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DAFTAR PUSTAKA

Aliyu, M., Nemitallah, M. A. and Habib, M. A. (2024) 'Impact of *excess air* factor on performance and NOx emissions of an industrial water tube boiler with hydrogen enrichment', *Engineering Applications of Computational Fluid Mechanics*. Taylor & Francis, 18(1), p. 2431102. doi: 10.1080/19942060.2024.2431102.

Álvarez-Bermúdez, C., Chapela, S., Gómez, M. A. and Porteiro, J. (2025) 'CFD simulation of a 4 MW biomass grate furnace using an Eulerian fixed-bed model: Validation of in-bed and *freeboard* results', *Fuel*, 387(January). doi: 10.1016/j.fuel.2025.134378.

Amaral, S. S., de Carvalho, J. A., Costa, M. A. M. and Pinheiro, C. (2016) 'Particulate matter *Emission Factor*s for biomass combustion', *Atmosphere*, 7(11), pp. 1–25. doi: 10.3390/atmos7110141.

Azarya, E. A. (2024) *Studi Numerik Pengaruh Excess air terhadap Emisi Karbon Dioksida dan Temperatur Pembakaran Ampas Tebu dalam Fixed grate furnace.*

Azarya, E. A., Nugraha, M. G. and Saptoadi, H. (2025) 'Evaluation of Catalytic Converter Utilization in Biomass Combustion Flue Gas Treatment', *Karya International Journal of Biofuel and Bioenergy*, 1(1), pp. 48–57. doi: 10.37934/kijbb.1.1.4857.

Basu, P. (2013) 'Biomass Gasification, Pyrolysis and Torrefaction: Practical Design and Theory', *Biomass Gasification, Pyrolysis and Torrefaction: Practical Design and Theory*, pp. 1–530.

Bindig, R., Butt, S., Hartmann, I., Matthes, M. and Thiel, C. (2012) 'Application of heterogeneous catalysis in small-scale biomass combustion systems', *Catalysts*, 2(2), pp. 223–243. doi: 10.3390/catal2020223.

Le Blond, J. S., Woskie, S., Horwell, C. J. and Williamson, B. J. (2017) 'Particulate matter produced during commercial sugarcane harvesting and processing: A respiratory health hazard?', *Atmospheric Environment*. Elsevier Ltd, 149, pp.

UNIVERSITAS
GADJAH MADA
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34–46. doi: 10.1016/j.atmosenv.2016.11.012.

Campbell, C. (1963) 'Combustion Efficiency', *The Sports Car Engine*, pp. 170–191. doi: 10.1007/978-1-4899-7204-0_9.

Çengel, Y. A. (2014) *Thermodynamics: An Engineering Approach*. McGraw-Hill Education (McGraw-Hill series in mechanical engineering). Available at: https://books.google.co.id/books?id=c1qFoAEACAAJ.

Cicilia Kemunto, M., Wang, E., Gou, X., Imran Shah, A. and Odhiambo Adwek, G. (2018) 'Fixed Bed Combustion of Biomass: Particulate Matter Mitigation by Optimising Temperature and Fuel Particle Size', *IOP Conference Series: Earth and Environmental Science*, 168(1). doi: 10.1088/1755-1315/168/1/012038.

Demirbas, A. (2007) 'Combustion of Biomass', *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*. Taylor & Francis, 29(6), pp. 549–561. doi: 10.1080/009083190957694.

Deng, M., Li, P., Shan, M. and Yang, X. (2020) 'Optimizing supply airflow and its distribution between primary and secondary air in a forced-draft biomass pellet stove', *Environmental Research*. Elsevier Inc., 184(July 2019), p. 109301. doi: 10.1016/j.envres.2020.109301.

Djamal, M., P., H., Satria, E. and Febrina, M. (2019) 'Konverter Asap Ramah Lingkungan Berbasis Limbah Arang dan Ampas Tebu', *Risalah Fisika*, 3(1), pp. 5–8.

Elorf, A. and Sarh, B. (2019) 'Case Studies in Thermal Engineering *Excess air* ratio effects on flow and combustion caracteristics of pulverized biomass (olive cake)', *Case Studies in Thermal Engineering*. Elsevier Ltd, 13(November 2018), p. 100367. doi: 10.1016/j.csite.2018.100367.

Faisal, M. (2025) 'Karakteristik Pembakaran Beberapa Jenis Biomassa dalam Fluidized Bed Boiler Combustion Characteristics of Several Biomasses in Fluidized Bed Boiler', 10(1).

Firmansyah, M. S. and Nurhayati, S. F. (2024) 'Pemanfaatan Briket Arang Tempurung Kelapa sebagai Energi Alternatif', *Determinasi: Jurnal Penelitian*

Studi Komparasi Pengaruh Konverter Katalitik, MetodeExcess AirdanAir Stagingterhadap Karakteristik
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Ekonomi Manajemen dan Akuntansi, 2(2), pp. 118–123. doi: 10.23917/determinasi.v2i2.227.

Glushkov, D. O., Nyashina, G. S., Anand, R. and Strizhak, P. A. (2021) 'Composition of gas produced from the direct combustion and pyrolysis of biomass', *Process Safety and Environmental Protection*. Elsevier, 156, pp. 43–56. doi: 10.1016/j.psep.2021.09.039.

Hartulistiyoso, E., Mawardi, H. and Yulianto, M. (2024) 'Studi Teoritis Karakteristik Termal Pembakaran Biomassa Tanaman Energi pada Berbagai Kondisi Udara dalam Tungku Adiabatik', *Jurnal Ilmiah Rekayasa Pertanian dan Biosistem*, 12, pp. 254–271. doi: 10.29303/jrpb.v12i2.659.

Houshfar, E., Skreiberg, Ø., Todorović, D., Skreiberg, A., Løvås, T., Jovovic, A. and Sørum, L. (2012) 'NOx emission reduction by staged combustion in grate combustion of biomass fuels and fuel mixtures', *Fuel*, 98, pp. 29–40. doi: 10.1016/j.fuel.2012.03.044.

Junejo, A., Al-Abdeli, Y. M. and Porteiro, J. (2024) 'Role of *Air Staging* in a Batch-Type Fixed Bed Biomass Combustor under Constant Primary Air', *Journal of Thermal Science*, 33(1), pp. 284–299. doi: 10.1007/s11630-023-1869-9.

Kabir Ahmad, R., Anwar Sulaiman, S., Yusup, S., Sham Dol, S., Inayat, M. and Aminu Umar, H. (2022) 'Exploring the potential of coconut shell biomass for charcoal production', *Ain Shams Engineering Journal*. Faculty of Engineering, Ain Shams University, 13(1), p. 101499. doi: 10.1016/j.asej.2021.05.013.

Kementerian ESDM (2023) *Potensi Biomassa Menjanjikan, Indonesia Prediksi Hasilkan Listrik Setara 56,97 GW*.

Kementrian Energi dan Sumber Daya Mineral (2023) *Potensi Biomassa Menjanjikan, Indonesia Prediksi Hasilkan Listrik Setara 56,97 GW*. Available at: https://www.esdm.go.id/id/media-center/arsip-berita/potensi-biomassa-menjanjikan-indonesia-prediksi-hasilkan-listrik-setara-5697-gw?

Khodaei, H., Al-Abdeli, Y. M., Guzzomi, F. and Yeoh, G. H. (2015) 'An overview of processes and considerations in the modelling of fixed-bed biomass

UNIVERSITAS
GADJAH MADA
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

combustion', *Energy*. Elsevier Ltd, 88, pp. 946–972. doi: 10.1016/j.energy.2015.05.099.

Khodaei, H., Guzzomi, F., Patiño, D., Rashidian, B. and Yeoh, G. H. (2017) '*Air Staging* strategies in biomass combustion-gaseous and particulate emission reduction potentials', *Fuel Processing Technology*. Elsevier B.V., 157, pp. 29–41. doi: 10.1016/j.fuproc.2016.11.007.

Kritsanaviparkporn, E., Baena-Moreno, F. M. and Reina, T. R. (2021) 'Catalytic Converters for Vehicle Exhaust: Fundamental Aspects and Technology Overview for Newcomers to the Field', *Chemistry (Switzerland)*, 3(2), pp. 630–646. doi: 10.3390/chemistry3020044.

Lamberg, H., Sippula, O., Tissari, J. and Jokiniemi, J. (2011) 'Effects of *Air Staging* and Load on Fine-Particle and Gaseous Emissions from a Small-Scale Pellet Boiler', *Energy & Fuels*. American Chemical Society, 25(11), pp. 4952–4960. doi: 10.1021/ef2010578.

Leach, F., Kalghatgi, G., Stone, R. and Miles, P. (2020) 'The scope for improving the efficiency and environmental impact of internal combustion engines', *Transportation Engineering*. Elsevier Ltd, 1(May). doi: 10.1016/j.treng.2020.100005.

Li, X., Rheinheimer, W., Dou, L. and Wang, H. (2021) 'Scripta Materialia Formation of liquid phase and nanostructures in flash sintered ZnO', *Scripta Materialia*. Elsevier Ltd, 195, p. 113719. doi: 10.1016/j.scriptamat.2020.113719.

Marangwanda, G. T., Madyira, D. M. and Babarinde, T. O. (2020) 'Combustion models for biomass: A review', *Energy Reports*. Elsevier Ltd, 6, pp. 664–672. doi: 10.1016/j.egyr.2019.11.135.

McGowan, T. F. and Santoleri, J. J. (2015) *COMBUSTION FLAMES AND APPLICATIONS*.

Medina, P., Mora, A. and Beltrán, A. (2024) 'Combustion efficiency and CO / NO *X* emissions for a biomass plancha-type stove : Effect of the air excess ratio', *Thermal Science and Engineering Progress*. Elsevier Ltd, 48(April 2023), p.

UNIVERSITAS
GADJAH MADA
**Studi Komparasi Pengaruh Konverter Katalitik, MetodeExcess AirdanAir Stagingterhadap Karakteristik
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

102411. doi: 10.1016/j.tsep.2024.102411.

Meyers, R. A. and Kaltschmitt, M. (2019) 'Energy from Organic Materials (Biomass)', *Springer New York*. doi: https://doi.org/10.1007/978-1- 4939-7813-7.

Muslih Nasution (2022) 'Bakar BSumber MYang EDiperlukan SKehidupan DHari SNasution MKunci KKalor NKimia R', *Cetak) Journal of Electrical Technology*, 7(1), pp. 29–33.

Nugraha, M. G., Sharfan, A., Prakoso, V. S. Y., Hidayat, M. and Saptoadi, H. (2024) 'Particulate matter emission in agricultural biomass residue combustion', *Global Journal of Environmental Science and Management*, 10(3), pp. 1047–1066. doi: 10.22034/gjesm.2024.03.08.

Nussbaumer, T., Klippel, N. and Johansson, L. (2008) 'Survey on measurements and *Emission Factor*s on particulate matter biomass combustion in IEA Countries', *16th European Biomass Conference and Exhibition*, (June), p. 40.

Obaidullah, M., Svend, B. and Jacques, D. R. (2018) 'Investigation of Optimal *Dilution Ratio* from a Dilution Tunnel Using in Particulate Matter Measurement', *International Journal of Engineering Technology and Sciences*, 5(1), pp. 17–33. doi: 10.15282/ijets.v5i1.2802.

Paces, N. and Kozek, M. (2011) 'Modeling of a grate-firing biomass furnace for real-time application', *IMCIC 2011 - 2nd International Multi-Conference on Complexity, Informatics and Cybernetics, Proceedings*, 1, pp. 357–362.

Patel, B. (2012) 'Biomass Characterization and its Use as Solid Fuel for Combustion', *Iranica Journal of Energy & Environment*, 3(2), pp. 123–128. doi: 10.5829/idosi.ijee.2012.03.02.0071.

Pérez-Orozco, R., Patiño, D., Porteiro, J. and Míguez, J. L. (2020) 'Novel test bench for the active reduction of biomass particulate matter emissions', *Sustainability (Switzerland)*, 12(1). doi: 10.3390/SU12010422.

Prakoso, V. S. Y. (2023) *Analisis Pengaruh Excess air terhadap Reduksi Emisi dan Karakteristik Pembakaran Ampas Tebu dalam Fixed grate furnace.*

Pusat Data dan Sistem Informasi Pertanian (2023) 'Outlook Komoditas Pertanian

UNIVERSITAS
GADJAH MADA
**Studi Komparasi Pengaruh Konverter Katalitik, MetodeExcess AirdanAir Stagingterhadap Karakteristik
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Tebu', *Pusat Data dan Sistem Informasi Pertanian*, pp. 1–2.

Ramli, S. (2010) *Petunjuk praktis manajemen kebakaran: fire management*. Jakarta: Dian Rakyat.

Rashidian, B., Al-Abdeli, Y. M., Patiño, D., Guzzomi, F. G. and Yeoh, G. H. (2016) 'Effect of *freeboard* deflectors in the fixed bed combustion of biomass', *Applied Thermal Engineering*. Elsevier Ltd, 103, pp. 543–552. doi: 10.1016/j.applthermaleng.2016.04.140.

Regyana, J. H., Stefi Anastasya, Mua, R. M. and Renita, C. (2025) 'Pemanfaatan limbah padat ampas tebu sebagai bahan bakar pembangkit listrik', *Jurnal Teknik Industri Terintegrasi (JUTIN)*, 8(1).

Reichert, G., Schmidl, C., Haslinger, W., Stressler, H., Sturmlechner, R., Schwabl, M., Wöhler, M. and Hochenauer, C. (2018) 'Catalytic efficiency of oxidizing honeycomb catalysts integrated in firewood stoves evaluated by a novel measuring methodology under real-life operating conditions', *Renewable Energy*, 117(2018), pp. 300–313. doi: 10.1016/j.renene.2017.10.065.

Ridhuan, K., Irawan, D. and Inthifawzi, R. (2019) 'Pyrolysis Combustion Process with Biomass Type and Characteristics of The Liquid Smoke Produced', *Turbo*, 8(1), pp. 69–78.

Ryšavý, J., Horák, J., Hopan, F., Kuboňová, L., Krpec, K., Molchanov, O., Garba, M. and Ochodek, T. (2022) 'Influence of flue gas parameters on conversion rates of honeycomb catalysts', *Separation and Purification Technology*, 278(July 2021). doi: 10.1016/j.seppur.2021.119491.

Ryšavý, J., Horák, J., Kubonová, L., Jaroch, M., Hopan, F., Krpec, K. and Kubesa, P. (2021) 'Beech leaves briquettes' and standard briquettes' combustion: Comparison of flue gas composition', *International Journal of Energy Production and Management*, 6(1), pp. 32–44. doi: 10.2495/EQ-V6-N1-32-44.

Saidal Siburian, M. M. M. M. and Efriza, S. I. P. M. S. (2020) *Pencemaran Udara dan Emisi Gas Rumah Kaca*. Kreasi Cendekia Pustaka. Available at: https://books.google.co.id/books?id=FRsMEAAAQBAJ.

UNIVERSITAS
GADJAH MADA
**Studi Komparasi Pengaruh Konverter Katalitik, MetodeExcess AirdanAir Stagingterhadap Karakteristik
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Santosh Kumar, G., Badulla, S., Nagaraju, J., Venkatesh, P. H. J., Narasimhulu, G. and Srinivasa Rao, V. (2023) 'Design and analysis of 3-way catalytic converter using CFD', *Materials Today: Proceedings*. Elsevier Ltd, 115, pp. 193–198. doi: 10.1016/j.matpr.2023.07.215.

Sarante, J. (2024) 'Energi Baru dan Terbarukan (EBT) Mendukung Pertahanan Negara', *Kementrian Pertahanan Republik Indonesia*, pp. 2–13. Available at: https://www.kalderanews.com/2020/05/apa-sih-bedanya-energi-baru-dan-terbarukan/.

Sehabudin, S. (2011) 'PENAMBATAN KARBON DIOKSIDA DAN PENGARUH DENSITAS ALGA AIR TAWAR (CHLORELLA SP.) TERHADAP PENGURANGAN EMISI KARBON DIOKSIDA', *Forest Ecology and Management*, 3(1), p. 1. Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-21244502256&partnerID=40&md5=bbe5799f53da1f737ee7a31c40a4109f%0Ahttps://doi.org/10.1093/forestscience/25.1.59%0Ahttp://dx.doi.org/10.1080/10549811.2016.1263575%0Ahttp://dx.doi.org/10.1016/j.sajb.2015.09.0.

Siegmund, T., Gollmer, C., Scherzinger, M. and Kaltschmitt, M. (2024) 'A review of CO emissions during solid biofuel combustion – Formation mechanisms and fuel-related reduction measures', *Journal of the Energy Institute*. Elsevier Ltd, 116(July), p. 101762. doi: 10.1016/j.joei.2024.101762.

Simões Amaral, S., Andrade de Carvalho, J., Martins Costa, M. A. and Pinheiro, C. (2016) 'Particulate Matter *Emission Factor*s for Biomass Combustion', *Atmosphere*, p. 141. doi: 10.3390/atmos7110141.

Sipayung, R. S. G. S. (2023) *Peningkatan Polusi Udara di Indonesia: Perspektif Ekonomi Berdasarkan Teori Freakonomics*, *Sekretariat Kabinet Republik Indonesia*. Available at: https://setkab.go.id/peningkatan-polusi-udara-di-indonesia-perspektif-ekonomi-berdasarkan-teori-freakonomics.

Su, X., Ma, L., Fang, Q., Yin, C., Zhuang, H., Qiao, Y., Zhang, C. and Chen, G. (2024) 'Optimizing biomass combustion in a 130 t/h grate boiler: Assessing gas-phase reaction models and primary air distribution strategies', *Applied*

UNIVERSITAS
GADJAH MADA
**Studi Komparasi Pengaruh Konverter Katalitik, MetodeExcess AirdanAir Stagingterhadap Karakteristik
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Thermal Engineering. Elsevier Ltd, 238(September 2023), p. 122043. doi: 10.1016/j.applthermaleng.2023.122043.

Sudia, B. and Samhuddin, S. (2021) 'POTENSI TEMPURUNG KELAPA SEBAGAI SUMBER ENERGI TERBARUKAN DI KABUPATEN BOMBANA PROVINSI SULAWESI TENGGARA', *Dinamika : Jurnal Ilmiah Teknik Mesin*, 13, p. 9. doi: 10.33772/djitm.v13i1.22043.

TSI (2003) *Combustion Efficiency and Excess air*, *Combustion Analysis Basics 19*. Available at: https://www.engineeringtoolbox.com/boiler-combustion-efficiency-d_271.html.

Väätäinen, S., Leskinen, J., Lamberg, H., Koponen, H., Kortelainen, M., Sippula, O. and Tissari, J. (2023) 'The effects of *Air Staging* and combustion air control on black carbon and other particulate and gaseous emissions from a sauna stove', *Fuel*, 331(June 2022). doi: 10.1016/j.fuel.2022.125769.

Wahyuni, E. T. and Prasetyo, I. (2002) 'Pemanfaatan Limbah Tempurung Kelapa Sebagai', 03, pp. 105–114.

Zhang, L., Xu, C. (Charles) and Champagne, P. (2010) 'Overview of recent advances in thermo-chemical conversion of biomass', *Energy Conversion and Management*. Elsevier Ltd, 51(5), pp. 969–982. doi: 10.1016/j.enconman.2009.11.038.

Yahya, A. M., Adeleke, A. A., Nzerem, P., Ikubanni, P. P., Ayuba, S., Rasheed, H. A., Gimba, A., Okafor, I., Okolie, J. A., & Paramasivam, P. (2023). *Comprehensive Characterization of Some Selected Biomass for Bioenergy Production*. ACS Omega, 8(46), 43771–43791. DOI: 10.1021/acsomega.3c05656

BPS 2025, NERACA ARUS ENERGI DAN NERACA EMISI GAS RUMAH KACA INDONESIA 2019–2023