

REFERENCES

- [1] S. S. Punchihewa, C. Chandrakumar, and A. K. Kulatunga, "Adaptation of Biomass Based Thermal Energy Generation of Sri Lankan Manufacturing Sector: Paragon for Policy Development," *Procedia CIRP*, vol. 40, pp. 56–61, 2016.
- [2] H. and G. S. (Pvt.) Limited, "Final Report, Fuelwood Resource Survey of Sri Lanka, 2016," 2016.
- [3] T. H. Jayah, "Evaluation of a Downdraft Wood Gasifier for Tea Manufacturing in Sri Lanka," no. March, 2002.
- [4] T. Nussbaumer, "OVERVIEW OF BIOMASS COMBUSTION," in *Developments in Thermochemical Biomass Conversion*, 1997, pp. 1229–1243.
- [5] P. Basu, *Biomass gasification and pyrolysis*, vol. 5. 2012.
- [6] T. Klason, "Modelling of Biomass Combustion in Furnaces," Ph.D. dissertation, Division of Fluid Mechanics, Department of Energy Science, Lund Institute of Technology, Media Tryck AB, 2006.
- [7] N. Duffy, "Investigation of Biomass Combustion in Grate Furnaces using CFD," Ph.D. dissertation, Department of Mechanical and Biomedical Engineering, National University of Ireland, Galway, 2012.
- [8] N. T. M. Duffy and J. a. Eaton, "Investigation of factors affecting channelling in fixed-bed solid fuel combustion using CFD," *Combust. Flame*, vol. 160, no. 10, pp. 2204–2220, Oct. 2013.
- [9] R. Mehrabian, A. Shiehnejadhesar, R. Scharler, and I. Obernberger, "Multi-physics modelling of packed bed biomass combustion," *Fuel*, vol. 122, no. April, pp. 164–178, 2014.
- [10] B. Peters, E. Schröder, C. Bruch, and T. Nussbaumer, "Measurements and

particle resolved modelling of heat-up and drying of a packed bed,” *Biomass and Bioenergy*, vol. 23, no. 4, pp. 291–306, 2002.

- [11] U. Sand, J. Sandberg, J. Larfeldt, and R. Bel Fdhila, “Numerical prediction of the transport and pyrolysis in the interior and surrounding of dry and wet wood log,” *Appl. Energy*, vol. 85, no. 12, pp. 1208–1224, 2008.
- [12] B. Peters and C. Bruch, “Drying and pyrolysis of wood particles: experiments and simulation,” *J. Anal. Appl. Pyrolysis*, vol. 70, no. 2, pp. 233–250, Dec. 2003.
- [13] W. C. R. Chan, M. Kelbon, and B. B. Krieger, “Modelling and experimental verification of physical and chemical processes during pyrolysis of a large biomass particle,” *Fuel*, vol. 64, no. 11, pp. 1505–1513, 1985.
- [14] H. Lu, W. Robert, G. Peirce, B. Ripa, and L. L. Baxter, “Comprehensive study of biomass particle combustion,” *Energy and Fuels*, vol. 22, no. 4, pp. 2826–2839, 2008.
- [15] J. C. Wurzenberger, S. Wallner, H. Raupenstrauch, A.- Graz, and J. G. Khinast, “Thermal Conversion of Biomass: Comprehensive Reactor and Particle Modeling,” vol. 48, no. 10, 2002.
- [16] M. G. Grønli, “A theoretical and experimental study of the thermal degradation of biomass,” The Norwegian University of Science and Technology, 1996.
- [17] J. E. White, W. J. Catallo, and B. L. Legendre, “Biomass pyrolysis kinetics: A comparative critical review with relevant agricultural residue case studies,” *J. Anal. Appl. Pyrolysis*, vol. 91, no. 1, pp. 1–33, May 2011.
- [18] Y. B. Yang, J. Goodfellow, V. N. Sharifi, and J. Swithenbank, “Investigation of biomass combustion systems using CFD techniques: a parametric study of packed-bed burning characteristics,” *Prog. Comput. Fluid Dyn.*, vol. 6, pp. 262–271, 2006.

- [19] R. P. Van Der Lans, L. T. Pedersen, A. Jensen, and P. Glarborg, "Modelling and experiments of straw combustion in a grate furnace," vol. 19, pp. 199–208, 2000.
- [20] T. Juřena, "Numerical Modelling of Grate Combustion," *Vutium.Vutbr.Cz*, 2012.
- [21] Y. B. Yang, C. Ryu, J. Goodfellow, V. N. Sharifi, and J. Swithenbank, "Modelling Waste Combustion in Grate Furnaces," *Process Saf. Environ. Prot.*, vol. 82, no. 3, pp. 208–222, May 2004.
- [22] D. Kurz, U. Schnell, and G. Scheffknecht, "CFD simulation of wood chip combustion on a grate using an Euler–Euler approach," *Combust. Theory Model.*, vol. 16, no. 2, pp. 251–273, 2012.
- [23] S. Frigerio, H. Thunman, B. Leckner, and S. Hermansson, "Estimation of gas phase mixing in packed beds," *Combust. Flame*, vol. 153, no. 1–2, pp. 137–148, Apr. 2008.
- [24] C. Di Blasi, "Multi-phase moisture transfer in the high-temperature drying of wood particles," *Chem. Eng. Sci.*, vol. 53, no. 2, pp. 353–366, 1998.
- [25] M. a. Gómez, J. Porteiro, D. Patiño, and J. L. Míguez, "CFD modelling of thermal conversion and packed bed compaction in biomass combustion," *Fuel*, vol. 117, pp. 716–732, Jan. 2014.
- [26] R. Mehrabian *et al.*, "A CFD model for thermal conversion of thermally thick biomass particles," *Fuel Process. Technol.*, vol. 95, pp. 96–108, 2012.
- [27] L. A. W. Joseph H. Flynn, "A Quick Direct Method for The Determination of Activation neergy from Thermogravimetric Data," *Polym. Sci. Part - B, Polymer Phys.*, vol. 4, pp. 323–328, 1966.
- [28] A. K. Burnham and R. L. Braun, "Global Kinetic Analysis of Complex Materials," *Energy & Fuels*, vol. 13, no. 1, pp. 1–22, 1999.

- [29] K. Miura, “A New and Simple Method to Estimate $f(E)$ and $k_0(E)$ in the Distributed Activation Energy Model from Three Sets of Experimental Data,” *Energy & Fuels*, vol. 9, no. 2, pp. 302–307, 1995.
- [30] C. Diblasi, “Modeling chemical and physical processes of wood and biomass pyrolysis,” *Prog. Energy Combust. Sci.*, vol. 34, no. 1, pp. 47–90, Feb. 2008.
- [31] R. A. Yetter, “Combustion of Nonvolatile Fuels,” in *Combustion*, Fifth Edit., Elsevier, 1996, pp. 435–481.
- [32] H. K. Versteeg and W. Malalasekera, *An Introduction to Computational Fluid Dynamics THE FINITE VOLUME METHOD*, Second Edi. Pearson Education Limited, 2007.
- [33] S. Hermansson and H. Thunman, “CFD modelling of bed shrinkage and channelling in fixed-bed combustion,” *Combust. Flame*, vol. 158, no. 5, pp. 988–999, May 2011.
- [34] J. J. . Sastamoinen, R. Taipale, M. Horttanainen, and P. Sarkomaa, “Propagation of the ignition front in beds of wood particles,” *Combust. Flame*, vol. 123, no. 1–2, pp. 214–226, 2000.
- [35] Y. Yang, C. Ryu, a Khor, N. Yates, V. Sharifi, and J. Swithenbank, “Effect of fuel properties on biomass combustion. Part II. Modelling approach—identification of the controlling factors,” *Fuel*, vol. 84, no. 16, pp. 2116–2130, Nov. 2005.
- [36] H. Ström, S. Sasic, and H. Thunman, “Challenges and opportunities in the Eulerian approach to numerical simulations of fixed-bed combustion of biomass,” *Procedia Eng.*, vol. 102, pp. 1573–1582, 2015.
- [37] F. El-Mahallawy and S. E.-D. Habik, “Chapter 5 - Combustion, Heat Transfer, and Emission in Boilers and Furnaces,” *Fundam. Technol. Combust.*, pp. 499–746, 2002.

- [38] A. Shiehnejadhesar, R. Mehrabian, R. Scharler, G. M. Goldin, and I. Obernberger, “Development of a gas phase combustion model suitable for low and high turbulence conditions,” *Fuel*, vol. 126, pp. 177–187, 2014.
- [39] S. Chapela, J. Porteiro, and M. Costa, “Effect of the Turbulence-Chemistry Interaction in Packed-Bed Biomass Combustion,” *Energy and Fuels*, vol. 31, no. 9, pp. 9967–9982, 2017.
- [40] W. B. Age *et al.*, “Combustion 14.1,” 1950.
- [41] M. G. Carvalho and T. L. Farias, “MODELLING OF HEAT TRANSFER IN RADIATING and Combusting Systems,” *Mech. Eng.*, vol. 76, no. February, 1998.
- [42] R. Viskanta, “Computation of radiative transfer in combustion systems,” *Int. J. Numer. Methods Heat Fluid Flow*, vol. 18, pp. 415–442, 2008.
- [43] Y. B. Yang, Y. R. Goh, R. Zakaria, V. Nasserzadeh, and J. Swithenbank, “Mathematical modelling of MSW incineration on a travelling bed,” *Waste Manag.*, vol. 22, pp. 369–380, 2002.
- [44] Y. B. Yang, V. N. Sharifi, and J. Swithenbank, “Numerical Simulation of the Burning Characteristics of Thermally-Thick Biomass Fuels in Packed-Beds,” *Process Saf. Environ. Prot.*, vol. 83, no. 6, pp. 549–558, Nov. 2005.
- [45] D. Shin and S. Choi, “The combustion of simulated waste particles in a fixed bed,” *Combust. Flame*, vol. 121, pp. 167–180, 2000.
- [46] H. Thunman and B. Leckner, “Co-current and counter-current fixed bed combustion of biofuel—a comparison☆,” *Fuel*, vol. 82, no. 3, pp. 275–283, Feb. 2003.
- [47] Robert Scharler, Ingwald Obernberger, “Numerical Modelling of Biomass Grate Furnaces,” in *European Conference on Industrial Furnaces and Boilers*, 2000, vol. 1, no. 3, pp. 550–556.

- [48] A. Shiehnejadhesar, K. Schulze, R. Scharler, and I. Obernberger, "A new innovative CFD-based optimisation method for biomass combustion plants," *Biomass and Bioenergy*, vol. 53, pp. 48–53, Jun. 2013.
- [49] M. Miltner, A. Makaruk, M. Harasek, and A. Friedl, "CFD-modelling for the combustion of solid baled biomass," *5th Int. Conf. CFD Process Ind.*, no. December, pp. 1–6, 2006.
- [50] P. in C. F. Dynamics, "CFD simulation of ash deposit formation in fixed bed biomass furnaces and boilers," vol. 6, no. 4/5, pp. 248–261, 2006.
- [51] R. Scharler and I. Obernberger, "Deriving guidelines for the design of biomass grate furnaces with CFD analysis - a new multifuel-Low-NO_x furnace as example," *6th Int. Conf. Ind. Furn. Boil.*, no. x, p. 15, 2001.
- [52] C. Jordan and M. Harasek, "Improvement of a combustion unit based on a grate furnace for granular dry solid biofuels using CFD methods," *Heat Transf. Eng.*, vol. 31, no. 9, pp. 774–781, 2010.
- [53] J. Chaney, H. Liu, and J. Li, "An overview of CFD modelling of small-scale fixed-bed biomass pellet boilers with preliminary results from a simplified approach," *Energy Convers. Manag.*, vol. 63, pp. 149–156, Nov. 2012.
- [54] R. Bauer, M. Göllles, T. Brunner, N. Dourdoumas, and I. Obernberger, "Modelling of grate combustion in a medium scale biomass furnace for control purposes," *Biomass and Bioenergy*, vol. 34, no. 4, pp. 417–427, Apr. 2010.
- [55] J. Collazo, J. Porteiro, D. Patiño, and E. Granada, "Numerical modeling of the combustion of densified wood under fixed-bed conditions," *Fuel*, vol. 93, pp. 149–159, Mar. 2012.
- [56] Y. B. Yang, J. Goodfellow, Y. R. Goh, V. Nasserzadeh, and J. Swithenbank, "Investigation of Channel Formation Due to Random Packing in a Burning Waste Bed," *Process Saf. Environ. Prot.*, vol. 79, no. September, pp. 267–277,

2001.

- [57] S. Schulze, P. Nikrityuk, F. Compart, A. Richter, and B. Meyer, “Particle-resolved numerical study of char conversion processes in packed beds,” *Fuel*, vol. 207, pp. 655–662, 2017.
- [58] C. Bruch, B. Peters, and T. Nussbaumer, “Modelling wood combustion under fixed bed conditions,” *Fuel*, vol. 82, pp. 729–738, 2003.
- [59] M. R. Karim and J. Naser, “Numerical study of the ignition front propagation of different pelletised biomass in a packed bed furnace,” *Appl. Therm. Eng.*, vol. 128, pp. 772–784, 2018.
- [60] K. Goerner and T. Klasen, “Modelling, simulation and validation of the solid biomass combustion in different plants,” *Prog. Comput. Fluid Dyn. An Int. J.*, vol. 6, no. 4/5, p. 225, 2006.
- [61] J. Porteiro, J. Collazo, D. Patiño, E. Granada, J. C. M. Gonzalez, and J. L. Míguez, “Numerical modeling of a biomass pellet domestic boiler,” *Energy and Fuels*, vol. 23, no. 2, pp. 1067–1075, 2009.
- [62] M. A. Gómez, J. Porteiro, D. Patiño, and J. L. Míguez, “Fast-solving thermally thick model of biomass particles embedded in a CFD code for the simulation of fixed-bed burners,” *Energy Convers. Manag.*, vol. 105, pp. 30–44, 2015.
- [63] M. A. Gómez, J. Porteiro, D. De la Cuesta, D. Patiño, and J. L. Míguez, “Dynamic simulation of a biomass domestic boiler under thermally thick considerations,” *Energy Convers. Manag.*, vol. 140, pp. 260–272, 2017.
- [64] Y. Bin Yang, C. Ryu, A. Khor, V. N. Sharifi, and J. Swithenbank, “Fuel size effect on pinewood combustion in a packed bed,” *Fuel*, vol. 84, no. 16, pp. 2026–2038, 2005.

- [65] R. Johansson, H. Thunman, and B. Leckner, "Influence of intraparticle gradients in modeling of fixed bed combustion," *Combust. Flame*, vol. 149, no. 1–2, pp. 49–62, Apr. 2007.
- [66] Y. B. Yang, C. N. Lim, J. Goodfellow, V. N. Sharifi, and J. Swithenbank, "A diffusion model for particle mixing in a packed bed of burning solids," *Fuel*, vol. 84, no. 2–3, pp. 213–225, 2005.
- [67] B. J. Peters, "Heat Transfer in Fixed and Moving Packed Beds Predicted by the Extended Discrete Element Method," pp. 295–338.
- [68] S. K. Kær, "Numerical modelling of a straw-fired grate boiler," *Fuel*, vol. 83, no. 9, pp. 1183–1190, Jun. 2004.
- [69] R. Mehrabian and A. Shiehnejadhesar, "Numerical modelling of biomass grate furnaces with a particle based model," *10th Eur. Conf. Ind. Furn. Boil. – Porto, Port.*, no. April, pp. 1–14, 2015.
- [70] B. J. Peters, A. Dziugys, L. Raslavicius, and L. Narbutas, "Prediction of straw gasification on a forward acting grate," *CHISA 2012 - 20th Int. Congr. Chem. Process Eng. PRES 2012 - 15th Conf. PRES*, no. January, 2012.
- [71] X. Zhang, M. Xu, R. Sun, and L. Sun, "Study on Biomass Pyrolysis Kinetics," *J. Eng. Gas Turbines Power*, vol. 128, p. 493, 2006.
- [72] M. Van de Velden, J. Baeyens, A. Brems, B. Janssens, and R. Dewil, "Fundamentals, kinetics and endothermicity of the biomass pyrolysis reaction," *Renew. Energy*, vol. 35, no. 1, pp. 232–242, Jan. 2010.
- [73] D. Tapasvi, R. Khalil, G. Várhegyi, K. Q. Tran, M. Grønli, and Ø. Skreiberg, "Thermal decomposition kinetics of woods with an emphasis on torrefaction," *Energy and Fuels*, vol. 27, no. 10, pp. 6134–6145, 2013.
- [74] M. Hu *et al.*, "Thermogravimetric kinetics of lignocellulosic biomass slow pyrolysis using distributed activation energy model , Fraser – Suzuki

- deconvolution , and iso-conversional method,” *ENERGY Convers. Manag.*, vol. 118, pp. 1–11, 2016.
- [75] A. Khawam and D. R. Flanagan, “Complementary use of model-free and modelistic methods in the analysis of solid-state kinetics,” *J. Phys. Chem. B*, vol. 109, no. 20, pp. 10073–10080, 2005.
- [76] T. Martí-rosselló, J. Li, and L. Lue, “Kinetic models for biomass pyrolysis .,” pp. 4–7, 2016.
- [77] S. Vyazovkin and C. A. Wight, “Model-free and model-fitting approaches to kinetic analysis of isothermal and nonisothermal data,” *Thermochim. Acta*, vol. 340–341, pp. 53–68, Dec. 1999.
- [78] E. S. Freeman and B. Carroll, “The application of thermoanalytical techniques to reaction kinetics: the thermogravimetric evaluation of the kinetics of the decomposition of calcium oxalate monohydrate,” *J. Phys. Chem.*, vol. 62, no. 4, pp. 394–397, 1958.
- [79] A. W. A. Coats and J. P. J. P. Redfern, “Kinetic parameters from thermogravimetric data,” *Nature*, vol. 201, no. 4914, pp. 68–69, 1964.
- [80] K. Jayaraman, M. V. Kok, and I. Gokalp, “Thermogravimetric and mass spectrometric (TG-MS) analysis and kinetics of coal-biomass blends,” *Renew. Energy*, vol. 101, pp. 293–300, 2017.
- [81] C. Lu, W. Song, and W. Lin, “Kinetics of biomass catalytic pyrolysis,” *Biotechnol. Adv.*, vol. 27, no. 5, pp. 583–587, 2009.
- [82] Y. F. Huang, W. H. Kuan, P. T. Chiueh, and S. L. Lo, “A sequential method to analyze the kinetics of biomass pyrolysis.,” *Bioresour. Technol.*, vol. 102, no. 19, pp. 9241–6, Oct. 2011.
- [83] H. E. Kissinger, “Reaction Kinetics in Differential Thermal Analysis,” *Anal. Chem.*, vol. 29, no. 11, pp. 1702–1706, 1957.

- [84] J. Cai, W. Wu, and R. Liu, "An overview of distributed activation energy model and its application in the pyrolysis of lignocellulosic biomass," *Renew. Sustain. Energy Rev.*, vol. 36, pp. 236–246, 2014.
- [85] L. Gašparoviè, J. Labovský, and J. Markoš, "Calculation of Kinetic Parameters of the Thermal Decomposition of Wood by Distributed Activation Energy Model (DAEM)," vol. 26, no. 1, pp. 45–53, 2012.
- [86] L. Kuo-Chao, W. Keng-Tung, C. Chien-Song, and T. Wei-The, "A New Study on Combustion Behavior of Pine Sawdust Characterized by the Weibull Distribution," *Chinese J. Chem. Eng.*, vol. 17, no. 5, pp. 860–868, 2009.
- [87] K. Miura and T. Maki, "A Simple Method for Estimating $f(E)$ and $k_0(E)$ in the Distributed Activation Energy Model," *Energy & Fuels*, vol. 12, no. 5, pp. 864–869, 1998.
- [88] D. K. Shen, S. Gu, B. Jin, and M. X. Fang, "Thermal degradation mechanisms of wood under inert and oxidative environments using DAEM methods," *Bioresour. Technol.*, vol. 102, no. 2, pp. 2047–2052, 2011.
- [89] L. Li, X. Wang, J. Sun, Y. Zhang, and S. Qin, "Pyrolytic and kinetic analysis of two coastal plant species: *Artemisia annua* and *Chenopodium glaucum*," *Biomed Res. Int.*, vol. 2013, pp. 1–7, 2013.
- [90] J. L. Goldfarb and S. Ceylan, "Second-generation sustainability: Application of the distributed activation energy model to the pyrolysis of locally sourced biomass-coal blends for use in co-firing scenarios," *Fuel*, vol. 160, pp. 297–308, 2015.
- [91] B. B. Nyakuma, "Thermogravimetric and kinetic analysis of Melon (*Citrullus colocynthis* L.) seed husk using the distributed activation energy model," *Environ. Clim. Technol.*, vol. 15, no. 1, pp. 77–89, 2015.
- [92] A. Soria-Verdugo, E. Goos, J. Arrieta-Sanagustín, and N. García-Hernando, "Modeling of the pyrolysis of biomass under parabolic and exponential

- temperature increases using the Distributed Activation Energy Model,” *Energy Convers. Manag.*, vol. 118, no. June, pp. 223–230, 2016.
- [93] S. Wang *et al.*, “Kinetic modeling of biomass components pyrolysis using a sequential and coupling method,” *Fuel*, vol. 185, pp. 763–771, 2016.
- [94] K.U.C.Perera and M Narayana, “Kissinger method: The sequential approach and DAEM for kinetic study of Rubber and Gliricidia,” *J. Natl. Sci. Found. Sri Lanka*, vol. 46, no. 2, pp. 187–196, 2018.
- [95] D. Chen, Y. Zheng, and X. Zhu, “In-depth investigation on the pyrolysis kinetics of raw biomass. Part I: kinetic analysis for the drying and devolatilization stages,” *Bioresour. Technol.*, vol. 131, pp. 40–6, Mar. 2013.
- [96] M. Otero, L. F. Calvo, M. V Gil, A. I. García, and A. Morán, “Co-combustion of different sewage sludge and coal: a non-isothermal thermogravimetric kinetic analysis,” *Bioresour. Technol.*, vol. 99, no. 14, pp. 6311–9, Sep. 2008.
- [97] J. A. Nelder and R. Mead, “A Simplex Method for Function Minimization,” *Comput. J.*, vol. 7, no. 4, pp. 308–313, 1965.
- [98] J. Riyaphan *et al.*, “Variability in chemical and mechanical properties of Pará rubber (*Hevea brasiliensis*) trees,” *ScienceAsia*, vol. 41, no. 4, pp. 251–258, 2015.
- [99] H. Yang, R. Yan, H. Chen, D. H. Lee, and C. Zheng, “Characteristics of hemicellulose, cellulose and lignin pyrolysis,” *Fuel*, vol. 86, no. 12–13, pp. 1781–1788, 2007.
- [100] A. Inc., *ANSYS Fluent Theory Guide*, no. November. Southpointe 275, Technology Drive, Canonsburg, PA 15317, 2013.
- [101] V. Kurdyumov and E. Fernandez, “Heat transfer from a circular cylinder at low Reynolds numbers,” *J. Heat Transfer*, vol. 120, no. 1, pp. 72–75, 1998.
- [102] I. Marsi, “Numerical Simulation of the Thermal Degradation of Biomass –

- Approaches,” *Transform. Biomass Theory to Pract.*, pp. 285–303, 2014.
- [103] R. W. Nachenius, F. Ronsse, R. H. Venderbosch, and W. Prins, “Biomass Pyrolysis,” in *Chemical Engineering for Renewables Conversion*, 1st ed., vol. 42, Elsevier, 2013, pp. 83–89.
- [104] H. Ström and H. Thunman, “A computationally efficient particle submodel for CFD-simulations of fixed-bed conversion,” *Appl. Energy*, vol. 112, pp. 808–817, Dec. 2013.
- [105] B. . Babu and a. . Chaurasia, “Modeling for pyrolysis of solid particle: kinetics and heat transfer effects,” *Energy Convers. Manag.*, vol. 44, no. 14, pp. 2251–2275, Aug. 2003.
- [106] H. Ström and H. Thunman, “CFD simulations of biofuel bed conversion: A submodel for the drying and devolatilization of thermally thick wood particles,” *Combust. Flame*, vol. 160, no. 2, pp. 417–431, Feb. 2013.
- [107] M. Bellais, *Modelling of the pyrolysis of large wood particles*, vol. 79. 2007.
- [108] N. Fernando and M. Narayana, “A comprehensive two dimensional Computational Fluid Dynamics model for an updraft biomass gasifier,” *Renew. Energy*, vol. 99, pp. 698–710, 2016.
- [109] A. K. Sharma, “Equilibrium and kinetic modeling of char reduction reactions in a downdraft biomass gasifier: A comparison,” *Sol. Energy*, vol. 82, no. 10, pp. 918–928, Oct. 2008.
- [110] P. Energy, C. Sci, M. L. Hobbs, and P. T. Radulovic, “Pergamon COMBUSTION AND GASIFICATION OF COALS IN FIXED-BEDS Up d ,” *Prog. Energy Combust. Sci.*, vol. 19, pp. 505–586, 1994.
- [111] T. M. Ismail and M. A. El-Salam, “Parametric studies on biomass gasification process on updraft gasifier high temperature air gasification,” *Appl. Therm. Eng.*, vol. 112, pp. 1460–1473, 2017.

- [112] M. R. Karim and J. Naser, “Numerical Modelling of Solid Biomass Combustion: Difficulties in Initiating the Fixed Bed Combustion,” *Energy Procedia*, vol. 110, no. December 2016, pp. 390–395, 2017.
- [113] C. A. Forero-Núñez, S. Ramirez-Rubio, and F. E. Sierra-Vargas, “Analysis of charcoal gasification on a downdraft fixed bed gasifier by CFD modeling,” *Int. Rev. Mech. Eng.*, vol. 9, no. 4, pp. 382–390, 2015.
- [114] R. Gupta, P. Jain, and S. Vyas, “CFD Modeling and Simulation of 10KWE Biomass Downdraft Gasifier,” vol. 7, no. 4, pp. 0–2, 2017.
- [115] R. B. Bird, W. E. Stewart, and E. N. Lightfoot, *Transport Phenomena*. 2002.
- [116] D. J. Gunn, “Transfer of heat or mass to particles in fixed and fluidised beds,” *Int. J. Heat Mass Transf.*, vol. 21, no. 4, pp. 467–476, 1978.
- [117] S. R.K, *Chemical Engineering Design*, vol. 70, no. 3. 2004.
- [118] H. Zhou, A. D. Jensen, P. Glarborg, P. A. Jensen, and A. Kavaliauskas, “Numerical modeling of straw combustion in a fixed bed,” *Fuel*, vol. 84, no. 4, pp. 389–403, 2005.
- [119] J. S. Ryan and W. L. H. Hallett, “Packed bed combustion of char particles: Experiments and an ash model,” *Chem. Eng. Sci.*, vol. 57, no. 18, pp. 3873–3882, 2002.
- [120] Q. Xiong and S. C. Kong, “High-Resolution Particle-Scale Simulation of Biomass Pyrolysis,” *ACS Sustain. Chem. Eng.*, vol. 4, no. 10, pp. 5456–5461, 2016.
- [121] K. Kwiatkowski, K. Bajer, A. Celińska, M. Dudyński, J. Korotko, and M. Sosnowska, “Pyrolysis and gasification of a thermally thick wood particle - Effect of fragmentation,” *Fuel*, vol. 132, no. November, pp. 125–134, 2014.
- [122] H. Kubler, “Indicators and significance of air supply in the combustion of wood for heat,” *Wood Fiber Sci.*, vol. 23, no. 2, pp. 153–164, 1991.

- [123] A. D. Hughes, "Fuelling around the boiler room," *For. Prod. J.*, vol. 26, pp. 33–38, 1976.
- [124] C. Yin, L. a. Rosendahl, and S. K. Kær, "Grate-firing of biomass for heat and power production," *Prog. Energy Combust. Sci.*, vol. 34, no. 6, pp. 725–754, Dec. 2008.
- [125] C. Ryu, Y. Bin Yang, A. Khor, N. E. Yates, V. N. Sharifi, and J. Swithenbank, "Effect of fuel properties on biomass combustion: Part I. Experiments - Fuel type, equivalence ratio and particle size," *Fuel*, vol. 85, no. 7–8, pp. 1039–1046, 2006.
- [126] J. F. Pérez, A. Melgar, and F. V. Tinaut, "Modeling of fixed bed downdraft biomass gasification: Application on lab-scale and industrial reactors," no. April 2013, pp. 319–338, 2014.
- [127] S. Suranani and V. R. Goli, "Fuel Particle Size Effect on Performance of Fluidized Bed Combustor Firing Ground Nutshells," *Int. J. Chem. Eng. Appl. Vol. 3, No. 2, April 2012 Fuel*, vol. 3, no. 2, pp. 147–151, 2012.
- [128] K. M. Bryden and K. W. Ragland, "Numerical Modeling of a Deep, Fixed Bed Combustor," *Energy & Fuels*, vol. 10, no. 2, pp. 269–275, 1996.
- [129] J. K. A. T. Rajika and M. Narayana, "Modelling and simulation of wood chip combustion in a hot air generator system," *Springerplus*, vol. 5, no. 1, 2016.