

## DAFTAR PUSTAKA

- Agus, Ryadin, A.U. and Masakin, A. (2022) *PERANCANGAN REVERSE FLOW PORTABLE FILTER PADA AKUARIUM*.
- Ahmed, T.H. (2019) *Reservoir Engineering Handbook*. Cambridge, MA: Gulf Professional Publishing.
- Aji Nugroho, A.P. (2015) *Analisa Kehilangan Energi pada Fire Tube Boiler Kapasitas 10 Ton*, 4.
- Alberta Infrastructure and Transportation (2006) *Water Treatment Program Training Manual*.
- Al-Arkawazi, S.A. (2019) *Analyzing and predicting the relation between Air–Fuel Ratio (AFR), lambda ( $\lambda$ ) and the exhaust emissions percentages and values of gasoline-fueled vehicles using versatile and portable emissions measurement system tool*, *SN Applied Sciences*, 1(11). doi:10.1007/s42452-019-1392-5.
- Al-Zgoul, B. (2016) *The Economic Thickness of Insulation for Steam Process Distribution Pipelines*, 6.
- Altret Industries Private Limited, A. (2022) *BLOWDOWN CALCULATION FOR BOILER*.
- Amaral Madeira, A. (2020) *Major and minor head losses in a hydraulic flow circuit: Experimental measurements and a moody's diagram application*, *Eclética Química Journal*, 45(3), pp. 47–56. doi:10.26850/1678-4618eqj.v45.3.2020.p47-56.
- American Boiler Manufacturers Association (2005) *Boiler Water Quality Requirements and Associated Steam Quality for Industrial/Commercial and Institutional Boiler*.
- A. O., A. et al. (2016) *Evaluation of nutritive value of mixture of Wheatbran and abattoir blood (Wheatblood)*, *Universal Journal of Agricultural Research*, 4(4), pp. 121–124. doi:10.13189/ujar.2016.040402.
- Awdhesh and Sinha, S. (2018) *STUDY OF EFFICIENCY IMPROVEMENT OF BOILER WITH THE USE OF PREHEATED FUEL*, 9(9), pp. 580–589.
- Babji, M. et al. (2017) *Performance and Analysis Of Modern Soot Blower By Improving Boiler Efficiency Of A Thermal Power Plant*, 5(3).

- Boilermech. (2023). *Boiler Water Tube*. <https://www.boilermech.com/industrial-biomass-boiler.html>
- Douglas, J.F. et al. (2005) *Fluid Mechanics Fifth Edition*.
- Dwivedi, V.K. et al. (2021) *Improvement in energy efficiency & heat loss minimization during boiler operation: A case study*, IOP Conference Series: Materials Science and Engineering, 1116(1), p. 012044. doi:10.1088/1757-899x/1116/1/012044.
- Elonka, S.M. and Kohan, A.L. (2008) *Standard Boiler Operators Question and Answer*.
- Ertl, P. et al. (2016) 'Feeding of wheat bran and sugar beet pulp as sole supplements in high-forage diets emphasizes the potential of dairy cattle for human food supply', *Journal of Dairy Science*, 99(2), pp. 1228–1236. doi:10.3168/jds.2015-10285.
- Fox, R. and McDonald, A. (1998) *Introduction to Fluid Mechanics*, 5th edition, John Wiley & Sons, Inc., New York
- Giurca, I. (2015) *Calculation of heat loss through the pipes of the Interior Central Heating System*, *Journal of Applied Engineering Sciences*, 5(2), pp. 29–36. doi:10.1515/jaes-2015-0018.
- Grundfos. (2023). *Feed Water Pump*. <https://product-selection.grundfos.com/categories/pumps?tab=categories>
- Grundfos. (2023). *Softener Pump*. <https://product-selection.grundfos.com/categories/water-treatment-systems?tab=categories>
- Gopalakrishnan, S. and Makesh, M. (2019) *Design And Analysis Of Fire Tube Boiler With Heat Flow Analysis*, 8(7).
- Harsh, Y. et al. (2020) *To Increase the Efficiency of Boiler through Various Techniques*, 2(2), pp. 289–293.
- Hatenboer Water. (2023). *Water Test Kit*. <https://www.hatenboer-water.com/maritime-test-kit/>
- Heselton, K. (2005) *Boiler Operator's Handbook*.
- Holman, J.P. (2002) *Heat Transfer*.
- Ibrahim, R.I., Humod, A.T. and Essa, N.A. (2020) *Design and implementation of an automatic control system to avoid fouling in pipes with blow down heat*

- recovery in steam boilers, IOP Conference Series: Materials Science and Engineering, 765(1), p. 012007. doi:10.1088/1757-899x/765/1/012007.*
- Kharisma, A.A. and Budiman, A. (2020) *PERHITUNGAN EFISIENSI (EFFICIENCY) MESIN BOILER JENIS FIRE – TUBE MENGGUNAKAN METODE DIRECT DAN INDIRECT UNTUK PRODUK BUTIRAN – BUTIRAN PELET*, 14.
- Kocabas, C. and Savaş, A.F. (2021) *Reducing energy losses of steam boilers caused by blowdown with using the FMEA method, Smart Science*, 9(2), pp. 70–79. doi:10.1080/23080477.2021.1898794.
- Savas, A. and Kocabas, C. (2023) *Reducing deaerator-related energy losses in steam boilers, Thermal Science*, 27(2 Part A), pp. 1313–1324. doi:10.2298/tsci220616128s.
- Koochakinia, S., Ebrahimi-Moghadam, A. and Deymi-Dashtebayaz, M. (2022) *Techno-environmental analyses and optimization of a utility boiler based on Real Data, Sustainability*, 14(5), p. 2592. doi:10.3390/su14052592.
- Komariah, L.N. et al. (2013) *Emission factors of biodiesel combustion in industrial boiler: A comparison to fossil fuel.*
- Lahijani, A.M. et al. Supeni, E.E. and Kalantari, F. (2018) *A REVIEW OF INDIRECT METHOD FOR MEASURING THERMAL EFFICIENCY IN FIRE TUBE STEAM BOILERS*, 1(1825–1832).
- Ministry Of Energy and Mineral Resources Republic of Indonesia (2017) *HANDBOOK OF ENERGY & ECONOMIC STATISTICS OF INDONESIA FINAL EDITION.*
- United Nations Industrial Development Organization (2016) *MANUAL FOR INDUSTRIAL STEAM SYSTEMS ASSESSMENT AND OPTIMIZATION.*
- Office of Energy Efficiency and Renewable Energy, Department of Energy. (2023) *Energy Conservation Program: Energy Conservation Standards for Commercial Packaged Boilers.*
- Patro, B. (2015) *Efficiency studies of combination tube boilers.*
- Purseth, S. and Dansena, J. (2021) *PERFORMANCE ANALYSIS AND EFFICIENCY IMPROVEMENT OF BOILER- A REVIEW*, 5(12), pp. 326–331.
- Putra, M.F., Wijayanto, D.S. and Pambudi, N.A. (2019) *Analisis Performa Boiler Basuki Berdasarkan Rasio Antara Bahan Bakar Dan Steam Di pt. Indo*

- Acidatama Tbk., NOZEL Jurnal Pendidikan Teknik Mesin, 1(2), p. 80.*  
 doi:10.20961/nozel.v1i1.28272.
- Raut, S.M., Khumbare, S.B. and Thakur, K.C. (2014) *Energy Performance Assessment of Boiler at P.S.S.K. Ltd, Basmathnagar, Maharashtra State*, 4(12).
- Rayaprolu, K. (2009) *BOILERS for POWER and PROCESS*.
- Sarapardeh, H.A. et al. (2023) *Thermal methods*. Amsterdam: Gulf Professional Publishing.
- Savaş, A.F. and Kocababaş, C. (2022) *Reducing surface heat loss in steam boilers*, *Open Chemistry*, 20(1), pp. 1458–1466. doi:10.1515/chem-2022-0241.
- Sullivan, G.P. et al. (2010) *Operations & Maintenance Best Practices A Guide to Achieving Operational Efficiency*.
- Spirax Sparco (2017) *Design of Fluid Systems Steam Utilization*.
- Tanwil, E. (2021) *Boiler Basics, Operation and Maintenance*.
- Thabit, Q., Nassour, A. and Nelles, M. (2022) *Flue Gas Composition And Treatment Potential Of A Waste Incineration Plant*, *Applied Sciences*, 12(10), p. 5236. doi:10.3390/app12105236.
- Trojan, M. et al. (2023) *Thermal-flow calculations for a thermal waste treatment plant*, *IOP Conference Series: Earth and Environmental Science*, 1128(1), p. 012003. doi:10.1088/1755-1315/1128/1/012003.
- White, F. (2011) *Fluid mechanics*. McGraw-Hill Higher Education.
- Wohlfarth, R. and Kohan, A.L. (2021) *Boiler Operator's Book Fifth Edition*
- Yin, W. et al. (2021) *Experimental investigation on steam flow loss characteristics in microchannels*, *AIP Advances*, 11(2). doi:10.1063/5.0040369.
- Zaman, M.R. and Sinaga, N. (2021) *EVALUASI KERUGIAN TERMAL PADA PEMBANGKIT TENAGA BATUBARA 660 MW MENGGUNAKAN METODE EFISIENSI TIDAK LANGSUNG*, 19.

Lampiran 1 *Master* Tabel Penelitian

Parameter	Hari		
	1	2	3
<b>Data PT. Eastern Pearl Flour Mills</b>			
<b>Parameter Boiler</b>			
Tekanan produk uap (kg/cm <sup>2</sup> /h)	7,32	7,54	7,20
Laju Konsumsi Bahan Bakar (kg/h)	88,57	100,42	96,04
GCV Biosolar (kkal/h)	10.702	10.702	10.702
Karbon (C) (wt%)	81,8	81,8	81,8
Oksigen bahan bakar (O <sub>2</sub> ) (wt%)	5,68	5,68	5,68
Nitrogen (N) (wt%)	0	0	0
Sulfur (S) (wt%)	0,073	0,073	0,073
Hidrogen (H <sub>2</sub> ) (wt%)	12,4	12,4	12,4
Oksigen gas buang (O <sub>2</sub> ) (%)	11,6	11,6	11,6
Karbondioksida (CO <sub>2</sub> ) (%)	6,16	6,16	6,16
Nitrogendioksida (NO <sub>2</sub> ) (%)	0,5	0,5	0,5
Tempratur gas buang (Tf) (°C)	231,2	229,8	233,4
Temperatur ruangan (Ta) (°C)	31,3	30,6	31,7
Kalor spesifik gas buang (cpf) (kkal/kg°C)	1,02	1,02	1,02
Kalor spesifik uap (cps) (kkal/kg°C)	0,25	0,25	0,25
Kelembaban (kg/kg dry air)	0,021	0,021	0,021
Laju Massa Uap (kg/h)	934,35	956,77	921,82
TDS air umpan (S) (PPM)	61	61	61
TDS air boiler (C <sub>a</sub> ) (PPM)	415	415	415
Max. TDS rekomendasi (C) (PPM)	3000	3000	3000
<b>Parameter Pipa Boiler ke Boiler Header</b>			
Massa jenis fluida ( $\rho$ ) (kg/m <sup>3</sup> )	3,748	3,856	3,695
Kecepatan fluida dalam pipa (V) (m/s)	3,769	3,763	3,711
Viskositas dinamika fluida ( $\mu$ ) (N/m <sup>2</sup> )	$14,57 \times 10^{-6}$	$14,61 \times 10^{-6}$	$14,55 \times 10^{-6}$
<b>Parameter Pipa Boiler Header ke Pelletizing Header</b>			
Massa jenis fluida ( $\rho$ ) (kg/m <sup>3</sup> )	3,392	3,178	3,402
Kecepatan fluida dalam pipa (V) (m/s)	2,392	2,343	2,393
Viskositas dinamika fluida ( $\mu$ ) (N/m <sup>2</sup> )	$14,42 \times 10^{-6}$	$14,33 \times 10^{-6}$	$14,43 \times 10^{-6}$

## Lampiran 2 Dokumentasi Penelitian

