

**Simulasi Desain *Air Preheater* menggunakan  
Solidworks *Flow Simulation System* untuk  
Peningkatan Kinerja *Water Tube Boiler* di Industri  
Kelapa Sawit**

**USULAN JUDUL SKRIPSI**



Oleh

**Faiz Akbarsyah M Harahap  
71220911065**

**PROGRAM STUDI TEKNIK MESIN  
FAKULTAS TEKNIK  
UNIVERSITAS ISLAM SUMATERA UTARA  
MEDAN  
2025**

**LEMBAR PENGESAHAN**

**SIMULASI DESAIN *AIR PREHEATER* MENGGUNAKAN *SOLIDWORKS FLOW SIMULATION SYSTEM* UNTUK PENINGKATAN KINERJA *WATER TUBE BOILER* DI INDUSTRI KELAPA SAWIT**

Diajukan Untuk Memenuhi Syarat Dalam Memperoleh Gelar Sarjana (S1) Pada  
Jurusan Teknik Mesin Fakultas Teknik Universitas Islam Sumatera Utara

Disusun oleh:

**FAIZ AKBARSYAH M HARAHAP**

NPM: 71220911065

Disetujui oleh:

Dosen Pembimbing I

Dosen Pembimbing II

Ir. Muslih Nasution, MT

Ahmad Bakhori, ST, MT

Mengetahui Oleh:

Ketua Program Studi Teknik Mesin

Ahmad Bakhori, ST, MT

**PROGRAM STUDI TEKNIK MESIN  
FAKULTAS TEKNIK  
UNIVERSITAS ISLAM SUMATERA UTARA  
MEDAN  
2025**

**LEMBAR PENGESAHAN**

**SIMULASI DESAIN *AIR PREHEATER* MENGGUNAKAN *SOLIDWORKS FLOW SIMULATION SYSTEM* UNTUK PENINGKATAN KINERJA *WATER TUBE BOILER* DI INDUSTRI KELAPA SAWIT**

Diajukan Untuk Memenuhi Syarat Dalam Memperoleh Gelar Sarjana (S1) Pada  
Jurusan Teknik Mesin Fakultas Teknik Universitas Islam Sumatera Utara

Disusun oleh:

**FAIZ AKBARSYAH M HARAHAP**

NPM: 71220911065

Disetujui oleh:

Dosen Pembimbing I

Dosen Pembimbing II

Ir. Muslih Nasution, MT

Ahmad Bakhori, ST, MT

Mengetahui Oleh:

Ketua Program Studi Teknik Mesin

Ahmad Bakhori, ST, MT

**PROGRAM STUDI TEKNIK MESIN  
FAKULTAS TEKNIK  
UNIVERSITAS ISLAM SUMATERA UTARA  
MEDAN  
2025**

## DAFTAR ISI

<b>KATA PENGANTAR .....</b>	<b>i</b>
<b>DAFTAR ISI.....</b>	<b>iii</b>
<b>DAFTAR TABEL.....</b>	<b>v</b>
<b>DAFTAR GAMBAR.....</b>	<b>vi</b>
<b>BAB 1 PENDAHULUAN.....</b>	<b>1</b>
1.1 Latar Belakang .....	1
1.2 Rumusan Masalah.....	4
1.3 Batasan Masalah.....	5
1.4 Tujuan Penelitian.....	6
1.5 Manfaat Penelitian .....	6
<b>BAB 2 TINJAUAN PUSTAKA.....</b>	<b>9</b>
2.1 Air Preheater .....	9
2.2 SOLIDWORKS 3D CAD Design Software & PDM Systems.....	12
2.3 Boiler.....	14
2.4 Bahan Bakar Boiler pada Pabrik Kelapa Sawit.....	15
2.5 CFD untuk Air Preheater pada Boiler Industri Kelapa Sawit.....	18
2.1 Computational Fluid Dynamics (CFD) dalam Analisis Heat Exchanger....	19
2.2 Air Preheater (APH) Sebagai Alat Pemulihan Panas di Pabrik Kelapa Sawit	20
<b>BAB 3 METODE PENELITIAN .....</b>	<b>22</b>
3.1 Tempat dan Waktu Penelitian .....	22
3.2 Alat dan Bahan yang digunakan.....	22
3.3 Diagram Alir Penelitian .....	23

3.4 Langkah – Langkah Kerja .....	24
3.5 Penjelasan Pemilihan Metode CFD .....	28
<b>BAB 4 HASIL DAN PEMBAHASAN.....</b>	<b>31</b>
4.1 Hasil Analisis .....	31
4.2 Pembahasan .....	39
4.3 Implikasi Terhadap Kinerja Boiler Pabrik Sawit.....	45
4.4 Pembahasan Maldistribution Thermal .....	45
4.5 Validasi dengan Teori.....	46
4.6 Implikasi Desain Terhadap Sistem Boiler Industri Sawit.....	46
4.7 Evaluasi Desain dan Rekomendasi Perbaikan .....	46
<b>BAB 5 PENUTUP .....</b>	<b>48</b>
5.1 Kesimpulan.....	48
5.2 Saran .....	49
<b>DAFTAR PUSTAKA .....</b>	<b>51</b>

## DAFTAR TABEL

Tabel 1. 1 Data Umum Persentase Kerugian Energi pada Sistem Boiler di Pabrik Kelapa Sawit .....	3
Table 3. 1 Data Input Kondisi Batas .....	27
Tabel 4. 1 Parameter Simulasi CFD .....	37
Tabel 4. 2 Data Jumlah Sel pada Simulasi .....	39

## DAFTAR GAMBAR

Gambar 2. 1 Air Pre-heater .....	9
Gambar 2. 2 Regenerative Air Preheater.....	10
Gambar 2. 3 Tubular Air Preheater .....	11
Gambar 2. 4 Solidworks 2022 Logo .....	13
Gambar 3. 1 Diagram Alir Penelitian.....	23
Gambar 4. 1 Drawing dari Air Preheater .....	31
Gambar 4. 2 2D Drawing dari Air Preheater (Sliced View).....	32
Gambar 4. 3 2D Drawing dari Air Preheater (Shell Part) .....	32
Gambar 4. 4 2D Drawing dari Air Preheater (Half-Section Cut)) .....	32
Gambar 4. 5 3D Rendered - Air Preheater - Front View.....	33
Gambar 4. 6 3D Rendered - Air Preheater - Isometric View .....	33
Gambar 4. 7 3D Rendered - Air Preheater - Top View .....	34
Gambar 4. 8 CFD Simulation Setup - Computational Domain .....	34
Gambar 4. 9 CFD Simulation Setup - Computational Domain Details .....	35
Gambar 4. 10 CFD Simulation Setup - Mendefinisikan Global Mesh .....	35
Gambar 4. 11 CFD Computational Setup - Menentukan Global Mesh .....	36
Gambar 4. 12 CFD Computational Setup - Menentukan Inlet Mass Flow dan Environment Pressure pada Hot Inlet & Outlet juga Cold Inlet & Outlet .....	37
Gambar 4. 13 CFD Simulation Result .....	38
Gambar 4. 14 CFD Simulation Result - Daftar Goals Simulasi CFD.....	39
Gambar 4. 15 CFD Simulation Result - Visualisasi Data Temperatur .....	41

Gambar 4. 16 Grafik Bar dari Perubahan Temperatur .....	41
Gambar 4. 17 CFD Simulation Result - Visualisasi Data Kecepatan .....	43

## DAFTAR PUSTAKA

- [1] Arora, C. P., "Refrigeration and Air Conditioning," Tata McGraw-Hill Education, 2008.
- [2] Azman, M., N. A. Ibrahim, M. N. Saad, et al., "Combustion performance of empty fruit bunches for steam generation," *International Journal of Environmental Science and Technology*, 2019.
- [3] Basu, P., "Biomass Gasification, Pyrolysis and Torrefaction: Practical Design and Theory," Academic Press, 2015.
- [4] Baukal, C. E., "Industrial Burners Handbook," CRC Press, 2013.
- [5] Bergman, T. L., Lavine, A. S., Incropera, F. P., and Dewitt, D. P., "Fundamentals of Heat and Mass Transfer," 8th ed., Wiley, 2020.
- [6] Chin, M. J., Poh, P. E., Tey, B. T., et al., "Energy efficiency improvements in palm oil mill industry through process integration techniques," *Clean Technologies and Environmental Policy*, 2015.
- [7] Dell, R. M., and Rand, D. A. J., "Energy Storage: A Key Technology for Global Energy Sustainability," Royal Society of Chemistry, 2017.
- [8] Gupta, A., "Boiler Operation Engineering: Questions and Answers," New Age International, 2018.
- [9] Koren, Y., "The Global Manufacturing Revolution: Product-Process-Business Integration and Reconfigurable Systems," Wiley, 2019.
- [10] Ku, H. H., "Notes on the Use of Propagation of Error Formulas," *Journal of Research of the National Bureau of Standards*, 2015.
- [11] Li, H., "Performance enhancement of rotary regenerative air preheater by baffles optimization," *Energy Reports*, 2018.

- [12] Planchard, D., and Planchard, M., "SOLIDWORKS 2021: A Tutorial Approach," SDC Publications, 2021.
- [13] Rajaseenivasan, T., et al., "Heat transfer enhancement in tubular heat exchangers," *International Journal of Heat and Mass Transfer*, 2021.
- [14] Rushford, R., "The Politics of Palm Oil Production: A Study of Market Forces and Sustainability," 2015.
- [15] Saidur, R., et al., "A review on biomass as a fuel for boilers," *Renewable and Sustainable Energy Reviews*, 2011.
- [16] Sarkar, B., "Thermal Power Plant: Design and Operation," Elsevier, 2016.
- [17] Taler, J., et al., "Heat Transfer and Pressure Drop in Heat Exchangers," Springer, 2019.