 2021, Catalytic hydrotreatment of pine sawdust hydrolysis vapor over Ni, Mo-impregnated HZSM-5 for optimal production of gasoline components, *Energy and Fuels.*, 36, 932-944.

Sie, S.T., 1992, Acid-Catalyzed Cracking of Paraffinic Hydrocarbons. 1. Discussion of Existing Mechanisms and Proposal of a New Mechanism, *Ind. Eng. Chem. Res.*, 31, 1881-1889.

Soroush, S., Ronsse, F., Park, J., Ghysels, S., Wu, D., Kim, K.W., and Heynderickx, P.M., 2023, Microwave assisted and conventional hydrothermal treatment of waste seaweed: Comparison of hydrochar properties and energy efficiency, *Sci. Total Environ.*, 878, 163193.

Speight, J. G., 2006, The chemistry and technology of petroleum, *CRC press*.

Speight, J. G., 2014, Handbook of offshore oil and gas operations, *Elsevier*.

Suriapparao, D. V., and Vinu, R., 2015, Resource recovery from synthetic polymers via microwave pyrolysis using different susceptors, *Journal of analytical and applied pyrolysis.*, 113, 701-712.

Tarachiwin, L., Sakdapipanich, J., Ute, K., Kitayama, T., and Tanaka, Y., 2005, Structural characterization of α -terminal group of natural rubber. 2. Decomposition of branch-points by phospholipase and chemical treatments,

Biomacromolecules., 6, 1858-1863.

- Thommes, M., Kaneko, K., Neimark, A. V., Olivier, J. P., Rodriguez-Reinoso, F., Rouquerol, J., and Sing, K. S., 2015, Physisorption of gases, with special reference to the evaluation of surface area and pore size distribution (IUPAC Technical Report), *Pure and applied chemistry.*, 87, 1051-1069.
- Tian, Y., Zuo, W., Ren, Z., and Chen, D., 2011, Estimation of a novel method to produce bio-oil from sewage sludge by microwave pyrolysis with the consideration of efficiency and safety, *Bioresource Technology.* 102, 2053-2061.
- Tomishige, K., Nakagawa, Y., and Tamura, M., 2020, Design of supported metal catalysts modified with metal oxides for hydrodeoxygenation of biomass-related molecules, *Current Opinion in Green Sustain. Chem.*, 22, 13–21.
- Trisunaryanti, W., Triyono, T., Ghoni, M. A., Fatmawati, D. A., Mahayuwati, P. N., & Suarsih, E., 2020, Hydrocracking of calophyllum inophyllum oil employing Co and/or Mo supported on γ -Al₂O₃ for biofuel production, *Bulletin of Chemical Reaction Engineering and Catalysis.*, 15, 743-751.
- Trisunaryanti, W., Wijaya, K., Kartini, I., Purwono, S., Rodian sono., Mara, A., Rahma, A.S., 2024, Hydrodeoxygenation of refined palm kernel oil (RPKO) into bio-jet fuel using Mo/H-ZSM-5 catalysts, *React. Kinet. Mech. Catal.*, 137, 843–878.
- Trisunaryanti, W., Wijaya, K., Triyono, T., Adriani, A.R., and Larasati, S., 2021, Green synthesis of hierarchical porous carbon prepared from coconut lumber sawdust as Ni-based catalyst support for hydrotreating Callophyllum inophyllum oil, *Results Eng.*, 11, 1–12.
- Upare, D.P., Park, S., Kim, M.S., Kim, J., Lee, D., Lee, J., Chang, H., Choi, W., Choi, S., Jeon, Y.P., Park, Y.K., and Lee, C.W., 2016, Cobalt promoted Mo/beta zeolite for selective hydrocracking of tetralin and pyrolysis fuel oil into monocyclic aromatic hydrocarbons, *J. Ind. Eng. Chem.*, 35, 99–107.
- Utami, M., Trisunaryanti, W., Shida, K., Tsushida, M., Kawakita, H., Ohto, K., and Tominaga, M., 2019, Hydrothermal preparation of a platinum-loaded sulphated nanozirconia catalyst for the effective conversion of waste low density polyethylene into gasoline-range hydrocarbons, *RSC advances.*, 9, 41392-41401.
- Viswanadham, N., Saxena, S. K., and Kumar, M., 2011, The transformation of light paraffins to LPG and aromatics over a Ni/ZSM-5 catalyst, *Petroleum Science and Technology.*, 29, 393-400.
- Vogt, E. T., and Weckhuysen, B. M., 2015, Fluid catalytic cracking: recent developments on the grand old lady of zeolite catalysis, *Chemical Society Reviews.*, 44, 7342-7370.

- Wang, F., Wei, Q., Li, K., Biney, B. W., Liu, H., Chen, K., and Guo, A., 2023, Coke formation of heavy oil during thermal cracking: New insights into the effect of olefinic-bond-containing aromatics, *Fuel.*, 336, 127138.
- Wang, Q., Li, X., Duan, J., Chen, J., Ye, Y., Wang, D., Li, S., and Zheng, Z., 2022, Rationally control the path of hydrodeoxygenation of palmitic acid over Ni/red-mud catalysts by surface decoration of oxophilic MoOx species, *Fuel.*, 329, 1–11.
- Wangsa, W., Saviola, A. J., Wijaya, K., Bhagaskara, A., Hauli, L., and Saputra, D. A., 2024, Utilization of laboratory glove waste for fuel production through pyrolysis-hydrocracking consecutive process catalyzed by sulfated Indonesian natural zeolite, *Reaction Kinetics, Mechanisms and Catalysis.*, 137, 1495-1514.
- Why, E.S.K., Ong, H.C., Lee, H.V., Gan, Y.Y., Chen, W.H., and Chong, C.T., 2019, Renewable aviation fuel by advanced hydroprocessing of biomass: Challenges and perspective, *Energy Convers. Manag.*, 199, 112015.
- Widayat, W., and Annisa, A. N., 2017, Synthesis and characterization of ZSM-5 catalyst at different temperatures, *In IOP Conference Series: Materials Science and Engineering.*, 214, 012032.
- Wijaya, K., Saviola, A. J., Amin, A. K., Vebryana, M. F., Bhagaskara, A., Ekawati, H. A., ... & Agustanhakri, A., 2024, Performance of hydrothermally prepared NiMo dispersed on sulfated zirconia nano-catalyst in the conversion of used palm cooking oil into jet fuel range bio-hydrocarbons, *Bulletin of Chemical Reaction Engineering & Catalysis.*, 19, 361-371.
- Wu, C., Budarin, V.L., Gronnow, M.J., De Bruyn, M., Onwudili, J.A., Clark, J.H., and Williams, P.T., 2014, Conventional and microwave-assisted pyrolysis of biomass under different heating rates, *J. Anal. Appl. Pyrolysis.*, 107, 276–283.
- Xu, L., Zhang, J., Ding, J., Liu, T., Shi, G., Li, X., Dang, W., Cheng, Y., and Guo, R., 2020, Pore structure and fractal characteristics of different shale lithofacies in the dalong formation in the western area of the lower yangtze platform, *Minerals.*, 10.
- Xu, W., Liu, J., Ding, Z., Fu, J., Evrendilek, F., Xie, W., and He, Y., 2022, Dynamic pyrolytic reaction mechanisms, pathways, and products of medical masks and infusion tubes, *Science of the Total Environment.*, 842, 156710.
- Yang, C., Wang, W., Wang, D., Gong, M., Xin, Y., Xiao, L., Kikhtyanin, O. V., Kubicka, D., and Wu, W., 2022, The promotion effects of MoOx species in the highly effective NiMo/MgAl₂O₄ catalysts for the hydrodeoxygenation of methyl palmitate, *J. Environ. Chem. Eng.*, 10, 107761.
- Yu, H., Li, F., He, W., Song, C., Zhang, Y., Li, Z., and Lin, H., 2020, Synthesis of micro-mesoporous ZSM-5 zeolite with microcrystalline cellulose as co-template and catalytic cracking of polyolefin plastics, *RSC advances.*, 10,

22126-22136.

- Yu, S., Jiang, P., Dong, Y., Zhang, P., Zhang, Y., and Zhang, W., 2012, Hydrothermal synthesis of nanosized sulfated zirconia as an efficient and reusable catalyst for esterification of acetic acid with n-butanol, *Bulletin of the Korean Chemical Society.*, 33, 524-528.
- Yu, Z. Q., Xiao, Y. X., Liang, D., Zhao, C., Huang, Z., Cheng, G. Q., and Chen, Y., 2025, Selective preparation of aromatic compounds from catalytic pyrolysis polyester coating over Ni, Mo and Co metal modified ZSM-5, *Journal of Environmental Chemical Engineering.*, 115608.
- Zang, Y., Niu, S., Wu, Y., Zheng, X., Cai, J., Ye, J., and Qian, Y., 2019, Tuning orbital orientation endows molybdenum disulfide with exceptional alkaline hydrogen evolution capability, *Nature Communications.*, 10, 1217.
- Zhang, J., Fang, H., Wang, H., Jia, M., Wu, J., and Fang, S., 2017, Energy efficiency of airlines and its influencing factors: A comparison between China and the United States. Resources., *Conservation and Recycling.*, 125, 1-8.
- Zhang, J., Wang, T., Shi, C., Pan, L., Zhang, X., Peng, C., and Zou, J.-J., 2023, Achieving super-dispersed metallic nickel nanoparticles over MCM-41 for highly active and stable hydrogenation of olefins and aromatics, *Chemical Engineering Journal*, 470, 144197.
- Zhang, X., Rajagopalan, K., Lei, H., Ruan, R., and Sharma, B. K., 2017, An overview of a novel concept in biomass pyrolysis: microwave irradiation, *Sustainable Energy & Fuels.*, 1, 1664-1699.
- Zhang, Y., A, Li., Zhang, Y.S., Xie, W., Liu, C., Peng, Y., Zhang, H., Kang, H., Qu, B., and G, Ji., 2024, In-situ catalytic pyrolysis of polyethylene to co-produce BTX aromatics and H₂ by Ni/ZSM-5 in the rotary reactor with solid heat carriers, *Fuel.*, 371, 131950.
- Zhang, Z., Ma, S., Zhao, H., Hu, Y., Avid, B., & Xue, S., 2025, Effect of bimetallic Co-La loaded fluoride-modified ZSM-5 catalyst on aromatic selectivity and kinetic equation modeling in the catalytic pyrolysis of lignite, *Fuel.*, 384, 134048.
- Zhang, Z., Wang, Q., and Zhang, X., 2019, Hydroconversion of waste cooking oil into bio-jet fuel over NiMo/SBUY-MCM-41, *Catalysts.*, 9, 466.
- Zhao, X., Wang, M., Liu, H., Li, L., Ma, C., and Song, Z., 2012, A microwave reactor for characterization of pyrolyzed biomass, *Bioresource technology.*, 104, 673-678.
- Zhao, X., Wei, L., Julson, J., Qiao, Q., Dubey, A., and Anderson, G., 2015, Catalytic cracking of non-edible sunflower oil over ZSM-5 for hydrocarbon bio-jet fuel, *N. Biotechnol.*, 32, 300-312.
- Zheng, D., Cheng, J., Dai, C., Xu, R., Wang, X., Liu, N., and Chen, B., 2022, Study



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of passenger-car-waste-tire pyrolysis: Behavior and mechanism under
kinetical regime, *Waste Management.*, 148, 71-82.