

DAFTAR PUSTAKA

- Abaide, E.R., Tres, M.V., Zabot, G.L., Mazutti, M.A. (2019). Reasons for processing of rice coproducts: Reality and expectations. *Biomass and Bioenergy*, 120, 240-256. DOI: 10.1016/j.biombioe.2018.11.032.
- Abdullah, H., Mediaswanti, K.A., Wu, H. (2010). Biochar as a fuel: 2. Significant differences in fuel quality and ash properties of biochars from various biomass components of Mallee trees. *Energy Fuels*, 24, 1972–1979. DOI:10.1021/ef901435f
- Abhijeet, P., Swagathnath, G., Rangabhashiyam, S., Rajkumar, M.A., Balasubramanian, P. (2019). Prediction of pyrolytic product composition and yield for various grass biomass feedstocks. *Biomass Conversion and Biorefinery*. DOI: <https://doi.org/10.1007/s13399-019-00475-5>
- Abu Bakar, M.S., dan Titiloye, J.O. (2013). Catalytic pyrolysis of rice husk for bio-oil production. *Journal of Analytical and Applied Pyrolysis*, 103, 362–368. <http://dx.doi.org/10.1016/j.jaap.2012.09.005>
- Adam, F., Appaturi, J.N., Iqbal, A. (2012). The utilization of rice husk silica as a catalyst: Review and recent progress. *Catalysis Today*, 190, 2-14. DOI: 10.1016/j.cattod.2012.04.056
- Aguiar, L., Marquez-Montesinos, F., Gonzalo, A., Sanchez, J.L., Arauzo, J. (2008). Influence of temperature and particle size on the fixed bed pyrolysis of orange peel residues. *Journal of Analytical and Applied Pyrolysis*, 83, 124-130. doi:10.1016/j.jaap.2008.06.009
- Ahangaran, F., Hassanzadeh, A., Nouri, S. (2013). Surface modification of Fe₃O₄@SiO₂ microsphere by silane coupling agent. *International Nano Letters*, 3(23). <http://www.inl-journal.com/content/3/1/23>
- Ahmad, M.F., Isa, N.A.M., Lim, W.H., Ang, K.M. (2022). Differential evolution: A recent review based on state-of-the-art works. *Alexandria Engineering Journal*, 61, 3831-3872. DOI: 10.1016/j.aej.2021.09.013.
- Ahmaruzzaman, M., Gupta, V.K. (2011). Rice husk and its ash as low-cost adsorbents in water and wastewater treatment. *Industrial & Engineering Chemistry Research*, 50, 13589-13613. DOI: 10.1021/ie201477c
- Alonso, A.D., Couce, A.A., Zobel, N., Behrendt, F. (2015). Understanding the primary and secondary slow pyrolysis mechanisms of holocellulose, lignin and wood with laser-induced fluorescence. *Fuel*, 153, 102-109. DOI: <http://dx.doi.org/10.1016/j.fuel.2015.02.097>
- Antal Jr., M.J. (1985). A review of the vapor phase pyrolysis of biomass derived material volatile matter. *Fundamentals of Thermochemical Biomass Conversion*, 511-536.
- Anca-Couce, A., Mehrabian, R., Scharler, R., Obernberger, I. (2014). Kinetic scheme of biomass pyrolysis considering secondary charring reactions. *Energy Conversion and Management*, 87, 687-696. DOI: 10.1016/j.enconman.2014.07.061
- Arabiourrutia, M., Bensidhom, G., Bolanos, M., Trabelsi, A.B.H., Olazar, M. (2022). Catalytic pyrolysis of date palm seeds on HZSM-5 and dolomite in a pyroprobe reactor in line with GC/MS. *Biomass Conversion and Biorefinery*, 14, 2799–2818. doi.org/10.1007/s13399-022-02493-2
- Armynah, B., Atika, Djafar, Z., Piarah, W.H., Tahir, D. (2018). Analysis of Chemical and Physical Properties of Biochar from Rice Husk Biomass. *Journal of Physics: Conf. Series*, 979, 012038. doi :10.1088/1742-6596/979/1/012038
- Asadullah M., Zhang S., Li C.Z. (2010). Evaluation of structural features of chars from pyrolysis of biomass of different particle sizes. *Fuel Processing Technology*, 91(8), 877-881. DOI: 10.1016/j.fuproc.2009.08.008
- Balasundram, V., Biomass Conversion and Biorefinery Ibrahim, N., Kasmani, R.M., Abd. Hamid, M.K., Isha, R., Hasbullah, H., Ali, R.R. (2017). Thermogravimetric catalytic pyrolysis and kinetic studies of coconut copra and rice husk for possible maximum production of pyrolysis oil. *Journal of Cleaner Production*, 167, 218-228. DOI: 10.1016/j.jclepro.2017.08.173.



- Ban, M.R., Jervis, R., Zhang, Y., Bodey, A.J., Rau, C., Shearing, P.R., Brett, D.J.L., Titirici, M.M., Volpe, R. (2021). Towards a mechanistic understanding of particle shrinkage during biomass pyrolysis via synchrotron X-ray microtomography and in-situ radiography. *Scientific Reports*, 11, 2626. <https://doi.org/10.1038/s41598-020-80228-x>
- Bernardi, A., Graciano, J.E.A., Chachuat, B. (2019). Production of chemicals from syngas: an enviro-economic model-based investigation. *Proceedings of the 29th European Symposium on Computer Aided Process Engineering*, 16 -19 Juni 2019, Eindhoven, The Netherland, pp 367-372. DOI: 10.1016/B978-0-12-818634-3.50062-X
- Bilbao, R., Mastral, J.F., Ceamanos, J., Aldea, M.E. (1996). Modelling of the pyrolysis of wet wood. *Journal of Analytical and Applied Pyrolysis*, 36, 81-97.
- Borrajó, J.P., Liste, S., Serra, J., Gonzalez, P., Chiussi, S., Leon, B., Perez-Amor, M., Ylanen, H.O., Hupa, M. (2004). Influence of the Network Modifier Content on the Bioactivity of Silicate Glasses. *Key Engineering Materials*, 254-256, 23-26. doi: 10.4028/www.scientific.net/KEM.254-256.23
- Braga, R.M., Melo, D.C.M., Aquino, F.M., Freitas, J.C.O., Melo, M.A.F., Barros, J.M.F., Fontes, M.S.B. (2014). Characterization and comparative study of pyrolysis kinetics of the rice husk and the elephant grass. *Journal of Thermal Analysis and Calorimetry*, 115, 1915-1920. DOI: 10.1007/s10973-013-3503-7
- Budiman, A., Surtijan, Sawitri, R.D. (2011). Graphical exergy analysis of retrofitted distillation column. *International Journal of Exergy*, 8(4), 477-493.
- Buentello-Montoya, D.A., Zhang, X., Li, J. (2019). The use of gasification solid products as catalysts for tar reforming. *Renewable and Sustainable Energy Reviews*, 107, 399-412. DOI: 10.1016/j.rser.2019.03.021
- Caballero, J.A., Front, R., Marcilla, A., Conesa, J.A. (1997). Characterization of sewage sludges by primary and secondary pyrolysis. *Journal of Analytics & Applied Pyrolysis*, 40, 433-450. [https://doi.org/10.1016/S0165-2370\(97\)00045-4](https://doi.org/10.1016/S0165-2370(97)00045-4)
- Cepeliogullar, O., Haykiri-Acma, H., Yaman, S. (2016). Kinetic modelling of RDF pyrolysis: model-fitting and model-free approaches. *Waste Management*, 48, 275-284. DOI:10.1016/j.wasman.2015.11.027
- Chen, Z., and Zhang, L. (2015). Catalyst and process parameters for the gasification of rice husk with pure CO₂ to produce CO. *Fuel Processing Technology*, 133, 227-231. DOI: 10.1016/j.fuproc.2015.01.027
- Chen, T., Liu, R., Scott, N. (2016). Characterization of energy carriers obtained from the pyrolysis of white ash, switch grass and corn stover – Biochar, syngas and bio-oil. *Fuel Processing Technology*, 142, 124-134. <http://dx.doi.org/10.1016/j.fuproc.2015.09.034>
- Chen, W.H., Eng, C.F., Lin, Y.Y., Lin, Y.Y., Bach, Q.V. (2020). Independent parallel pyrolysis kinetics of cellulose, hemicelluloses and lignin at various heating rates analyzed by evolutionary computation. *Energy Conversion and Management*, 221, 113165. DOI: 10.1016/j.enconman.2020.113165
- Chen, D., Cen, K., Zhuang, X., Gan, Z., Zhou, J., Zhang, Y., Zhang, H. (2022). Insight into biomass pyrolysis mechanism based on cellulose, hemicellulose, and lignin: Evolution of volatiles and kinetics, elucidation of reaction pathways, and characterization of gas, biochar and bio-oil. *Combustion and Flame*, 242, 112142. <https://doi.org/10.1016/j.combustflame.2022.112142>
- Choi H.S., Choi Y.S., Park H.C. (2012). Fast pyrolysis characteristics of lignocellulosic biomass with varying reaction conditions. *Renewable Energy*, 42, 131-135. DOI: 10.1016/j.renene.2011.08.049
- Collard, F.X., Blin, J. (2014). A review on pyrolysis of biomass constituents: Mechanisms and composition of the products obtained from the conversion of cellulose, hemicelluloses and lignin. *Renewable and Sustainable Energy Reviews*, 38, 594-608. DOI: 10.1016/j.rser.2014.06.013.
- Couhert, C., Commandre, J.M., Salvador, S. (2009). Is it possible to predict gas yields of any biomass after rapid pyrolysis at high temperature from its composition in cellulose, hemicellulose and lignin?. *Fuel*, 88, 408-417. doi:10.1016/j.fuel.2008.09.019



- Dale, V.H., Parish, E., Kline, K.L., Tobin, E. (2017). How is wood-based pellet production affecting forest conditions in the southern United State. *Forest Ecology and Management*, 396, 143-149. DOI: 10.1016/j.foreco.2017.03.022
- Damartzis, T., Vamvuka, D., Sfakiotakis, S., Zabanitoutou, A. (2011). Thermal degradation studies and kinetic modeling of cardoon (*Cynara cardunculus*) pyrolysis using thermogravimetric analysis (TGA). *Bioresources Technology*, 102, 6230–6238. <https://doi.org/10.1016/j.biortech.2011.02.060>
- Daniyanto, Sutijan, Deendarlianto, and Budiman, A. (2015). Effect of dry torrefaction on kinetics of catalytic pyrolysis of sugarcane bagasse. Presented on International Conference of Chemical and Material Engineering (ICCME) 2015. *AIP Conference Proceedings*, 1699, 030017. DOI: 10.1063/1.4938302
- Defonseka, C. (2018). Rice hulls pellets as alternate solid fuel for energy generation. *Polymers from Renewable Resources*, 9 (3-4), 133-144. DOI: 10.1177/2041247918799774
- Deshmukh, P., Bhatt, J., Peshwe, D., Pathak, S. (2012). Determination of Silica Activity Index and XRD, SEM and EDS Studies of Amorphous SiO₂ Extracted from Rice Husk Ash. *Transactions of the Indian Institute of Metals*, 65 (1), 63-70. doi:10.1007/s12666-011-0071-z.
- Di Blasi, C. (1996). Heat, momemtum and mass transport through a shrinking biomass particle exposed to thermal radiation. *Chemical Engineering Science*, 51 (7), 1121-1132.
- Di Blasi, C., Branca, C. (1999). Global degradation kinetics of wood and agricultural residues in air. *The Canadian Journal of Chemical Engineering*, 77, 555-561.
- Di Blasi, C., Branca, C. (2001). Kinetics of Primary Product Formation from Wood Pyrolysis. *Industrial & Engineering Chemistry Research*, 40 (23), 5547-5556. DOI: 10.1021/ie000997e
- Diez, D., Uruena, A., Pinero, R., Barrio, A., Tamminen, T. (2020). Determination of Hemicellulose, Cellulose, and Lignin Content in Different Types of Biomasses by Thermogravimetric Analysis and Pseudocomponent Kinetic Model (TGA-PKM Method). *Processes*, 8, 1048. DOI: 10.3390/pr8091048.
- Dragoi, E.N., Curteanu, S. (2016). The use of differential evolution algorithm for solving chemical engineering problems. *Reviews in Chemical Engineering* 2016. DOI: 10.1515/revce-2015-0042.
- Drewitt, J. W. E., Hennet, L., Neuville, D. R. (2022). From short to medium range order in glasses and melts by diffraction and Raman spectroscopy. *Reviews in Mineralogy & Geochemistry*, 87(1), 55-103. <https://doi.org/10.2138/rmg.2022.87.02>
- Eke, J., Onwudili, J.A., Bridgwater, A.V. (2018). Influence of moisture contents on the fast pyrolysis of Trommel Fines in a bubbling bed reactor. *Waste and Biomass Valorization*. DOI: 10.1007/s12649-018-00560-2
- El-Said, A.G., Badawy, N.A., Garamon, S.E. (2018). Adsorption of Heavy Metal Ions from Aqueous Solutions onto Rice Husk Ash Low Cost Adsorbent *Journal of Environmental & Analytical Toxicology*, 8 (1), 1000543. DOI: 10.4172/2161-0525.1000543
- Esfahani, R.A.M., R., Osmieri, L., Specchia, S., Yusup, S., Tavasoli, A., Zamaniyan, A. (2017). H₂-rich syngas production through mixed residual biomass and HDPE waste via integrated catalytic gasification and tar cracking plus bio-char upgrading. *Chemical Engineering Journal*, 308, 578–587. <https://doi.org/10.1016/j.cej.2016.09.049>
- Fan, H., Chang, X., Wang, J., Zhang, Z. (2019). Catalytic pyrolysis of agricultural and forestry wastes in a fixed-bed reactor uaing K₂CO₃ as the catalyst. *Waste Management & Research*, 1-10. DOI: 10.1177/0734242X19875508
- Fardhyanti, D.S., Triwibowo, B., Prsetiawan, H., Chafidz, A., Andriyani, S., Cahyani, N.N. (2019). Improving the Quality of Bio-Oil Produced from Rice Husk Pyrolysis by Extraction of its Phenolic Compounds. *Jurnal Bahan Alam Terbarukan*, 8(2), 90-100. DOI: <https://doi.org/10.15294/jbat.v8i2.22530>
- Ferreiro, A.I.M. (2015). Pyrolysis of Pine Bark, Wheat Straw and Rice Husk: Thermogravimetric Analysis and Kinetic Study. *Thesis report*. Mechanical Engineering – Tecnico Lisboa.
- Fu, P., Yi, W., Bai, X., Li, Z., Cai, H., Hu, S., Xiang, J. (2011). Research on catalytic gasification characteristics and reaction kinetics of rice husk. *Asia-Pacific Power and Energy Engineering Conference*, APPEEC 2011, Article number 5748763. DOI:10.1109/appeec.2011.5748763



- Fu, Y., Zhang, N., Shen, Y., Ge, X., Chen, M. (2018). Micro-mesoporous carbons from original and pelletized rice husk via one-step pyrolysis. *Bioresources Technology*, 269, 67-73. DOI: 10.1016/j.biortech.2018.08.083
- Gadek, M., Kubica, R., Jedrysik, E. (2013). Production of Methanol and Dimethyl ether from biomass derived syngas – a comparison of the different synthesis pathways by means of flowsheet simulation. *Proceedings of the 23rd European Symposium on Computer Aided Process Engineering*, 9 -12 Juni 2013, Lappeenranta, Finland, pp 55-60.
- Gao, X., Zhang, Y., Xu, F., Yin, Z., Wang, Y., Bao, F., Li, B. (2019). Experimental and kinetic studies on the intrinsic reactivities of rice husk char. *Renewable Energy*, 135, 608-616. DOI: 10.1016/j.renene.2018.12.041
- Garba, M.U., Charise, S.G., Bilyaminu, I., Alhassan, M., Musa, U., Isah, A.G. (2016). Kinetic Modeling of Rice Husk Components Pyrolysis Based on Independent Parallel Reactions. *Nigeria Journal of Engineering and Applied Sciences*, 3 (1), 35-42. <http://repository.futminna.edu.ng:8080/jspui/handle/123456789/9211>.
- Gil, M.V., Gonzalez-Vasquez, M.P., Garcia, R., Rubiera, F., Pevida, C. (2019). Assessing the influence of biomass properties on the gasification process using multivariate data analysis. *Energy Conversion and Management*, 184, 649-660. DOI: 10.1016/j.enconman.2019.01.093
- Golinski, T., Foltynowicz, Z. (2012). Pellet-a key to biomass energy. *International Journal of Economic Practices and Theories*, 2 (4), 197-204.
- Grafmuller, J., Bohm, A., Zhuang, Y., Spahr, S., Muller, P., Otto, T.N., Bucheli, T.D., Leifeld, J., Giger, R., Tobler, M., Schmidt, H.P., Dahmen, N., Hagemann, N. (2022). Wood Ash as an Additive in Biomass Pyrolysis: Effects on Biochar Yield, Properties, and Agricultural Performance. *ACS Sustainable Chemistry & Engineering*, 10, 2720–2729. <https://doi.org/10.1021/acssuschemeng.1c07694>
- Guida, M.Y., Lanaya, S., Rbihi, Z., Hannioui, A. (2019). Thermal degradation behaviors of sawdust wood waste: pyrolysis kinetic and mechanism. *Journal of Materials and Environmental Sciences*, 10(8), 724-755. <http://www.jmaterenvironsci.com>
- Guizani, C., Jeguirim, M., Valin, S., Limousy, L., Salvador, S. (2017). Biomass Chars: The Effects of Pyrolysis Conditions on Their Morphology, Structure, Chemical Properties and Reactivity. *Energies*, 10(6), 796. DOI: 10.3390/en10060796
- Guldogan, Y., Evren, V., Durusoy, T., Bozdemir, T. (2001). Effects of Heating Rate and Particle Size on Pyrolysis Kinetics of Mengen Lignite. *Energy Sources*, 23(4), 337-344, DOI: 10.1080/009083101300110887
- Hameed, S., Sharma, A., Pareek, V., Wu, H., Yu, Y. (2019). A review on biomass pyrolysis models: Kinetics, network and mechanistic models. *Biomass and Bioenergy*, 123, 104-122. DOI: 10.1016/j.biombioe.2019.02.008
- Hannon, A., Vaishnav, S., Alderman, O., Bingham, P. (2021). The Structure of Sodium Silicate Glass from Neutron Diffraction and Modelling of Oxygen-Oxygen Correlations. *Journal of the American Ceramic Society*. <http://shura.shu.ac.uk/28787/>
- Hasbullah, R., Bantacut, T. (2007). Teknologi Pengolahan Beras ke Beras. *Pangan*, 48(XVI), 23-37.
- Heryadi, R., Uyun, A.S., Nur, S.M., Abdullah, K. (2019). Single stage dimethyl ether plant model based on gasification of palm empty fruit bunch. *IOP Conf. Series: Materials Science and Engineering* 532 (2019) 012009, 1-9. DOI: 10.1088/1757-899X/532/1/012009
- Hlavsova, A., Corsaro, A., Raclavska, H., Juchelkova, D., Skrobankova, H., Frydrych, J. (2014). Syngas Production from Pyrolysis of Nine Composts Obtained from Nonhybrid and Hybrid Perennial Grasses. *The Scientific World Journal*, Volume 2014, Article ID 723092. DOI: <http://dx.doi.org/10.1155/2014/723092>
- Horsfall, I.T., Ndukwe, M.C., Abam, F.I., Olatunji, O.M., Ojong, O.J., Osa-Aria, K. (2021). Validation of MATLAB algorithm to implement a two-step parallel pyrolysis model for the prediction of maximum %char yield. *Discover Chemical Engineering*, 1(3), DOI: 10.1007/s43938-021-00003-w.
- Hu, S., Jess, A., Xu, M. (2007). Kinetic study of Chinese biomass slow pyrolysis: Comparison of different kinetic models. *Fuel*, 86, 2778–2788. doi:10.1016/j.fuel.2007.02.031



- Hu, S., Jiang, L., Wang, Y., Su, S., Sun, L., Xu, B., He, L., Xiang, J. (2015). Effects of inherent alkali and alkaline earth metallic species on biomass pyrolysis at different temperatures. *Bioresource Technology*, 192, 23–30. <http://dx.doi.org/10.1016/j.biortech.2015.05.042>
- Islam, M.N., Ali, M.H., Ahmad, I. (2017). Fixed bed slow pyrolysis of biomass solid waste for bio-char. *Materials Science and Engineering*, 206, 012014. doi:10.1088/1757-899X/206/1/012014
- Jalan. R.K., Srivastava, V.K. (1999). Studies on pyrolysis of a single biomass cylindrical pellet-kinetic and heat transfer effects. *Energy Conversion & Management*, 40, 467-494.
- Jamilatun, S., Budiman, A., Budhijanto, Rochmadi. (2017a). Non-catalytic slow pyrolysis of *Spirulina Platensis* residue for production of liquid biofuel. *International Journal of Renewable Energy Research*, 7 (4), 1901-1908; ISSN: 1309-0127
- Jamilatun, S., Budhijanto, Rochmadi and Budiman, A. (2017b). Thermal decomposition and kinetic studies of pyrolysis of *Spirulina platensis* residue. *International Journal of Renewable Energy Development*, 6 (3), 193-201. DOI: 10.14710/ijred.6.3.193-201
- Jamilatun, S., Budhijanto, Rochmadi, Yuliestyan, A., Budiman, A. (2019). Effect of grain size, temperature and catalyst amount on pyrolysis products of *Spirulina Platensis* residue (SPR). *International Journal of Technology*, 10 (3), 541-550. DOI: 10.14716/ijtech.v10i3.2918
- Japhet, J.A., Tokan, A., Muhammad, M.H. (2015). Production and characterization of rice husk pellet. *American Journal of Engineering Research*, 4 (12), 112-119.
- Jenkins, B.M., Baxter, L.L., Miles Jr., T.R., Miles, T.R. (1998). Combustion properties of biomass. *Fuel Processing Technology*, 54, 17-46. DOI: 10.1016/S0378-3820(97)00059-3
- Jeon, M.J., Kim, S.S., Jeon, J.K., Park, S.H., Kim, J.M., Sohn, J.M., Lee, S.H., Park, Y.K. (2012). Catalytic pyrolysis of waste rice husk over mesoporous materials. *Nanoscale Research Letters*, 7 (18), 1-5. <http://www.nanoscalereslett.com/content/7/1/18>.
- Jia, C., Chen, J., Liang, J., Song, S., Liu, K., Jiang, A., Wang, Q. (2020). Pyrolysis characteristic and kinetic analysis of rice husk. *Journal of Thermal Analysis and Calorimetry*, 139, 577-587. DOI: 10.1007/s10973-019-08366-7
- Jiang, L., Hu, S., Wang, Y., Su, S., Sun, L., Xu, B., He, L., Xiang, J. (2015). Catalytic effects of inherent alkali and alkaline earth metallic species on steam gasification of biomass. *International Journal of Hydrogen Energy*, 40, 15460-15469. DOI: 10.1016/j.ijhydene.2015.08.111
- Jiang, G. and Wei, L. (2018). Phase Change Materials and Their Application, Chapter 8: Analysis of pyrolysis kinetic model for processing of thermogravimetric analysis data, pp 143-163; DOI: 10.5772/intechopen.79226.
- Jinn, T.C. (2013). Determination of optimum condition for the production of rice husk-derived bio-oil by slow pyrolysis process. *Dissertation report*, Chemical Engineering Programme, Universiti Teknologi PETRONAS.
- Jouiad, M., Al-Nofeli, N., Khalifa, N., Benyettou, F., Yousef, L.F. (2015). Characteristics of slow pyrolysis biochars produced from rhodes grass and fronds of edible date palm. *Journal of Analytical and Applied Pyrolysis*, 111, 183–190. <http://dx.doi.org/10.1016/j.jaap.2014.10.024>
- Kabakci, S.B., Hacibektasoglu, S. (2017). Catalytic Pyrolysis of Biomass. *Book Chapter: Pyrolysis, Chapter 7, Intech*, 167-196. <http://dx.doi.org/10.5772/67569>
- Kajita, M., Kimura, T., Norinaga, K., Li, C., Hayashi, J. (2010). Catalytic and noncatalytic mechanisms in steam gasification of char from the pyrolysis of biomass. *Energy & Fuels*, 24, 108-116. DOI: 10.1021/ef900513a
- Kanaujia, P.K. (2014). Production, Upgrading and Analysis of Bio-oils Derived from Lignocellulosic Biomass. *Polysaccharides*, 2-26. Springer International Publishing Switzerland. DOI 10.1007/978-3-319-03751-6_41-1
- Kaur, R., Gera, P., Jha, M.K., Bhaskar, T. (2018). Pyrolysis kinetics and thermodynamic parameters of castor (*Ricinus communis*) residue using thermogravimetric analysis. *Bioresources Technology*, 250, 422–428. DOI: 10.1016/j.biortech.2017.11.077
- Khonde, R., Nanda, J., Chaurasia, A. (2017). Experimental investigation of catalytic cracking of rice husk tar for hydrogen production. *Journal of Material Cycles and Waste Management*, 20 (2), 1310-1319. DOI: 10.1007/s10163-017-0695-0



- Kim, J.Y., Moon, J., Lee, J.H., Jin, X., Choi, J.W. (2020). Conversion of phenol intermediates into aromatic hydrocarbons over various zeolites during lignin pyrolysis. *Fuel*, 279, 118484. doi: <https://doi.org/10.1016/j.fuel.2020.118484>
- Kitsuka, T., Bayarsaikhan, B., Sonoyama, N., Hosokai, S., Li, C., Norinaga, K., Hayashi, J. (2007). Behavior of inherent metallic species as a crucial factor for kinetics of steam gasification of char from coal pyrolysis. *Energy & Fuels*, 21, 387-394. DOI: 10.1021/ef0603986
- Kobayashi, J., Kawamoto, K., Kobayashi, N. (2019). Effect of porous silica on the removal of tar component generated from waste biomass during catalytic reforming. *Fuel Processing Technology*, 194, 106104. DOI: 10.1016/j.fuproc.2019.05.027
- Kosov, V., Kosov, V., Zaichenko, V. (2014). Experimental Research of Heterogeneous Cracking of Pyrolysis Tars. *Chemical Engineering Transactions*, 37, 211-216. DOI: 10.3303/CET1437036
- Koufopoulos, C.A., Papayannakos, N., Maschio, G., Lucchesi, A. (1991). Modelling of the pyrolysis of biomass particles. Studi on kinetics, thermal and heat transfer effects. *The Canadian Journal of Chemical Engineering*, 69, 907-915.
- Li, J., Liu, J., Liao, S., Yan, R. (2010). Hydrogen-rich gas production by air-steam gasification of rice husk using supported nano-NiO/ γ -Al₂O₃ catalyst. *International Journal of Hydrogen Energy*, 35, 7399-7404. DOI: 10.1016/j.ijhydene.2010.04.108
- Li, J., Xiong, Z., Zeng, K., Zhong, D., Zhang, X., Chwn, W., Nzihou, A., Flamat, G., Yang, H., Chen, H. (2021). Characteristics and Evolution of Nitrogen in the Heavy Components of Algae Pyrolysis Bio-Oil. *Environmental Science and Technology*, 55(9), 6373-6385. DOI: 10.1021/acs.est.1c00676
- Liang, S., Han, Y., Wei, L., McDonald, A.G. (2014). Production and characterization of bio-oil and bio-char from pyrolysis of potato peel wastes. *Biomass Conversion and Biorefinery*, 5(3), 237-246. DOI 10.1007/s13399-014-0130-x
- Lim, J.S., Manan, Z.A., Wan Alwi, S.R., Hashim, H. (2012). A review on utilisation of biomass from rice industry as a source of renewable energy. *Renewable and Sustainable Energy Reviews*, 16, 3084-3094. DOI: 10.1016/j.rser.2012.02.051
- Loy, A.C.M., Gan, D.K.W., Yusup, S., Chin, B.L.F., Lam, M.K., Shahbaz, M., Unrean, P., Acda, M.N., and Rianawati, E. (2018a), Thermogravimetric kinetic modelling of in-situ catalytic pyrolytic conversion of rice husk to bioenergy using rice hull ash catalyst, *Bioresource Technology*, 261, 213-222. DOI: 10.1016/j.biortech.2018.04.020
- Loy, A.C.M., Yusup, S., Chin, B.L.F., Gan, D.K.W., Shahbaz, M., Acda, M.N., Unrean, P., Rianawati, E. (2018b). Comparative study of in-situ catalytic pyrolysis of rice husk for syngas production: Kinetics modelling and product gas analysis. *Journal of Cleaner Production*, 197, 1231-1243. DOI: 10.1016/j.jclepro.2018.06.245.
- Loy, A.C.M., Yusup, S., Lam, M.K., Chin, B.L.F., Shahbaz, M., Yamamoto, A., Acda, M.N. (2018c). The effect of industrial waste coal bottom ash as catalyst in catalytic pyrolysis of rice husk for syngas production. *Energy Conversion and Management*, 165, 541-554. DOI: <https://doi.org/10.1016/j.enconman.2018.03.063>
- Lu, Q., Zhang, T., Deng, X., He, R., Yuan, S., Li, J., Xie, X., Li, W., Liu, Z., Zhang, X. (2020). Enhancement of gas and aromatics by in-situ catalytic pyrolysis of biomass in the presence of silica gel. *Biomass and Bioenergy*, 138, 105567. DOI: 10.1016/j.biombioe.2020.105567
- Lu, X. and Gu, X. (2022). A review on lignin pyrolysis: pyrolytic behavior, mechanism, and relevant upgrading for improving process efficiency. *Biotechnology for Biofuels and Bioproducts*, 15(106), 1-43. <https://doi.org/10.1186/s13068-022-02203-0>
- Luo S., Yi C., Zhou Y. (2013). Bio-oil production by pyrolysis of biomass using hot blast furnace slag. *Renewable Energy*, 50, 373-377. DOI:10.1016/j.renene.2012.07.008
- Lv, Y. dan Duan, J. (2015). Numerical Investigation of the Impact of Shrinkage on the Pyrolysis of Biomass. *International Conference on Materials, Environmental and Biological Engineering (MEBE 2015)* - Atlantis Press, 375-380.
- Mahadevan, R., Adhikari, S., Shakya, R., Wang, K., Dayton, D., Lehrich, M., Taylor, S.E. (2016). Effect of Alkali and Alkaline Earth Metals on in-Situ Catalytic Fast Pyrolysis of



- Lignocellulosic Biomass: A Microreactor Study. *Energy Fuels*, 30(4), 3045–3056. <https://doi.org/10.1021/acs.energyfuels.5b02984>
- Mallick, D., Buragohain, B., Mahanta, P., Moholkar, V.S. (2018). Gasification of mixed biomass: analysis using equilibrium, semi-equilibrium, and kinetic models. *Coal and Biomass Gasification, Energy, Environment, and Sustainability*, Springer Nature Singapore Pte Ltd, 2018. DOI: 10.1007/978-981-10-7335-9.
- Mansaray, K.G., Ghaly, A.E. (1998). Thermogravimetric Analysis of Rice Husks in an Air Atmosphere. *Energy Sources* 20, 653-663. DOI: 10.1080/00908319808970084
- Mecozzi, M., Pietroletti, M., Scarpiniti, M., Acquistucci, R., Conti, M.E. (2012). Monitoring of marine mucilage formation in Italian seas investigated by infrared spectroscopy and independent component analysis. *Environmental Monitoring and Assessment*, 184, 6025-6036. DOI 10.1007/s10661-011-2400-4
- Meesri, C., Moghtaderi, B. (2002). Lack of synergetic effects in the pyrolytic characteristics of woody biomass/coal blends under low and high heating rate regimes. *Biomass & Bioenergy*, 23, 55–66. [https://doi.org/10.1016/S0961-9534\(02\)00034-X](https://doi.org/10.1016/S0961-9534(02)00034-X)
- Mian, I., Li, X., Jian., Dacres, O.D., Zhong, M., Liu, J., Ma., F., Rahman, N. (2019). Kinetic study of biomass pellet pyrolysis by using distributed activation energy model and Coats Redfern methods and their comparison. *Bioresource Technology*, 294, 122099. DOI: 10.1016/j.biortech.2019.122099
- Mishra, R.K., Mohanty, K. (2018). Pyrolysis kinetics and thermal behavior of waste sawdust biomass using thermogravimetric analysis. *Bioresource Technology*, 251, 63-74. DOI: 10.1016/j.biortech.2017.12.029.
- Mohamed, B.A., Ellis, N., Kim, C.S., Bi, X. (2020). Synergistic Effects of Catalyst Mixtures on Biomass Catalytic Pyrolysis. *Frontiers in Bioengineering and Biotechnology*, 8, 615134. DOI: 10.3389/fbioe.2020.615134.
- Morf, P., Hasler, P., Nussbaumer, T. (2002). Mechanisms and kinetics of homogeneous secondary reactions of tar from continuous pyrolysis of wood chips. *Fuel*, 81, 843-853.
- Muhammad, I. dan Manos, G. (2021). Improving the Conversion of Biomass in Catalytic Pyrolysis via Intensification of Biomass-Catalyst Contact by Co-Pressing. *Catalysts*, 11, 805. DOI: <https://doi.org/10.3390/catal11070805>
- Muneer, B., Zeeshan, M., Qaisar, S., Razzaq, M., Iftikhar, H. (2019). Influence of in-situ and ex-situ HZSM-5 catalyst on co-pyrolysis of corn stalk and polystyrene with a focus on liquid yield and quality. *Journal of Cleaner Production*, 237, 117762. DOI: 10.1016/j.jclepro.2019.117762
- Neville, A.M. (1995). Properties of concrete, 4th Edition, ISBN 0 582 23070 5, Longman Group Limited, England 1995, p. 82.
- Nguyen, H.T., Gallardo, S.M., Bacani, F., Hinode, H., Minh Do, Q., Promentilla, M.A. (2015). Evaluating thermal properties of geopolymer produced from Red Mud, Rice Husk Ash and Diatomaceous Earth. *ASEAN Engineering Journal Part B*, 4 (1), 51-65.
- Ochoa, A., Bilbao, J., Gayubo, A.G., Casta, P. (2020). Coke formation and deactivation during catalytic reforming of biomass and waste pyrolysis products: A review. *Renewable and Sustainable Energy Reviews*, 119, March 2020, 109600. doi: <https://doi.org/10.1016/j.rser.2019.109600>
- Oh, T.K., Choi, B., Shinogi, Y., Chikushi, J. (2012). Characterization of Biochar Derived from Three Types of Biomass. *Journal of the Faculty of Agriculture Kyushu University*, 57(1), 61-66. <https://doi.org/10.5109/22049>
- Okekunle, P.O., Watanabe, H., Okazaki, K. (2013). Analysis of Biomass Pyrolysis Product Yield Distribution in Thermally Thin Regime at Different Heating Rates. *Mathematical Theory and Modeling*, 3(11), 29-34.
- Onsree, T., Tippayawong, N., Zheng, A., Li, H. (2018). Pyrolysis behavior and kinetics of corn residue pellets and eucalyptus wood chips in a macro thermogravimetric analyzer. *Case Studies in Thermal Engineering*, 12, 546-556. <https://doi.org/10.1016/j.csite.2018.07.011>
- Orfao, J.J.M., Antunes, F.J.A., Figueiredo, J.L. (1999). Pyrolysis kinetics of lignocellulosic materials – three independent reactions model. *Fuel*, 78, 349-358.



- Oyeleke, O.O., Ohunakin, O.S., Adelekan, D.S. (2021). Catalytic Pyrolysis in Waste to Energy Recovery Applications: A Review. *Material Science and Engineering*, 1107, 012226. doi:10.1088/1757-899X/1107/1/012226
- Park, W.C., Atreya, A., Baum, H.R. (2010). Experimental and theoretical investigation of heat and mass transfer processes during wood pyrolysis. *Combustion and Flame*, 157, 481-494. DOI: 10.1016/j.combustflame.2009.10.006
- Parthasarathy, P., Narayanan, K.S. (2014). Hydrogen production from steam gasification of biomass: influence of process parameters on hydrogen yield – A review. *Renewable Energy*, 66, 570-579. DOI: 10.1016/j.renene.2013.12.025
- Paulsen, A.D., Mettler, M.S., Dauenhauer, P.J. (2013). The role of sample dimension and temperature in cellulose pyrolysis. *Energy Fuels*, 27 (4), 2126–2134. DOI: 10.1021/ef302117j
- Prabahar, R.S.S., Nagaraj, H., Jeyasubramanian, K. (2019). Enhanced recovery of H₂ gas from rice husk and its char enabled with nano catalytic pyrolysis/gasification. *Microchemical Journal*, 146, 922-930. DOI: 10.1016/j.microc.2019.02.024
- Pradana, Y.S., Daniyanto, Hartono, M., Prasakti, L., Budiman, A. (2019). Effect of calcium and magnesium catalyst on pyrolysis kinetic of Indonesian sugarcane bagasse for biofuel production. *Energy Procedia*, 158, 431-439. DOI: 10.1016/j.egypro.2019.01.128
- Prakash, P., Sheeba, K. N. (2016). Prediction of pyrolysis and gasification characteristics of different biomass from their physico-chemical properties. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 38(11), 1530–1536. DOI: 10.1080/15567036.2014.953713
- Pranoto, Himawanto, D.A., Fawazeni, F.A. (2019). The effect of various heating rate and final temperature towards heating value and activation energy on rice husk pyrolysis. *Materials Science and Engineering*, 509, 012110. doi:10.1088/1757-899X/509/1/012110
- Prasara-A, J., Gheewala, S.H. (2017). Sustainable utilization of rice husk ash from power plants: A review. *Journal of Cleaner Production*, 167, 1020-1028. DOI: 10.1016/j.jclepro.2016.11.042
- Prasertcharoensuk, P., Hernandez, D.A., Bull, S.J., Phan, A.N. (2018). Optimisation of a throat downdraft gasifier for hydrogen production. *Biomass and Bioenergy*, 116, 216-226. DOI: 10.1016/j.biombioe.2018.06.019
- Prasetyo, T.A.B. dan Soegijono, B. (2018). Characterization of sonicated natural zeolite/ferric chloride hexahydrate by infrared spectroscopy. *Journal of Physics: Conf. Series*, 985, 012022. doi:10.1088/1742-6596/985/1/012022
- Priya Shreedatta Tanvidkar. (2015). Catalytic Up-Gradation of Bio-Oil by Pyrolysis of Biomass. *Master Thesis*. Department of Chemical Engineering National Institute of Technology Rourkela.
- Putun E. (2020). Catalytic pyrolysis of biomass: effect of pyrolysis temperature, sweep-ing gas flow rate and MgO catalyst. *Energy*, 35(7), 2761-2766. DOI: 10.1016/j.energy.2010.02.024
- Quiroga, E., Molto, J., Conesa, J.A., Valero, M.F., Cobo, M. (2020). Kinetics of the catalytic thermal degradation of Sugarcane residual biomass over Rh-Pt/CeO₂-SiO₂ for syngas production. *Catalysts*, 10, 508, 1-20; doi.org/10.3390/catal10050508.
- Radmanesh, R., Courbariaux, Y., Chaouki, J., Guy, C. (2006). A unified lumped approach in kinetic modeling of biomass pyrolysis. *Fuel*, 85, 1211-1220. DOI:10.1016/j.fuel.2005.11.021
- Ragula, U.B.R., Devanathan, S., Subramanian, S. (2019). Modeling and Optimization of Product Profiles in Biomass Pyrolysis. *Book Chapter: Pyrolysis*, Intechopen. DOI: <http://dx.doi.org/10.5772/intechopen.85581>
- Ramachandran, R.P.B., van Rossum, G., van Swaaij, W.P.M., Kersten, S.R.A. (2009). Evaporation of Biomass Fast Pyrolysis Oil: Evaluation of Char Formation. *Environmental Progress & Sustainable Energy*, 28(3), 410-417. <https://doi.org/10.1002/ep>
- Ramchandran Poda. (2016). Potential application of rice husk ash waste from rice husk biomass power plant. *Renewable and Sustainable Energy Reviews*, 53, 1468-1485. DOI: 10.1016/j.rser.2015.09.051
- Rasool, T., Srivastava, V.C., Khan, M.N.S. (2018). Kinetic and thermodynamic analysis of thermal decomposition of Deodar (*Cedrus Deodara*) saw dust and rice husk as potential



- feedstock for pyrolysis. *International Journal of Chemical Reactor Engineering*, 20170184. DOI: 10.1515/ijcre-2017-0184.
- Ratnasari, D.K., Bijl, A., Yang, W., Jonsson, P.G. (2020). Effect of H-ZSM-5 and Al-MCM-41 Proportions in Catalyst Mixtures on the Composition of Bio-Oil in Ex-Situ Catalytic Pyrolysis of Lignocellulose Biomass. *Catalysts*, 10, 868. doi:10.3390/catal10080868
- Rei, M.H., Yang, S.J., Hong, C.H. (1986a). Catalytic gasification of rice hull and other biomass, The general effect of catalyst. *Agricultural Wastes*, 18, 269-281.
- Rei, M.H., Lin, F.S., Su, T.B., (1986b). Catalytic gasification of rice hull,(II) The steam reforming reaction. *Applied Catalysis*, 26, 27-37. DOI: 10.1016/0141-4607(86)90072-7
- Rong, C., Li, B., Liu, W., Zhao, N. (2018). The effect of oyster shell powder & rice husk ash on the pyrolysis of rice husk for bio-oil. *Energy Sources Part A: Recovery, Utilization, and Environmental Effects*, 40(11), 1291-1304; doi.org/10.1080/15567036.2018.1469690
- Safdari, M.S., Amini, E., Weise, D.R., Fletcher, T.H. (2019). Heating rate and temperature effects on pyrolysis products from live wildland fuels. *Fuel*, 242, 295-304. <https://doi.org/10.1016/j.fuel.2019.01.040>
- Sahraei, O.A.Z., Larachi, F., Abatzoglou, N., & Iliuta, M. C. (2017). Hydrogen production by glycerol steam reforming catalyzed by Ni-promoted Fe/Mg-bearing metallurgical wastes. *Applied Catalysis B: Environmental*, 219, 183–193; doi.org/10.1016/j.apcatb.2017.07.039
- Said, M.M., John, G.R., Mhilu, C.F. (2014). Thermal characteristics and kinetics of rice husk for pyrolysis process. *International Journal of Renewable Energy Research*, 4 (2), 275-278; www.ijrer.org/ijrer/index.php/ijrer/article/view/1120.
- Salman, C.A., Naqvi, M., Thorin, E., and Yan, J. (2018). Gasification process integration with existing combined heat and power plants for poly-generation of dimethyl ether or methanol: A detailed profitability analysis. *Applied Energy*, 226, 116-128; doi.org/10.1016/j.apenergy.2018.05.069
- Santos, K. G., Lira, T. S., Giancesella, M., Lobato, F. S., Murata, V. V., Barrozo, M. A. S. (2012). Bagasse Pyrolysis: A Comparative Study of Kinetic Models. *Chemical Engineering Communications*, 199 (1), 109-121. DOI: 10.1080/00986445.2011.575906.
- Sarkar, J.K. and Wang, Q. (2020). Characterization of pyrolysis products and kinetic analysis of waste Jute Stick biomass. *Processes*, 8, 837. DOI:10.3390/pr8070837
- Selvarajoo, A. & Oochit, D. (2020). Effect of pyrolysis temperature on product yields of palm fibre and its biochar characteristics. *Materials Science for Energy Technologies*, 3, 575–583. <https://doi.org/10.1016/j.mset.2020.06.003>
- Shafizadeh, F., Chin, P.P.S. (1977). Thermal Deterioration of Wood. *ACS Symposium Series: In Wood Technology: Chemical Aspects*, Goldstein I. DOI: 10.1021/bk-1977-0043.ch005
- Shahbaz, M., Alnouss, A., Parthasarathy, P., Abdelaal, A.H., Mackey, H., McKay, G., Al-Ansari, T. (2022). Investigation of biomass components on the slow pyrolysis products yield using Aspen Plus for techno-economic analysis. *Biomass Conversion and Biorefinery*, 12, 669–681. DOI: 10.1007/s13399-020-01040-1
- Sharma, R., Sheth, P.N. (2018). Multi reaction apparent kinetic scheme for the pyrolysis of large size biomass particles using macro-TGA. *Energy*, 151, 1007-1017. DOI: 10.1016/j.energy.2018.03.075
- Shayan, E., Zare, V., Mirzaee, I. (2018). Hydrogen production from biomass gasification: a theoretical comparison of using different gasification agents. *Energy Conversion and Management*, 159, 30-41. DOI: 10.1016/j.enconman.2017.12.096
- Shen, Y., Zhao, P., Ma, D., Yoshikawa, K. (2014a). Tar in-situ conversion for biomass gasification via mixing-simulation with rice husk char-supported catalysts. *Energy Procedia*, 61, 1549-1552; doi.org/10.1016/j.egypro.2014.12.167
- Shen, Y., Zhao, P., Shao, Q., Ma, D., Takahashi, F., Yoshikawa, K. (2014b). In-situ catalytic conversion of tar using rice husk char-supported nickel-iron catalysts for biomass pyrolysis/gasification. *Applied Catalysis B: Environmental*, 152-153, 140-151; doi.org/10.1016/j.apcatb.2014.01.032
- Shen, Y., Zhao, P., Shao, Q., Takahashi, F., Yoshikawa, K. (2015). In-situ catalytic conversion of tar using rice husk char/ash supported nickel-iron catalysts for biomass pyrolytic



- gasification combined with the mixing-simulation in a fluidized-bed gasifier. *Applied Energy*, 160, 808-819; doi.org/10.1016/j.apenergy.2014.10.074
- Sheth, P.N., Babu, B.V. (2009). Differential Evolution Approach for Obtaining Kinetic Parameters in Nonisothermal Pyrolysis of Biomass. *Material and Manufacturing Processes*, 24, 47-52. DOI: 10.1080/10426910802540661
- Shirazi, Y., Viamajala, S., Varanasi, S. (2020). In situ and Ex situ Catalytic Pyrolysis of Microalgae and Integration With Pyrolytic Fractionation. *Frontiers in Chemistry*, 8, 786. DOI: 10.3389/fchem.2020.00786
- Sidabutar, V.T.P. (2018). Kajian peningkatan potensi ekspor pelet kayu Indonesia sebagai sumber energi biomassa yang terbarukan. *Jurnal Ilmu Kehutanan*, 12, 99-116. <https://jurnal.ugm.ac.id/jikfkt>
- Soleimanikutanaei, S., Ghasemisahebi, E., Lin, C.X. (2018). Numerical study of heat transfer enhancement using transverse microchannels in a heat sink. *International Journal of Thermal Sciences*, 125, 89-100. DOI: 10.1016/j.ijthermalsci.2017.11.009
- Song, Y., Zhao, Y., Hu, X., Zhang, L., Sun, S., Li, C.Z. (2018). Destruction of tar during material volatil-char interactions at low temperature. *Fuel Processing Technology*, 171, 215-222. DOI: 10.1016/j.fuproc.2017.11.023
- Soong, T.T. (2004). *Fundamentals of Probability and Statistics for Engineers*. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England. ISBN 0-470-86814-7 (Paper)
- Sotelo, C.D.R. (2018). Heat and mass transfer limitations in the pyrolysis of wood particles. *Thesis report*. Chemical Engineering – School of Engineering Sciences in Chemistry, Biotechnology and Health, Sweden.
- Srivastava, V.K., Sushil, Jalan, R.K. (1996). Prediction of concentration in the pyrolysis of biomass material – II. *Energy Conversion and Management*, 37(4), pp. 473-483.
- Storn, R., Price, K. (1997). Differential Evolution – A Simple and Efficient Heuristic for Global Optimization over Continuous Spaces. *Journal of Global Optimization*, 11, 341–359.
- Sunarno, Rochmadi, Mulyono, P., Aziz, M., Budiman, A. (2017). Kinetic Study of Catalytic Cracking of Bio-oil over Silica-alumina Catalyst. *BioResources*, 13 (1), 1917-1929. DOI: 10.15376/biores.13.1.1917-1929.
- Szucs, T., Szentannai, P., Szilagyi, I.M., Bakos, L.P. (2019). Comparing different reaction models for combustion kinetics of solid recovered fuel. *Journal of Thermal Analysis and Calorimetry*, DOI: 10.1007/s10973-019-08438-8
- Thakkar, M., Makwana, J.P., Mohanty, P., Shah, M., Singh, V. (2016). In bed catalytic tar reduction in the auto-thermal fluidized bed gasification of rice husk: Extraction of silica, energy and cost analysis. *Industrial Crops and Products*, 87, 324-332; doi.org/10.1016/j.indcrop.2016.04.031
- Tsai, W.T., Lee, M.K., Chang, Y.M. (2007). Fast pyrolysis of rice husk: Product yields and compositions. *Bioresourc Technology*, 98, 22–28. doi:10.1016/j.biortech.2005.12.005
- Turmanova, S. (2008). Non-isothermal degradation kinetics of filled with rise husk ash polypropene composites. *Express Polym. Lett.* DOI: 10.3144/expresspolymlett.2008.18
- Uddin, M.J., Khan, M.M.R., Iftekhar, M.S., Islam, M.A. (2006). Cr(VI) removal from wastewater by using rice husk ash (RHA). *ASEAN Journal of Chemical Engineering*, 6 (1), 53-57.
- Varhegyi, G., Szabo, P., Till, F., Zelei, B. (1998). TG, TG-MS, and FTIR Characterization of High-Yield Biomass Charcoals. *Energy & Fuels*, 12, 969-974.
- Vassilev, S.V., Vassileva, C.G. (2019). Water-soluble fractions of biomass and biomass ash and their significance for biofuel application. *Energy & Fuels*, 33, 2763-2777. DOI: 10.1021/acs.energyfuels.9b00081
- Vassilev, S.V., Vassileva, C.G., Song, Y., Li, W., Feng, J. (2017). Ash content and ash-forming elements of biomass and their significance for solid biofuel combustion. *Fuel*, 208, 377-409. DOI: 10.1016/j.fuel.2017.07.036
- Vichaphund, S., Sricharoenchaikul, V., Atong, D. (2017). Industrial waste derived CaO-based catalyst for upgrading volatiles during pyrolysis of Jatropha residues. *Journal of Analytical and Applied Pyrolysis*, 124, 568-575. DOI: <http://dx.doi.org/10.1016/j.jaap.2017.01.017>



- Vieira, F.R., Luna, C.M.R., Arce, G.L.A.F., Avila, I. (2020). Optimization of slow pyrolysis process parameters using a fixed bed reactor for biochar yield from rice husk. *Biomass and Bioenergy*, 132, 105412. <https://doi.org/10.1016/j.biombioe.2019.105412>
- Waheed, Q.M.K., Nahil, M.A., Williams, P.T. (2013). Pyrolysis of waste biomass: investigation of fast pyrolysis and slow pyrolysis process conditions on product yield and gas composition. *Journal of the Energy Institute*, 86 (4), 233 - 241. DOI: 10.1179/1743967113Z.00000000067
- Waheed, Q.M.K., Wu, C., Williams, P.T. (2016). Pyrolysis/reforming of rice husks with a Niedolomite catalyst: Influence of process conditions on syngas and hydrogen yield. *Journal of the Energy Institute*, 89, 657-667. <http://dx.doi.org/10.1016/j.joei.2015.05.006>
- Wang, K., Johnston, P.A., Brown, R.C. (2014). Comparison of in-situ and ex-situ catalytic pyrolysis in a micro-reactor system. *Bioresource Technology*, 173, 124–131. <http://dx.doi.org/10.1016/j.biortech.2014.09.097>
- Wang, M. (2014). Optimization Rastrigin Function by Differential Evolution algorithm. Version 1.0.0.0. (<https://www.mathworks.com/matlabcentral/fileexchange/46818-optimization-rastrigin-function-by-differential-evolution-algorithm>), MATLAB Central File Exchange. Retrieved March 05, 2021.
- Wang, Q., Endo, T., Apar., P., Gui, L., Chen, Q., Mitsumura, N, (2013). Study on heterogeneous reaction between tar and ash from waste biomass pyrolysis and gasification. *WIT Transactions on Ecology and The Environment*, 176, 291-302. doi:10.2495/ESUS130251
- Wang, Q., Zhang, X., Sun, S., Wang., Z., Cui., D. (2020). Effect of CaO on pyrolysis products and reaction mechanism of a Corn Stover. *ACS Omega*, 5, 10276-10287. DOI: 10.1021/acsomega.9b03945
- Wang, S-W., Li, D-X., Ruan, W-B., Jin, C-L., and Farahani, M.R. (2018a). A techno-economic review of biomass gasification for production of chemicals. *Energy Sources, Part B: Economics, Planning, and Policy*, 13(8), 351-356; doi.org/10.1016/j.egypro.2017.03.1111
- Wang, Y., Kang, K., Yao., Z., Sun, G., Qiu, L., Zhao, L., Wang, G. (2018b). Effects of different heating patterns on the decomposition behavior of white pine wood during slow pyrolysis. *International Journal of Agricultural and Biological Engineering*, 11(5), 218-222. <https://www.ijabe.org>
- Wang, Z. & Xiong, Y. (2020). Simultaneous improvement in qualities of bio-oil and syngas from catalytic pyrolysis of rice husk by demineralization. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects* (Article in press); doi.org/10.1080/15567036.2020.1824038
- Wang, W., Gu, Y., Zhou, C., Hu, C. (2022). Current Challenges and Perspectives for the Catalytic Pyrolysis of Lignocellulosic Biomass to High-Value Products. *Catalysts*, 12, 1524. DOI: <https://doi.org/10.3390/catal12121524>
- Weldekidan, H., Strezov, V., Li, R., Kan., T., Town, G., Kumar, R., He., J., Flamant, G. (2020). Distribution of solar pyrolysis products and product gas composition produced from agricultural residues and animal wastes at different operating parameters. *Renewable Energy*, 151, 1102-1109. DOI: <https://doi.org/10.1016/j.renene.2019.11.107>
- Wibowo, W.A., Pranolo, S.H., Sunarno, J.W., Purwadi, D. (2014). Effect of biomass feed size and air flow rate on the pressure drop of gasification reactor. *Science & Engineering*, 68 (3), 7-12. DOI: 10.11113/jt.v68.2962
- Widiyannita, A.M., Pradana, Y.S., Cahyono, R.B., Sutijan, Akiyama, T., Budiman, A. (2020). Kinetic Study of Pyrolysis of Ulin Wood Residue using Thermogravimetric Analysis. *International Journal on Advanced Science, Engineering and Information Technology*, 10 (4), 1624-1630; <http://insightsociety.org/ojaseit/index.php/ijaseit/article/view/3640>
- Wijayanti, H., Jelita, R., Nata, I.F., Irawan, C. (2020). Biofuel from Rice Husk Pyrolysis: Effect of Temperature to Pyrolysis Oil and Its Kinetic Study. *Iranian Journal of Chemistry and Chemical Engineering*, 39(6), 271-279. DOI: 10.30492/IJCCE.2019.36138
- Williams, P.T., and Nugranad, N. (2000). Comparison of products from the pyrolysis and catalytic pyrolysis of rice husks. *Energy*, 25, 493-513. [https://doi.org/10.1016/S0360-5442\(00\)00009-8](https://doi.org/10.1016/S0360-5442(00)00009-8)
- Xiang, Z., Liang, J., Morgan, H.M., Liu, Y., Mao, H., Bu, Q. (2018). Thermal behavior and kinetic study for co-pyrolysis of lignocellulosic biomass with polyethylene over Cobalt modified



- ZSM-5 catalyst by thermogravimetric analysis. *Bioresources Technology*, 247, 804–811. <https://doi.org/10.1016/j.biortech.2017.09.178>
- Xu, Y., and Chen, B. (2013). Investigation of thermodynamic parameters in the pyrolysis conversion of biomass and manure to biochars using thermogravimetric analysis. *Bioresources Technology*, 146, 485–493. DOI: 10.1016/j.biortech.2013.07.086
- Yang, H., Yan, R., Chen, H., Lee, D.H., Zheng, C. (2007). Characteristics of hemicellulose, cellulose and lignin pyrolysis. *Fuel*, 86, 1781-1788. DOI: 10.1016/j.fuel.2006.12.013
- Yao, X., Xu, K., Liang, Y. (2017). Assessing the effects of different process parameters on the pyrolysis behaviors and thermal dynamics of corncob fraction. *BioResources*, 12(2), 2748-2767.
- Yip, K., Xu, M., Li, C.-Z., Jiang, S.P., Wu, H. (2010). Biochar as a fuel: 3. Mechanistic understanding on biochar thermal annealing at mild temperatures and its effect on biochar reactivity. *Energy Fuels*, 25, 406–414. DOI:10.1021/ef101472f
- Yoon, S.J., Son, Y.I, Kim, Y.K., and Lee, J.G. (2012). Gasification and power generation characteristics of rice husk and rice husk pellet using a downdraft fixed-bed gasifier. *Renewable Energy*, 42, 163-167; doi.org/10.1016/j.renene.2011.08.028
- Yu, J., Sun, L., Berruoco, C., Fidalgo, B., Paterson, N., Millan, M. (2018). Influence of temperature and particle size on structural characteristics of chars from Beechwood pyrolysis. *Journal of Analytical and Applied Pyrolysis*, 130, 127-134. DOI: 10.1016/j.jaap.2018.01.018
- Yuan, R., Shen, Y. (2019). Catalytic pyrolysis of biomass-plastic wastes in the presence of MgO and MgCO₃ for hydrocarbon-rich oils production. *Bioresources Technology*, 293, 122076; doi.org/10.1016/j.biortech.2019.122076
- Yuan, R., Yu, S., Shen, Y. (2019). Pyrolysis and combustion kinetics of lignocellulosic biomass pellets with calcium-rich wastes from agroforestry residues. *Waste Management*, 87, 86-96; doi.org/10.1016/j.wasman.2019.02.009
- Yudiantono, Anindhita, Sugiyono, A., Laode M.A., Wahid, A. (2018). Indonesia Energy Outlook 2018, Sustainable Energy for Land Transportation. *Center of Assessment for Process and Energy Industry - Agency for the Assessment and Application of Technology*, Jakarta, Indonesia. ISBN 978-602-1328-05-7. www.bppt.go.id
- Zabeti, M., Nguyen, T.S., Lefferts, L., Heeres, H.J., Seshan, K. (2012). In situ catalytic pyrolysis of lignocellulose using alkali-modified amorphous silica alumina. *Bioresource Technology*, 118, 374-381. DOI: 10.1016/j.biortech. 2012.05.034
- Zhang, X., de Jong, W., Preto, F. (2009). Estimating kinetic parameters in TGA using B-spline smoothing and the Friedman method. *Biomass and Bioenergy*, 33, 1435-1441. DOI: 10.1016/j.biombioe.2009.06.009.
- Zhou L., Yang H., Wu H., Wang M., Cheng D. (2013). Catalytic pyrolysis of rice husk by mixing with zinc oxide: characterization of bio-oil and its rheological behavior. *Fuel Processing Technology*, 106, 385-391. DOI: 10.1016/j.fuproc.2012.09.003
- Ziad Abu El-Rub. (2008). Biomass char as an in-situ catalyst for tar removal in gasification systems. *PhD thesis*, Twente University, Enschede, The Netherlands, ISBN: 978-90-365-2637-1.
- <https://www.bps.go.id/indicator/53/1498/1/luas-panen-produksi-dan-produktivitas-padi-menurut-provinsi.html>. Diakses pada: 12 April 2021, pk. 11:49 WIB