LAMPIRAN I
DATA HASIL PENELITIAN

1. Data Ukuran dan Perhitungan Desain Alat

Tabel L1.1 Data Ukuran dan Perhitungan Desain Alat

Nama Alat	Jari-Jari (cm)		Tinggi (cm)		Volume (Liter)
Heater	5,08		52		4,2137
Mixer	5,08		25		2,0258
Reaktor *Multi Tubular*	Pipa 2 inch tanpa tubing	2,54	Pipa 2 inch tanpa tubing	5	0,2026
	Pipa 2 inch dengan tubing 3/8 inch	0,311	Pipa 2 inch dengan tubing 3/8 inch	40	0,1341
	Total				0,3367
Kondensor	Pipa 2 inch tanpa tubing	2,54	Pipa 2 inch tanpa tubing	5	0,2026
	Pipa 2 inch dengan tubing 3/8 inch	0,311	Pipa 2 inch dengan tubing 3/8 inch	20	0,0244
	Total				0,2270
Separator	5,08		52		4,2137

2. Data Penelitian

Tabel L1.1 Data Penelitian

$P_{reaktor}$ (atm)	Temperatur (^oC)	Volume Produk (ml)
14	400	446
16	400	457
18	400	516
20	400	555
22	400	526

3. Data Densitas

Tabel L1.3 Data Densitas

Berat Piknometer Kosong (gr)	Berat Piknometer + Aquadest (gr)	Berat Piknometer + Sampel (gr)
11,85	16,85	15,719
11,85	16,85	15,832
11,85	16,85	15,912
11,85	16,85	15,831
11,85	16,85	15,681

4. Data Viskositas

Tabel L1.4 Data Viskositas

Konstanta Bola (mPa.s cm3/gr.s)	Diameter Bola (cm)	t_1 (s)	t_2 (s)	t_3 (s)	t rata-rata
0,09	1,5	2,83	2,98	2,82	2,87
0,09	1,5	2,98	3,10	3,03	3,04
0,09	1,5	4,10	4,20	4,21	4,17
0,09	1,5	3,25	3,30	3,38	3,31
0,09	1,5	2,35	2,43	2,07	2,28

5. Data Hasil Uji Analisa dan Perhitungan

Tabel L1.5 Data Hasil Uji Analisa dan Perhitungan

$P_{Hidrogen}$ (psi)	ρ_{sampel} (kg/m^3)	Viskositas (mm^2/s)	Titik Nyala (˚C)	Angka Setana	% *Yield*	*SEC* (kWh/ml)
1	773,8	2,59	60,5	88,7	22,30	0,0306
2	796,3	2,65	59,4	89,2	22,85	0,0300
3	812,4	3,56	59,7	86,8	25,80	0,0265
4	796,2	2,89	60,8	88,4	27,75	0,0246
5	766,2	2,08	60,9	87,9	26,30	0,0260

LAMPIRAN II
PERHITUNGAN

1. Perhitungan Desain Alat

1. Heater

- π = 3,14 cm
- d = 10,16 cm

  r $= \frac{d}{2}$

  $= \frac{10{,}16\ cm}{2}$

  = 5,08 cm
- t = 52 cm
- V = π x r^2 x t

  = 3,14 cm x $5{,}08^2$ cm x 52 cm

  = 4213,7 cm^3

  = 4213,7 $cm^3 \times \frac{1\ cm^3}{1000\ dm^3}$

  = 4,2137 dm^3

  = 4,2137 liter

2. Mixer

- π = 3,14 cm
- d = 10,16 cm

  r $= \frac{d}{2}$

  $= \frac{10{,}16\ cm}{2}$

  = 5,08 cm
- t = 25 cm
- V = π x r^2 x t

  = 3,14 cm x $5{,}08^2$ cm x 25 cm

  = 2025,8 cm^3

  = 2025,8 $cm^3 \times \frac{1\ cm^3}{1000\ dm^3}$

  = 2,0258 dm^3

  = 2,0258 liter

3. Reaktor *Multi Tubular*

Terbagi menjadi 2 bagian, bagian pipa *stainless* 2 inch tanpa *tubing* dan bagian pipa *stainless* 2 inch dengan *tubing* $^{3}/_{8}$

a. Pipa Stainless 2 inch tanpa *Tubing*

- π = 3,14 cm
- d = 5,08 cm

  r $= \frac{d}{2}$

  $= \frac{10{,}16\ cm}{2}$

  = 2,54 cm
- t = 5 cm
- V_1 = π x r^2 x t

  = 3,14 cm x 2,54,^{2} cm x 5 cm

  = 101,29 cm^3

  = 101,29 $cm^3 \times \frac{1\ cm^3}{1000\ dm^3}$

  = 0,1013 dm^3 x 2 (bagian atas dan bawah)

  = 0,2026 dm^3

  = 0,2026 liter

b. Pipa Stainless 2 inch dengan *Tubing* $^{3}/_{8}$

- π = 3,14 cm
- d = 0,623 cm

  r $= \frac{d}{2}$

  $= \frac{10{,}16\ cm}{2}$

  = 0,311 cm
- t = 40 cm
- V_2 = π x r^2 x t

  = 3,14 cm x 0,311^2 cm x 40 cm

  = 12,187 cm^3

  = 12,187 $cm^3 \times \frac{1\ cm^3}{1000\ dm^3}$

  = 0,1218 dm^3 x 11 (*Tubing*)

= 0,1341 dm^3

= 0,1341 liter

- V_{total} = $V_1 + V_2$

  = 0,2026 liter + 0,1341 liter

  = 0,3367 liter

4. Kondensor

Terbagi menjadi 2 bagian, bagian pipa *stainless* 2 inch tanpa *tubing* danbagian pipa *stainless* 2 inch dengan *tubing* $^3/_8$

a. Pipa *Stainless* 2 inch tanpa *Tubing*

- π = 3,14 cm
- d = 5,08 cm

  r = $\frac{d}{2}$

  = $\frac{5{,}08\ cm}{2}$

  = 2,54 cm
- t = 5 cm
- V_1 = π x r^2 x t

  = 3,14 cm x 2,54,^{2} cm x 5 cm

  = 101,29 cm^3

  = 101,29 $cm^3 \times \frac{1\ cm^3}{1000\ dm^3}$

  = 0,1013 dm^3 x 2 (bagian atas dan bawah)

  = 0,2026 dm^3

  = 0,2026 liter

b. Pipa *Stainless* 2 inch dengan *Tubing* $^3/_8$

- π = 3,14 cm
- d = 0,623 cm

  r = $\frac{d}{2}$

  = $\frac{0{,}623\ cm}{2}$

  = 0,311 cm
- t = 20 cm

- V_2 = π x r^2 x t
  = 6,0936 cm^3
  = 6,0936 $cm^3 \times \frac{1\ cm^3}{1000\ dm^3}$
  = 0,0061 dm^3 x 4 (*Tubing*)
  = 0,0244 dm^3
  = 0,0244 liter
- V_{total} = $V_1 + V_2$
  = 0,2026 liter + 0,0244 liter
  = 0,2270 liter

5. Separator

- π = 3,14 cm
- d = 10,16 cm

  r = $\frac{d}{2}$
  = $\frac{0{,}623\ cm}{2}$
  = 0,311 cm
  = 5,08 cm
- t = 52 cm
- V = π x r^2 x t
  = 3,14 cm x $5{,}08^2$ cm x 52 cm
  = 4213,7 cm^3
  = 4213,7 $cm^3 \times \frac{1\ cm^3}{1000\ dm^3}$
  = 4,2137 dm^3
  = 4,2137 liter

2. Perhitungan Densitas

a. Menghitung Volume Aquadest

Berat Piknometer Kosong (a)	= 11,85 gram
Berat Piknometer + Aquadest (b)	= 16,85 gram
Densitas Aquadest (b)	= 1 gr/cm^3
Berat Aquadest	= b – a

= 16,85 gr – 11,85 gr

= 5,00 gr

Volume Aquadest $= \frac{m}{\rho}$

$= \frac{5{,}00\ gr}{1{,}000\ gr/cm^3}$

= 5,00 cm^3

Menghitung Densitas Sampel

- Sampel 1

Berat Piknometer Kosong (a) = 11,85 gram

Berat Piknometer + Sampel (b) = 15,72 gram

Volume Piknometer = 5,00 cm^3

Berat Sampel = b – a

= 15,72 gr – 11,85 gr

= 3,87 gr

$= \frac{m}{v}$

$= \frac{3{,}87\ gr}{5{,}00\ gr/cm^3}$

= 0,77 cm^3

= 773,8 kg/m^3

- Sampel 2

Berat Piknometer Kosong (a) = 11,85 gram

Berat Piknometer + Sampel (b) = 15,83 gram

Volume Piknometer = 5,00 cm^3

Berat Sampel = b – a

= 15,83 gr – 11,85 gr

= 3,98 gr

$= \frac{m}{v}$

$= \frac{3{,}98\ gr}{5{,}00\ gr/cm^3}$

= 0,80 cm^3

= 796,4 kg/m^3

- Sampel 3

  Berat Piknometer Kosong (a) = 11,85 gram

  Berat Piknometer + Sampel (b) = 15,91 gram

  Volume Piknometer = 5,00 cm^3

  Berat Sampel = b – a

  = 15,91 gr – 11,85 gr

  = 4,06 gr

  = $\frac{m}{v}$

  = $\frac{4{,}06\ gr}{5{,}00\ gr/cm^3}$

  = 0,81 cm^3

  = 812,4 kg/m^3

- Sampel 4

  Berat Piknometer Kosong (a) = 11,85 gram

  Berat Piknometer + Sampel (b) = 15,83 gram

  Volume Piknometer = 5,00 cm^3

  Berat Sampel = b – a

  = 15,83 gr – 11,85 gr

  = 3,98 gr

  = $\frac{m}{v}$

  = $\frac{3{,}98\ gr}{5{,}00\ gr/cm^3}$

  = 0,80 cm^3

  = 796,2 kg/m^3

- Sampel 5

  Berat Piknometer Kosong (a) = 11,85 gram

  Berat Piknometer + Sampel (b) = 15,68 gram

  Volume Piknometer = 5,00 cm^3

  Berat Sampel = b – a

  = 15,68 gr – 11,85 gr

  = 3,83 gr

  = $\frac{m}{v}$

$= \frac{3{,}83\ gr}{5{,}00\ gr/cm^3}$

$= 0{,}77\ cm^3$

$= 766{,}2\ kg/m^3$

3. Perhitungan Viskositas

Densitas Bola (ρ1) $= 8{,}5134\ gr/cm^3$

Konstanta Bola (K) $= 0{,}09$ mPa.s cm3/gr.s

- Sampel 1

Densitas Sampel (ρ2) $= 0{,}77\ gr/cm^3$

Rata-Rata Waktu Tempuh $= \frac{t1+t2+t3}{3}$

$= \frac{2{,}83+2{,}98+2{,}83}{3}$

$= 2{,}88$ s

Viskositas Dinamik (μ) $= K\ (\rho 1 - \rho 2)\ t$

$= 0{,}09\ (8{,}5 - 0{,}77)\ 2{,}88$

$= 2{,}0061$ mPa.s

$= 0{,}0201$ gr/cm.s

Viskositas Kinematik (ν) $= \frac{Viskositas\ Dinamik}{Densitas\ \ (\rho 2)}$

$= \frac{2{,}0061 \frac{gr}{cm}.s}{0{,}77\ gr/cm3}$

$= 0{,}026\ cm^2/s$

$= 2{,}5925\ mm^2/s$

- Sampel 2

Densitas Sampel (ρ2) $= 0{,}80\ gr/cm^3$

Rata-Rata Waktu Tempuh $= \frac{t1+t2+t3}{3}$

$= \frac{2{,}98+3{,}1\ +3{,}03}{3}$

$= 3{,}0378$ s

Viskositas Dinamik (μ) $= K\ (\rho 1 - \rho 2)\ t$

$= 0{,}09\ (8{,}5 - 0{,}80)\ 3{,}0378$

$= 2{,}1098$ mPa.s

= 0,0211 gr/cm.s

Viskositas Kinematik (ν) $= \frac{Viskositas\ Dinamik}{Densitas\ \ (\rho 2)}$

$= \frac{2{,}0211 \frac{gr}{cm}.s}{0{,}80\ gr/cm3}$

= 0,026 cm^2/s

= 2,6496 mm^2/s

- Sampel 3

Densitas Sampel (ρ2) = 0,81 gr/cm^3

Rata-Rata Waktu Tempuh $= \frac{t1+t2+t3}{3}$

$= \frac{4{,}1 + 4{,}2 + 4{,}21}{3}$

= 4,17 s

Viskositas Dinamik (μ) = K (ρ1 - ρ2) t

= 0,09 (8,5 – 0,81) 4,17

= 2,8902 mPa.s

= 0,0289 gr/cm.s

Viskositas Kinematik (ν) $= \frac{Viskositas\ Dinamik}{Densitas\ \ (\rho 2)}$

$= \frac{0{,}0289 \frac{gr}{cm}.s}{0{,}81\ gr/cm3}$

= 0,036 cm^2/s

= 3,5576 mm^2/s

- Sampel 4

Densitas Sampel (ρ2) = 0,80 gr/cm^3

Rata-Rata Waktu Tempuh $= \frac{t1+t2+t3}{3}$

$= \frac{3{,}25 + 3{,}3 + 3{,}38}{3}$

= 3,31 s

Viskositas Dinamik (μ) = K (ρ1 - ρ2) t

= 0,09 (8,5 – 0,80) 3,31

= 2,299 mPa.s

= 0,023 gr/cm.s

Viskositas Kinematik (ν) $= \frac{Viskositas\ Dinamik}{Densitas\ \ (\rho 2)}$

$= \frac{0{,}023 \frac{gr}{cm}.s}{0{,}80\ gr/cm3}$

$= 0{,}026\ cm^2/s$

$= 2{,}8874\ mm^2/s$

- Sampel 5

Densitas Sampel (ρ2) $= 0{,}77\ gr/cm^3$

Rata-Rata Waktu Tempuh $= \frac{t1+t2+t3}{3}$

$= \frac{2{,}35+2{,}43+2{,}07}{3}$

$= 2{,}2833\ s$

Viskositas Dinamik (μ) $= K\ (\rho 1 - \rho 2)\ t$

$= 0{,}09\ (8{,}5 - 0{,}77)\ 2{,}2833$

$= 1{,}5920\ mPa.s$

$= 0{,}0159\ gr/cm.s$

Viskositas Kinematik (ν) $= \frac{Viskositas\ Dinamik}{Densitas\ \ (\rho 2)}$

$= \frac{0{,}0159 \frac{gr}{cm}.s}{0770\ gr/cm3}$

$= 0{,}021\ cm^2/s$

$= 2{,}08\ mm^2/s$

4. Perhitungan % Yield

Volume Bahan Baku = 2000 ml

- Sampel 1

Volume Produk = 446 ml

% Yield $= \frac{Volume\ Produk}{Volume\ Bahan\ Baku}$

$= \frac{446\ ml}{2000\ ml}$

$= 22{,}30\ \%$

- Sampel 2

Volume Produk = 457 ml

% Yield $= \frac{Volume\ Produk}{Volume\ Bahan\ Baku}$

$= \frac{456\ ml}{2000\ ml}$

= 22,85 %

- Sampel 3

  Volume Produk = 516 ml

  % Yield $= \frac{Volume\ Produk}{Volume\ Bahan\ Baku}$

  $= \frac{516\ ml}{2000\ ml}$

  = 25,80 %

- Sampel 4

  Volume Produk = 555 ml

  % Yield $= \frac{Volume\ Produk}{Volume\ Bahan\ Baku}$

  $= \frac{555\ ml}{2000\ ml}$

  = 27,75 %

- Sampel 5

  Volume Produk = 526 ml

  % Yield $= \frac{Volume\ Produk}{Volume\ Bahan\ Baku}$

  $= \frac{526\ ml}{2000\ ml}$

  = 26,30 %

5. Perhitungan *Spesific Energi Comsumption*

Menghitung konsumsi listrik (kWh) waktu operasi selama 250 menit

1. *Band Heater* pada *Heater*

   - Daya (P_1) = 940 Watt

     $= 940\ \text{Watt} \times \frac{1\ \text{kW}}{1000\ \text{Watt}} \times \frac{250\ \text{mnt}}{60\ \text{mnt/h}}$

     = 3,916 kWh

   - Tegangan (V) = 220 Volt

   - Kuat Arus (I) $= \frac{940}{220}$

     = 4,27 Amper

2. *Band Heater* pada Reaktor

- Daya (P_2) = 940 Watt

  = 940 Watt x $\frac{1\ \text{kW}}{1000\ \text{Watt}}$ x $\frac{250\ \text{mnt}}{60\ \text{mnt/h}}$

  = 3,916 kWh
- Tegangan (V) = 220 Volt
- Kuat Arus (I) = $\frac{940}{220}$

  = 4,27 Amper

3. *Cooler Box*

- Daya (P_3) = 1400 Watt

  = 1400 Watt x $\frac{1\ \text{kW}}{1000\ \text{Watt}}$ x $\frac{250\ \text{mnt}}{60\ \text{mnt/h}}$

  = 5,83 kWh
- Tegangan (V) = 220 Volt
- Kuat Arus (I) = $\frac{1800}{220}$

  = 6,364 Amper

4. Total Daya

- P_{Total} = P_1 + P_2 + P_3

  = 3,916 + 3,916 + 7,50

  = 13,667 kWh

Menghitung *Spesific Energi Comsumption (SEC)*

1. Sampel 1 (446 ml)

- *SEC* = $\frac{\text{Daya Yang digunakan}}{\text{volume Produk}}$

  = $\frac{15{,}33\ \text{kWh}}{446\ \text{ml}}$

  = 0,0306 kWh/ml

2. Sampel 2 (457 ml)

- *SEC* = $\frac{\text{Daya Yang digunakan}}{\text{volume Produk}}$

  = $\frac{15{,}33\ \text{kWh}}{457\ \text{ml}}$

  = 0,0299 kWh/ml

3. Sampel 3 (516 ml)

- $SEC = \frac{\text{Daya Yang digunakan}}{\text{volume Produk}}$

$= \frac{15{,}33\ \text{kWh}}{516\ \text{ml}}$

$= 0{,}0265\ {}^{\text{kWh}}/_{\text{ml}}$

4. Sampel 4 (555 ml)

- $SEC = \frac{\text{Daya Yang digunakan}}{\text{volume Produk}}$

$= \frac{15{,}33\ \text{kWh}}{555\ \text{ml}}$

$= 0{,}0246\ {}^{\text{kWh}}/_{\text{ml}}$

5. Sampel 5 (526 ml)

- $SEC = \frac{\text{Daya Yang digunakan}}{\text{volume Produk}}$

$= \frac{15{,}33\ \text{kWh}}{526\ \text{ml}}$

$= 0{,}0260\ {}^{\text{kWh}}/_{\text{ml}}$

LAMPIRAN III
DOKUMENTASI PENELITIAN

- **Pembuatan Reaktor *Multi Tubular***

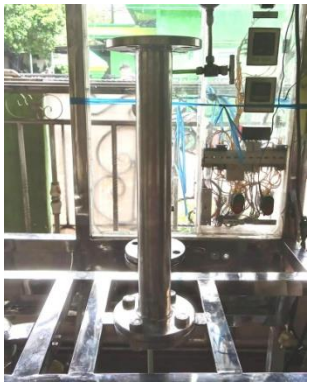
Pemotongan pipa stainless 2 inch

Memasukan Tube 3/8

Menutup Ronga kosong

Penyambungan Pipa dengan Flange

Merapihkan dan pempolesan Reaktor



Menginstalasi Reaktor

- **Pembuatan Jaket Reaktor**

Pemotongan Plat

Pengelasan Plat Jaket

- **Bahan Baku dan Katalis**

Minyak Jelantah

Bleaching Earth

Katalis Ni-Zn/ γ Al_2O_3

Gas Hidrogen

- **Alat yang Digunakan**

Rangkain Alat *Green Diesel*

Reaktor *Multi Tubular*

- **Tahapan *Start Up***

MemasukkanMinyakJelantah

MemasukkanKatalis Ni-Zn/ γ Al_2O_3

Menginjeksi Gas Hidrogen

Menghidupkan Alat

Mengeluarkan Produk *Green Diesel*

- **Produk**

Bahan Bakar *Green Diesel*

- **Uji Analisa SampelProduk**

Analisa Viskositas

Analisa Densitas

- **Kelompok *Green Diesel***