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LAMPIRAN

Lampiran 1 Prosedur Pengukuran/Analisis**Lampiran 1.1 Kadar air**

Kadar air adalah jumlah air yang terkandung dalam bahan hasil pertanian. Kadar air dapat diukur dengan menggunakan alat otomatis. *Moisture tester* adalah alat yang digunakan untuk mengukur kadar air pada biji kopi. Cara menggunakan *moisture tester* adalah dengan menyalakan tombol power terlebih dahulu dan memilih komoditas pertanian yang akan diukur kadar airnya. Kemudian masukkan kopi lubang bagian atas *moisture tester*. Tekan “enter” dan tunggu beberapa saat hingga kadar airnya muncul pada layar. Beberapa alat menggunakan sensor SHT11 yang terhubung ke Arduino Uno untuk mendeteksi kadar air dan suhu, kemudian menampilkannya pada layar LCD (Fatkhurrozi *et al.*, 2024; Rahman *et al.*, 2025).

Lampiran 1.2 Laju Pengeringan (Susana *et al.*, 2023)

Laju pengeringan adalah kecepatan penguapan air dari bahan selama proses pengeringan yang dipengaruhi oleh perbedaan suhu antara bahan dan udara pengering. Proses pengeringan terdiri dari dua periode utama, yaitu periode laju pengeringan tetap (*constant rate period*), dimana air bebas di permukaan bahan menguap dengan kecepatan konstan. periode yang lain adalah periode laju pengeringan menurun (*falling rate period*) yang terjadi setelah air bebas habis dan pengeringan bergantung pada pindah air dari dalam bahan ke permukaan. Pada periode laju pengeringan tetap, laju pengeringan cenderung konstan karena penguapan air berlangsung secara terus-menerus, sedangkan pada periode menurun, laju pengeringan berkurang secara bertahap hingga mencapai kadar air kesetimbangan.

$$m_p = \frac{m_w}{t}$$

m_p = Laju pengeringan (kg/h)

m_w = Rasio berat air yang diuapkan (kg)

t = Waktu pengeringan (jam)

Lampiran 1.3 Efisiensi pengeringan (Çengel *et al.*, 2015)

Efisiensi pengeringan adalah perbandingan antara energi yang benar-benar digunakan untuk menguapkan air dari bahan dengan total energi yang disuplai ke sistem pengeringan. Efisiensi ini menggambarkan seberapa efektif energi yang diberikan kepada alat pengering dapat dimanfaatkan untuk proses penghilangan kadar air dari bahan. Semakin tinggi nilai efisiensi pengeringan, semakin baik kinerja alat pengering tersebut karena lebih sedikit energi yang terbuang atau hilang selama proses pengeringan.

1.3.1 Efisiensi *sun drying* (Khan *et al.*, 2025)

Efisiensi pada metode *sun drying* dihitung untuk mengetahui seberapa besar persentase energi radiasi matahari yang mampu diserap oleh permukaan bahan untuk menguapkan kandungan air. Nilai efisiensi ini ditentukan berdasarkan perbandingan antara energi konveksi laten pengeringan dengan total energi radiasi matahari yang diterima selama luasan waktu proses, yang dirumuskan sebagai berikut:

$$\eta = \frac{(m_1 - m_2) \times h_{fg}}{A_s \times I_t \times t_s} \times 100\%$$

m_1 = Berat sebelum pengeringan (kg)

m_2 = Berat setelah pengeringan (kg)

h_{fg} = Kalor laten penguapan (kJ/kg)

A_s = Area pengeringan (m²)

I_t = Radiasi matahari (W/m²)

t_s = waktu (s)

1.3.2 Efisiensi Fermentor (Çengel *et al.*, 2015)

Efisiensi fermentor dihitung untuk mengetahui seberapa besar persentase energi panas yang disuplai oleh pemanas media air yang benar-benar termanfaatkan secara efektif untuk proses termal di dalam ruang fermentor. Nilai efisiensi ini diperoleh melalui perbandingan antara energi berguna konveksi-konduksi (Q_{useful}) terhadap total energi masuk (Q_{in}), yang dirumuskan sebagai berikut:

$$\eta = \frac{Q_{useful}}{Q_{in}} \times 100\%$$

$$\eta = \left(\frac{Q_{konduksi} + Q_{konveksi}}{Q_{in}} \right) \times 100\%$$

$$\eta = \left(\frac{(m_w \times C_p \times \Delta T) + (m_w \times h_{fg})}{P \times t} \right) \times 100\%$$

a. Q_{useful}

$$Q_{total} = Q_{konduksi} + Q_{konveksi}$$

1. $Q_{konduksi}$

$$Q_{konduksi} = m_w \times C_p \times \Delta t$$

m_w = Rasio massa bahan setiap interval (kg)

C_p = Kalor spesifik pada tekanan konstan (kJ/kg°C)

$$C_p = (1,424 \times X_h) + (1,549 \times X_p) + (1,675 \times X_f) + (0,837 \times X_a) + (4,187 \times X_w)$$

X_h = fraksi massa karbohidrat

X_p = fraksi massa protein

X_f = fraksi massa lemak

X_a = fraksi massa abu

X_w = fraksi massa kadar air

$$\Delta t = T_{in} - T_{amb} \text{ (°C)}$$

T_{in} = suhu dinding bagian dalam (°C)

T_{amb} = suhu dinding bagian luar (°C)

2. $Q_{konveksi}$

$$Q_{konveksi} = m_w \times h_{fg}$$

m_w = Rasio massa bahan setiap interval (kg)

h_{fg} = Kalor laten penguapan (kJ/kg)

b. Q_{in}

$$Q_{in} = P \times t$$

P = daya (W)

t = waktu (s)

Lampiran 1.4 *Cupping test* (SCAA)

Pengujian cita rasa kopi dengan metode *cupping test* mengikuti protokol khusus dari *Specialty Coffee Association of America* (SCAA) yang diawali dengan pemeriksaan visual warna sangrai kopi sebagai referensi selama penilaian atribut

rasa. Penilaian dilakukan secara berurutan berdasarkan perubahan persepsi rasa yang terjadi akibat penurunan suhu kopi saat mendingin. Menurut protokol SCAA (2018), pengujian mutu *cupping test* bertujuan untuk menentukan perbedaan antar sampel, menggambarkan rasa kopi, dan menentukan preferensi produk. *Cupping test* sangat penting untuk menilai kualitas kopi sebelum distribusi dan dilakukan berdasarkan 11 atribut utama, yaitu fragrance/aroma, flavor, aftertaste, acidity, body, balance, sweetness, clean cup, uniformity, defect, dan overall.

Aroma dinilai dari bau bubuk kopi sebelum diseduh, aroma saat kerak/busanya pecah, dan aroma setelah kopi mengendap. Flavor adalah kombinasi rasa dan aroma yang dirasakan saat kopi masuk mulut, sedangkan aftertaste adalah rasa positif yang bertahan setelah menelan. Acidity menilai keasaman yang enak dan segar, body adalah rasa yang dirasakan di lidah dan langit-langit mulut, dan balance menilai keseimbangan keseluruhan rasa. Sweetness menilai kemanisan alami kopi, clean cup menunjukkan tidak adanya nilai negatif dari atribut rasa, uniformity menilai keseragaman antar gelas, defect adalah aroma atau rasa negatif yang mengurangi kualitas, dan overall adalah penilaian keseluruhan berdasarkan pengalaman penilai. Penilaian ini dilakukan secara sistematis dan dicatat pada lembar cupping untuk mendapatkan skor yang menggambarkan kualitas kopi secara objektif (Adam *et al.*, 2022).

Lampiran 1.5 *Bulk density*

Bulk density merupakan rasio antara massa keseluruhan dari sekumpulan biji kopi robusta terhadap total volume ruang yang ditempatinya, termasuk volume pori atau rongga udara di antara biji kopi tersebut. Parameter ini dihitung untuk mengetahui karakteristik fisik bahan yang berguna dalam perencanaan ruang penyimpanan, kapasitas pengemasan, serta desain sistem transportasi bahan. Nilai *bulk density* ditentukan menggunakan persamaan berikut:

$$\rho_b = \frac{m}{V}$$

ρ_b = *bulk density* (kg/l)

m = massa total biji kopi (kg)

V = volume wadah (l)

Lampiran 2. Data Hasil Analisis

2.1 Kadar Sir

2.1.1 *Sun drying*

Jam	U1	U2	U3	x
0	51%	51,04%	50,74%	50,93%
5,4	21,89%	20,90%	26,95%	23,25%
11,0	14,24%	14,46%	18,11%	15,60%
16,6	14,09%	14,04%	13,85%	13,99%
21,8	13,50%	12,90%	13,09%	13,16%
27,5	12,32%	12,46%	12,34%	12,37%

2.1.2 F40

Jam	U1	U2	U3	X
0	50,55%	51,57%	50,19%	50,77%
5,4	18,57%	18,72%	18,99%	18,76%
11,4	17,59%	17,67%	17,94%	17,73%
17,4	16,66%	16,73%	16,96%	16,78%
23,4	15,84%	15,85%	16,15%	15,95%
29,4	15,13%	15,15%	15,35%	15,21%
35,4	14,52%	14,48%	14,74%	14,58%
41,4	14,09%	13,95%	14,19%	14,08%
47,4	13,65%	13,47%	13,74%	13,62%
53,4	13,32%	13,12%	13,35%	13,26%
59,4	13,05%	12,87%	13,05%	12,99%
65,4	12,82%	12,67%	12,77%	12,75%
71,4	12,67%	12,52%	12,59%	12,59%
77,4	12,52%	12,45%	12,44%	12,47%
83,4	12,43%	12,39%	12,38%	12,40%

2.1.3 F50

Jam	U1	U2	U3	x
0	48,79%	50,65%	52,18%	50,54%
5,4	18,46%	18,44%	18,15%	18,35%
11,4	16,81%	16,73%	16,73%	16,76%
17,4	15,97%	15,88%	15,88%	15,91%
23,4	15,15%	15,09%	15,09%	15,11%
29,4	14,56%	14,49%	14,59%	14,55%
35,4	14,00%	13,95%	14,09%	14,01%
41,4	13,45%	13,44%	13,65%	13,51%
47,4	13,00%	12,95%	13,21%	13,05%
53,4	12,65%	12,65%	12,77%	12,69%
59,4	12,47%	12,41%	12,41%	12,43%

2.1.4 F60

Jam	U1	U2	U3	x
0	52,18%	50,66%	51,96%	51,60%
5,4	18,67%	18,58%	18,00%	18,42%
11,4	15,14%	14,94%	14,67%	14,92%
17,4	14,24%	14,09%	13,85%	14,06%
23,4	13,35%	13,33%	13,09%	13,26%
29,4	12,85%	12,79%	12,68%	12,77%
35,4	12,46%	12,46%	12,36%	12,43%

2.2 Efisiensi Pengeringan

2.2.1 *Sun drying*

Jam	U1	U2	U3	X
5,4	0,8770%	0,7987%	1,0839%	0,9199%
11,0	0,1166%	0,1213%	0,1494%	0,1291%
16,6	0,0209%	0,0218%	0,0423%	0,0283%
21,8	0,0222%	0,0232%	0,0161%	0,0205%
27,5	0,0183%	0,0175%	0,0134%	0,0164%

2.2.2 F40

Jam	U1	U2	U3	x
5,4	0,8146%	0,8419%	0,7630%	0,8065%
11,4	0,2927%	0,3142%	0,3303%	0,3124%
17,4	0,2593%	0,2754%	0,2980%	0,2776%
23,4	0,2269%	0,2517%	0,2732%	0,2506%
29,4	0,2107%	0,2226%	0,2484%	0,2272%
35,4	0,1838%	0,2064%	0,2097%	0,2000%
41,4	0,1763%	0,1849%	0,2021%	0,1878%
47,4	0,1516%	0,1634%	0,1827%	0,1659%
53,4	0,1301%	0,1333%	0,1623%	0,1419%
59,4	0,1161%	0,1322%	0,1483%	0,1322%
65,4	0,1032%	0,1128%	0,1343%	0,1168%
71,4	0,0838%	0,1010%	0,0881%	0,0910%
77,4	0,0698%	0,0902%	0,0204%	0,0601%
83,4	0,0559%	0,0666%	0,0172%	0,0466%

2.2.3 F50

Jam	U1	U2	U3	x
5,4	0,7298%	0,8225%	0,7298%	0,7607%
11,4	0,3793%	0,4171%	0,3932%	0,3965%
17,4	0,3358%	0,3671%	0,3606%	0,3545%
23,4	0,2956%	0,3172%	0,3107%	0,3078%
29,4	0,2587%	0,2739%	0,2696%	0,2674%
35,4	0,2250%	0,2219%	0,2251%	0,2240%
41,4	0,1936%	0,1807%	0,1829%	0,1857%
47,4	0,1612%	0,1493%	0,1612%	0,1572%

Jam	U1	U2	U3	x
53,4	0,1319%	0,0887%	0,0530%	0,0912%
59,4	0,0779%	0,0400%	0,0498%	0,0559%

2.2.4 F60

Jam	U1	U2	U3	x
5,4	0,8523%	0,7975%	0,9004%	0,8501%
11,4	1,0990%	1,3581%	1,4542%	1,3038%
17,4	0,5454%	0,6004%	0,5080%	0,5513%
23,4	0,3271%	0,3182%	0,2537%	0,2997%
29,4	0,1745%	0,0953%	0,0763%	0,1154%
35,4	0,1014%	0,0711%	0,0368%	0,0698%

2.3 Laju Pengeringan

2.3.1 *Sun drying*

Jam	U1	U2	U3	x
5,4	0,1130	0,1019	0,1390	0,1180
11,0	0,0150	0,0157	0,0192	0,0166
16,6	0,0027	0,0028	0,0054	0,0036
21,8	0,0028	0,0030	0,0021	0,0026
27,5	0,0023	0,0022	0,0017	0,0021

2.3.2 F40

Jam	U1	U2	U3	x
5,4	0,1044	0,1079	0,0978	0,1034
11,4	0,0045	0,0049	0,0051	0,0048
17,4	0,0040	0,0043	0,0046	0,0043
23,4	0,0035	0,0039	0,0042	0,0039
29,4	0,0033	0,0035	0,0039	0,0036
35,4	0,0029	0,0032	0,0033	0,0031
41,4	0,0027	0,0029	0,0031	0,0029
47,4	0,0024	0,0025	0,0028	0,0026
53,4	0,0020	0,0021	0,0025	0,0022
59,4	0,0018	0,0021	0,0023	0,0021
65,4	0,0016	0,0018	0,0021	0,0018
71,4	0,0013	0,0016	0,0014	0,0014
77,4	0,0011	0,0014	0,0003	0,0009
83,4	0,0009	0,0010	0,0003	0,0007

2.3.3 F50

Jam	U1	U2	U3	x
5,4	0,2175	0,1054	0,1163	0,1464
11,4	0,0058	0,0064	0,0061	0,0061
17,4	0,0052	0,0057	0,0056	0,0055
23,4	0,0046	0,0049	0,0048	0,0048
29,4	0,0040	0,0042	0,0042	0,0041

Jam	U1	U2	U3	x
35,4	0,0035	0,0034	0,0035	0,0035
41,4	0,0030	0,0028	0,0028	0,0029
47,4	0,0025	0,0023	0,0025	0,0024
53,4	0,0020	0,0014	0,0008	0,0014
59,4	0,0012	0,0006	0,0008	0,0009

2.3.4 F60

Jam	U1	U2	U3	x
5,4	0,1093	0,1048	0,1154	0,1098
11,4	0,0168	0,0178	0,0190	0,0179
17,4	0,0083	0,0079	0,0067	0,0076
23,4	0,0050	0,0042	0,0033	0,0042
29,4	0,0027	0,0013	0,0010	0,0017
35,4	0,0016	0,0009	0,0005	0,0010

2.4 Cupping test

Karakteristik	Sampel			
	SD	F40	F50	F60
<i>Fragrance</i>	8.00	8.00	8.00	7.88
<i>Flavor</i>	7.88	7.75	7.75	7.63
<i>Aftertaste</i>	7.75	7.75	7.75	7.50
<i>Salt/Acid</i>	7.50	7.50	7.63	7.50
<i>Bitter/Sweet</i>	7.63	7.50	7.50	7.50
<i>Mouthfeel/Body</i>	7.75	7.75	7.75	7.50
<i>Uniform Cups</i>	10.00	10.00	10.00	10.00
<i>Balance</i>	8.13	7.75	7.75	7.50
<i>Clean Cups</i>	10.00	10.00	10.00	10.00
<i>Overall</i>	7.75	7.75	7.75	7.50
<i>Taints-Faults</i>	0.00	0.00	0.00	0.00
<i>Final Score</i>	82.38	81.75	81.88	80.50
<i>Notes</i>	Brown sugar, caramel, spicy-chili like, harsh, astringent, aftertaste, nutty, chocolatey	Chocolatey, spicy-chilli like, astringent, aftertaste, brown sugar, cereally, caramel	Chocolatey, spicy-cili like, herbal	Brown sugar, toasty, nutty, spicy-chilli, chocolatey, nutty

2.5 Bulk density

Sampel	Bulk density (kg/l)			Rata-rata	Standar Deviasi
	U1	U2	U3		
SD	0,4412	0,4498	0,4443	0,4451	0,0044
F40	0,4465	0,4531	0,4477	0,4491	0,0035
F50	0,4621	0,4718	0,4665	0,4668	0,0049
F60	0,4712	0,4805	0,4757	0,4758	0,0047

Lampiran 3. Perhitungan

Lampiran 3.1 Efisiensi pengeringan

3.1.1 Sun drying

a. U1 sun drying

1. Interval 1 (hari ke 0 hingga hari ke 1)

$$\begin{aligned}\eta &= \frac{(1,7512 \text{ kg} - 1,1184 \text{ kg}) \times 2394 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 5,6 \text{ h}} \times 100\% \\ &= \frac{0,6328 \text{ kg} \times 2394 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 20.160 \text{ s}} \times 100\% \\ &= \frac{1.514,9232 \text{ kJ}}{172.730.880 \text{ ws}} \times 100\% \\ &= \frac{1.514,9232 \text{ kJ}}{172.730.880 \text{ J}} \times 100\% \\ &= \frac{1.514,9232 \text{ kJ}}{172.730,88 \text{ kJ}} \times 100\% \\ &= 0,0088770 \times 100\% \\ \eta &= 0,8770\%\end{aligned}$$

2. Interval 2 (hari ke 1 hingga hari ke 2)

$$\begin{aligned}\eta &= \frac{(1,1184 \text{ kg} - 1,0287 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 6 \text{ h}} \times 100\% \\ &= \frac{0,6328 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 21.600 \text{ s}} \times 100\% \\ &= \frac{215,8282 \text{ kJ}}{185.068.800 \text{ ws}} \times 100\% \\ &= \frac{215,8282 \text{ kJ}}{185.068.800 \text{ J}} \times 100\% \\ &= \frac{215,8282 \text{ kJ}}{185.068,8 \text{ kJ}} \times 100\% \\ &= 0,001166 \times 100\% \\ \eta &= 0,1166\%\end{aligned}$$

3. Interval 3 (hari ke 2 hingga hari ke 3)

$$\begin{aligned}\eta &= \frac{(1,0287 \text{ kg} - 1,0143 \text{ kg}) \times 2417,9 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 5,4 \text{ h}} \times 100\% \\ &= \frac{0,0144 \text{ kg} \times 2417,9 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 19.440 \text{ s}} \times 100\% \\ &= \frac{34,8178 \text{ kJ}}{166.561.920 \text{ ws}} \times 100\%\end{aligned}$$

$$= \frac{34,8178 \text{ kJ}}{166.561.920 \text{ J}} \times 100\%$$

$$= \frac{34,8178 \text{ kJ}}{166.561.920 \text{ kJ}} \times 100\%$$

$$= 0,000209 \times 100\%$$

$$\eta = 0,0209\%$$

4. Interval 4 (hari ke 3 hingga hari ke 4)

$$\eta = \frac{(1,0143 \text{ kg} - 1,0018 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 4,4 \text{ h}} \times 100\%$$

$$= \frac{0,0125 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 15.840 \text{ s}} \times 100\%$$

$$= \frac{30,0750 \text{ kJ}}{135.717.120 \text{ ws}} \times 100\%$$

$$= \frac{30,0750 \text{ kJ}}{135.717.120 \text{ J}} \times 100\%$$

$$= \frac{30,0750 \text{ kJ}}{135.717,12 \text{ kJ}} \times 100\%$$

$$= 0,000222 \times 100\%$$

$$\eta = 0,0222\%$$

5. Interval 5 (hari ke 4 hingga hari ke 5)

$$\eta = \frac{(1,0018 \text{ kg} - 0,9889 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 5,5 \text{ h}} \times 100\%$$

$$= \frac{0,0129 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 19.800 \text{ s}} \times 100\%$$

$$= \frac{31,0374 \text{ kJ}}{169.646.400 \text{ ws}} \times 100\%$$

$$= \frac{31,0374 \text{ kJ}}{169.646.400 \text{ J}} \times 100\%$$

$$= \frac{31,0374 \text{ kJ}}{169.646,4 \text{ kJ}} \times 100\%$$

$$= 0,000183 \times 100\%$$

$$\eta = 0,0183\%$$

b. U2 sun drying

1. Interval 1 (hari ke 0 hingga hari ke 1)

$$\eta = \frac{(1,7621 \text{ kg} - 1,1184 \text{ kg}) \times 2417,9 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 6,5 \text{ h}} \times 100\%$$

$$= \frac{0,5697 \text{ kg} \times 2417,9 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ W/m}^2 \times 23.400 \text{ s}} \times 100\%$$

$$= \frac{1.601,3752 \text{ kJ}}{200.491.200 \text{ Ws}} \times 100\%$$

$$= \frac{1.601,3752 \text{ kJ}}{200.491.200 \text{ J}} \times 100\%$$

$$= \frac{1.601,3752 \text{ kJ}}{200.491,2 \text{ kJ}} \times 100\%$$

$$= 0,007987 \times 100\%$$

$$\eta = 0,7987\%$$

2. Interval 2 (hari ke 1 hingga hari ke 2)

$$\eta = \frac{(1,2233 \text{ kg} - 1,0244 \text{ kg}) \times 2382 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ W/m}^2 \times 4,8 \text{ h}} \times 100\%$$

$$= \frac{0,0754 \text{ kg} \times 2382 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ W/m}^2 \times 17.280 \text{ s}} \times 100\%$$

$$= \frac{179,6068 \text{ kJ}}{148.055.040 \text{ Ws}} \times 100\%$$

$$= \frac{179,6068 \text{ kJ}}{148.055.040 \text{ J}} \times 100\%$$

$$= \frac{179,6068 \text{ kJ}}{148.055,04 \text{ kJ}} \times 100\%$$

$$= 0,001213 \times 100\%$$

$$\eta = 0,1213\%$$

3. Interval 3 (hari ke 2 hingga hari ke 3)

$$\eta = \frac{(1,0244 \text{ kg} - 1,0105 \text{ kg}) \times 2417,9 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ W/m}^2 \times 5 \text{ h}} \times 100\%$$

$$= \frac{0,0139 \text{ kg} \times 2417,9 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ W/m}^2 \times 18.000 \text{ s}} \times 100\%$$

$$= \frac{33,6088 \text{ kJ}}{154.224.000 \text{ Ws}} \times 100\%$$

$$= \frac{33,6088 \text{ kJ}}{154.224.000 \text{ J}} \times 100\%$$

$$= \frac{33,6088 \text{ kJ}}{154.224 \text{ kJ}} \times 100\%$$

$$= 0,000218 \times 100\%$$

$$\eta = 0,0218\%$$

4. Interval 4 (hari ke 3 hingga hari ke 4)

$$\begin{aligned}
 \eta &= \frac{(1,0105 \text{ kg} - 0,9985 \text{ kg}) \times 2382 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 4 \text{ h}} \times 100\% \\
 &= \frac{0,0120 \text{ kg} \times 2382 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 144.000 \text{ s}} \times 100\% \\
 &= \frac{28,5840 \text{ kJ}}{123.379.200 \text{ ws}} \times 100\% \\
 &= \frac{28,5840 \text{ kJ}}{123.379.200 \text{ J}} \times 100\% \\
 &= \frac{28,5840 \text{ kJ}}{123.379,2 \text{ kJ}} \times 100\% \\
 &= 0,000232 \times 100\% \\
 \eta &= 0,0232\%
 \end{aligned}$$

5. Interval 5 (hari ke 4 hingga hari ke 5)

$$\begin{aligned}
 \eta &= \frac{(0,9985 \text{ kg} - 0,9873 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 5 \text{ h}} \times 100\% \\
 &= \frac{0,0112 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 18.000 \text{ s}} \times 100\% \\
 &= \frac{26,9472 \text{ kJ}}{154.224.000 \text{ ws}} \times 100\% \\
 &= \frac{26,9472 \text{ kJ}}{154.224.000 \text{ J}} \times 100\% \\
 &= \frac{26,9472 \text{ kJ}}{154,224 \text{ kJ}} \times 100\% \\
 &= 0,000175 \times 100\% \\
 \eta &= 0,0175\%
 \end{aligned}$$

c. U3 sun drying

1. Interval 1 (hari ke 0 hingga hari ke 1)

$$\begin{aligned}
 \eta &= \frac{(1,7281 \text{ kg} - 1,1584 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 4,1 \text{ h}} \times 100\% \\
 &= \frac{0,5697 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 14,760 \text{ s}} \times 100\% \\
 &= \frac{1.370,6982 \text{ kJ}}{126.463.680 \text{ ws}} \times 100\% \\
 &= \frac{1.370,6982 \text{ kJ}}{126.463.680 \text{ J}} \times 100\%
 \end{aligned}$$

$$= \frac{1.370,6982 \text{ kJ}}{126.463,68 \text{ kJ}} \times 100\%$$

$$= 0,001494 \times 100\%$$

$$\eta = 0,1494\%$$

2. Interval 2 (hari ke 1 hingga hari ke 2)

$$\eta = \frac{(1,1584 \text{ kg} - 1,0435 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 6 \text{ h}} \times 100\%$$

$$= \frac{0,1149 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 21.600 \text{ s}} \times 100\%$$

$$= \frac{276,4494 \text{ kJ}}{185.068.800 \text{ ws}} \times 100\%$$

$$= \frac{633,252 \text{ kJ}}{185.068.800 \text{ J}} \times 100\%$$

$$= \frac{633,252 \text{ kJ}}{185.068,8 \text{ kJ}} \times 100\%$$

$$= 0,001494 \times 100\%$$

$$\eta = 0,1494\%$$

3. Interval 3 (hari ke 2 hingga hari ke 3)

$$\eta = \frac{(1,0435 \text{ kg} - 1,0088 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 6,4 \text{ h}} \times 100\%$$

$$= \frac{0,0347 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 23.040 \text{ s}} \times 100\%$$

$$= \frac{83,4882 \text{ kJ}}{197.406.720 \text{ ws}} \times 100\%$$

$$= \frac{83,4882 \text{ kJ}}{197.406.720 \text{ J}} \times 100\%$$

$$= \frac{83,4882 \text{ kJ}}{197.406,72 \text{ kJ}} \times 100\%$$

$$= 0,000423 \times 100\%$$

$$\eta = 0,0423\%$$

4. Interval 4 (hari ke 3 hingga hari ke 4)

$$\eta = \frac{(1,0088 \text{ kg} - 0,9939 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 7,2 \text{ h}} \times 100\%$$

$$= \frac{0,0149 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 25.920 \text{ s}} \times 100\%$$

$$= \frac{35,8494 \text{ kJ}}{222.082.560 \text{ ws}} \times 100\%$$

$$= \frac{35,8494 \text{ kJ}}{222.082.560 \text{ J}} \times 100\%$$

$$= \frac{35,8494 \text{ kJ}}{222.082,56 \text{ kJ}} \times 100\%$$

$$= 0,000161 \times 100\%$$

$$\eta = 0,0161\%$$

5. Interval 5 (hari ke 4 hingga hari ke 5)

$$\eta = \frac{(0,9939 \text{ kg} - 0,9826 \text{ kg}) \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 6,6 \text{ h}} \times 100\%$$

$$= \frac{0,0113 \text{ kg} \times 2406 \text{ kJ/kg}}{2040 \text{ m}^2 \times 4,2 \text{ w/m}^2 \times 23.760 \text{ s}} \times 100\%$$

$$= \frac{27,1878 \text{ kJ}}{203.575.680 \text{ ws}} \times 100\%$$

$$= \frac{27,1878 \text{ kJ}}{203.575.680 \text{ J}} \times 100\%$$

$$= \frac{27,1878 \text{ kJ}}{203.575,68 \text{ kJ}} \times 100\%$$

$$= 0,000134 \times 100\%$$

$$\eta = 0,0134\%$$

d. Rata-rata SD

1. Interval 1 (hari ke 0 hingga ke 1)

$$\bar{x} = \frac{0,8770\% + 0,7987\% + 1,0839\%}{3}$$

$$= 0,9199\%$$

2. Interval 2 (hari ke 1 hingga ke 2)

$$\bar{x} = \frac{0,1166\% + 0,1213\% + 0,1494\%}{3}$$

$$= 0,1291\%$$

3. Interval 3 (hari ke 2 hingga ke 3)

$$\bar{x} = \frac{0,0209\% + 0,0218\% + 0,0423\%}{3}$$

$$= 0,0283\%$$

4. Interval 4 (hari ke 3 hingga ke 4)

$$\bar{x} = \frac{0,0222\% + 0,0232\% + 0,0161\%}{3}$$

$$= 0,0205\%$$

5. Interval 5 (hari ke 4 hingga ke 5)

$$\bar{x} = \frac{0,0118\% + 0,0103\% + 0,0103\%}{3}$$

$$= 0,0108\%$$

3.1.2 Fermentor F40

a. U1 fermentor F40

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,1926 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1759)$$

$$cp = 2,4400 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{(1,1758 - 1,1486) \text{ kg} \times 2,4400 \text{ kJ/kg}^\circ\text{C} \times (41,3 - 31,3)^\circ\text{C} + ((1,1758 - 1,1486) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0272 \text{ kg} \times 2,4400 \text{ kJ/kg}^\circ\text{C} \times 10^\circ\text{C}) + (0,0272 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,6637 \text{ kJ} + 64,1294 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{64,7931 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002927 \times 100\%$$

$$\eta = 0,2927\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 1666)$$

$$cp = 2,4011 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1486 - 1,1245) \text{ kg} \times 2,4011 \text{ kJ/kg}^\circ\text{C} \times (41,2 - 31,2)^\circ\text{C}) + (1,1486 - 1,1245) \text{ kg} \times 2357,7 \text{ kJ/kg}}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0241 \text{ kg} \times 2,4011 \text{ kJ/kg}^\circ\text{C} \times 10^\circ\text{C}) + (0,0241 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,5787 \text{ kJ} + 56,8206 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{57,3993 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002593 \times 100\%$$

$$\eta = 0,2593\%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1584)$$

$$cp = 2,3668 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1245 - 1,1034) \text{ kg} \times 2,3668 \text{ kJ/kg}^\circ\text{C} \times (40,9 - 31)^\circ\text{C}) + ((1,1245 - 1,1034) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0211 \text{ kg} \times 2,3668 \text{ kJ/kg}^\circ\text{C} \times 9,9^\circ\text{C}) + (0,0211 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,4944 \text{ kJ} + 49,7475 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{50,2419 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002269 \times 100\%$$

$$\eta = 0,2269\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1513)$$

$$cp = 2,3370 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1034 - 1,0838) \text{ kg} \times 2,3370 \text{ kJ/kg}^\circ\text{C} \times (40,6 - 30,8)^\circ\text{C}) + ((1,1034 - 1,0838) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0196 \text{ kg} \times 2,3370 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0196 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,4489 \text{ kJ} + 46,2109 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{46,6598 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002107 \times 100\%$$

$$\eta = 0,2107\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 1452)$$

$$cp = 2,3115 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0838 - 1,0667) \text{ kg} \times 2,3115 \text{ kJ/kg}^\circ\text{C} \times (40,9 - 31,1)^\circ\text{C}) + ((1,0838 - 1,0667) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0171 \text{ kg} \times 2,3115 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0171 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3874 \text{ kJ} + 40,3167 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{40,7041 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001838 \times 100\%$$

$$\eta = 0,1838\%$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1409)$$

$$cp = 2,2935 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0667 - 1,0503) \text{ kg} \times 2,2935 \text{ kJ/kg}^\circ\text{C} \times (41,1 - 31,3)^\circ\text{C}) + ((1,0667 - 1,0503) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0164 \text{ kg} \times 2,2935 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0164 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3686 \text{ kJ} + 38,6663 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{39,0349 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001763 \times 100\%$$

$$\eta = 0,1763\%$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1365)$$

$$c_p = 2,2751 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0503 - 1,0362) \text{ kg} \times 2,2751 \text{ kJ/kg}^\circ\text{C} \times (40,2 - 30,4)^\circ\text{C}) + ((1,0503 - 1,0362) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0141 \text{ kg} \times 2,2751 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0141 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3144 \text{ kJ} + 33,2436 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{33,5580 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001516 \times 100\%$$

$$\eta = 0,1516\%$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1332)$$

$$c_p = 2,2613 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0362 - 1,0241) \text{ kg} \times 2,2613 \text{ kJ/kg}^\circ\text{C} \times (40,6 - 30,9)^\circ\text{C}) + ((1,0362 - 1,0241) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0121 \text{ kg} \times 2,2613 \text{ kJ/kg}^\circ\text{C} \times 9,7^\circ\text{C}) + (0,0121 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2654 \text{ kJ} + 28,5282 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{28,7936 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001301 \times 100\%$$

$$\eta = 0,1301\%$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1305)$$

$$c_p = 2,2499 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0241 - 1,0133) \text{ kg} \times 2,2499 \text{ kJ/kg}^\circ\text{C} \times (40,4 - 30,7)^\circ\text{C}) + ((1,0241 - 1,0133) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0108 \text{ kg} \times 2,2499 \text{ kJ/kg}^\circ\text{C} \times 9,7^\circ\text{C}) + (0,0108 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2357 \text{ kJ} + 25,4632 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{25,6989 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001161 \times 100\%$$

$$\eta = 0,1161\%$$

10) Interval 10 (Jam ke 54 hingga jam ke 60)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1282)$$

$$cp = 2,2403 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0133 - 1,0037)\text{kg} \times 2,2403\text{kJ/kg}^\circ\text{C} \times (40,9 - 31,2)^\circ\text{C}) + ((1,0133 - 1,0037)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0096 \text{ kg} \times 2,2403 \text{ kJ/kg}^\circ\text{C} \times 9,7^\circ\text{C}) + (0,0096 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2086\text{kJ} + 22,6339\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{22,8425 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001032 \times 100\%$$

$$\eta = 0,1032\%$$

11) Interval 11 (Jam ke 60 hingga jam ke 66)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1267)$$

$$cp = 2,2340 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0037 - 0,9959)\text{kg} \times 2,2340\text{kJ/kg}^\circ\text{C} \times (40,9 - 31,2)^\circ\text{C}) + ((1,0037 - 0,9959)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0078 \text{ kg} \times 2,2340 \text{ kJ/kg}^\circ\text{C} \times 9,6^\circ\text{C}) + (0,0078 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1673\text{kJ} + 18,3901\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{18,5574 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000838 \times 100\%$$

$$\eta = 0,0838\%$$

12) Interval 12 (Jam ke 66 hingga jam ke 72)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1252)$$

$$cp = 2,2278 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9959 - 0,9894)\text{kg} \times 2,2278\text{kJ/kg}^\circ\text{C} \times (40,5 - 30,9)^\circ\text{C}) + ((0,9959 - 0,9894)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0065 \text{ kg} \times 2,2278 \text{ kJ/kg}^\circ\text{C} \times 9,6^\circ\text{C}) + (0,0065 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1390\text{kJ} + 15,3251\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{15,4641 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000698 \times 100\%$$

$$\eta = 0,0698\%$$

13) Interval 13 (Jam ke 72 hingga jam ke 78)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1243)$$

$$cp = 2,2240 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9894 - 0,9842)\text{kg} \times 2,2240\text{kJ/kg}^\circ\text{C} \times (40,1 - 30,7)^\circ\text{C}) + ((0,9894 - 0,9842)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0052 \text{ kg} \times 2,2240 \text{ kJ/kg}^\circ\text{C} \times 9,4^\circ\text{C}) + (0,0052 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1087\text{kJ} + 12,2600\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{12,3687 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000559 \times 100\%$$

$$\eta = 0,0559\%$$

b. U2 Fermentor F40

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1767)$$

$$cp = 2,4434 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1926 - 1,1634)\text{kg} \times 2,4434\text{kJ/kg}^\circ\text{C} \times (41,1 - 31,1)^\circ\text{C}) + ((1,1926 - 1,1634)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0292\text{kg} \times 2,4434\text{kJ/kg}^\circ\text{C} \times 10^\circ\text{C}) + (0,0292\text{kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,7135\text{kJ} + 68,8448\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{69,5583 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003142 \times 100\%$$

$$\eta = 0,3142\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1673)$$

$$cp = 2,4040 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1634 - 1,1378)\text{kg} \times 2,4040\text{kJ/kg}^\circ\text{C} \times (41,3 - 31,3)^\circ\text{C}) + ((1,1634 - 1,1378)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,6154 \text{ kg} \times 2,4040 \text{ kJ/kg}^\circ\text{C} \times 10^\circ\text{C}) + (0,6154 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,6154 \text{ kJ} + 60,3571 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{60,9725 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002754 \times 100\%$$

$$\eta = 0,2754\%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1585)$$

$$c_p = 2,3672 \text{ kJ/kg}^\circ\text{C}$$

$$\begin{aligned}\eta &= \frac{((1,1378 - 1,1144)\text{kg} \times 2,3672\text{kJ/kg}^\circ\text{C} \times (41 - 31)^\circ\text{C}) + ((1,1378 - 1,1144)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\% \\ &= \frac{((0,0234\text{kg} \times 2,3672 \text{ kJ/kg}^\circ\text{C} \times 10^\circ\text{C}) + (0,5539\text{kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\% \\ &= \frac{(0,5539 \text{ kJ} + 55,1702\text{kJ})}{22.140.000 \text{ J}} \times 100\% \\ &= \frac{55,7241 \text{ kJ}}{22.140 \text{ kJ}} \times 100\% \\ &= 0,002517 \times 100\%\end{aligned}$$

$$\eta = 0,2517\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1515)$$

$$c_p = 2,3379 \text{ kJ/kg}^\circ\text{C}$$

$$\begin{aligned}\eta &= \frac{((1,1144 - 1,0937)\text{kg} \times 2,3379\text{kJ/kg}^\circ\text{C} \times (40,5 - 30,6)^\circ\text{C}) + ((1,1144 - 1,0937)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\% \\ &= \frac{((0,0207 \text{ kg} \times 2,3379 \text{ kJ/kg}^\circ\text{C} \times 9,9^\circ\text{C}) + (0,0207\text{kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\% \\ &= \frac{(0,04791 \text{ kJ} + 48,8044 \text{ kJ})}{22.140.000 \text{ J}} \times 100\% \\ &= \frac{49,2835 \text{ kJ} + 57,8563 \text{ W}}{22.140 \text{ kJ}} \times 100\% \\ &= 0,002226 \times 100\%\end{aligned}$$

$$\eta = 0,2226\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1448)$$

$$c_p = 2,3098 \text{ kJ/kg}^\circ\text{C}$$

$$\begin{aligned}\eta &= \frac{((1,0937 - 1,0745)\text{kg} \times 2,3098\text{kJ/kg}^\circ\text{C} \times (41,1 - 31,3)^\circ\text{C}) + ((1,0937 - 1,0745)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\% \\ &= \frac{((0,0192 \text{ kg} \times 2,3098 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0192 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\% \\ &= \frac{(0,04346 \text{ kJ} + 45,2678 \text{ kJ})}{22.140.000 \text{ J}} \times 100\% \\ &= \frac{45,7024 \text{ kJ}}{22.140 \text{ kJ}} \times 100\% \\ &= 0,002064 \times 100\%\end{aligned}$$

$$\eta = 0,2064\%$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1395)$$

$$cp = 2,2875 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0745 - 1,0537)\text{kg} \times 2,2875 \text{ kJ/kg}^\circ\text{C} \times (41,2 - 31,5)^\circ\text{C}) + ((1,0745 - 1,0537)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0172 \text{ kg} \times 2,2875 \text{ kJ/kg}^\circ\text{C} \times 9,7^\circ\text{C}) + (0,0172 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3817 \text{ kJ} + 40,5524 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{40,9341 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001849 \times 100\%$$

$$\eta = 0,1849\%$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1347)$$

$$cp = 2,2675 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0573 - 1,0421)\text{kg} \times 2,2675\text{kJ/kg} \times (40,4 - 30,7)^\circ\text{C}) + ((1,0573 - 1,0421)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0152 \text{ kg} \times 2,2675 \text{ kJ/kg}^\circ\text{C} \times 9,7^\circ\text{C}) + (0,0152 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3343\text{kJ} + 35,8370\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{36,1713 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001634 \times 100\%$$

$$\eta = 0,1634\%$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1312)$$

$$cp = 2,2529 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0421 - 1,0297)\text{kg} \times 2,2529\text{kJ/kg}^\circ\text{C} \times (40,7 - 31)^\circ\text{C}) + ((1,0421 - 1,0297)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0124\text{kg} \times 2,2529 \text{ kJ/kg}^\circ\text{C} \times 9,7^\circ\text{C}) + (0,0124\text{kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2710 \text{ kJ} + 29,2355 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{29,5065 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001333 \times 100\%$$

$$\eta = 0,1333\%$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1287)$$

$$c_p = 2,2424 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0297 - 1,0174) \text{ kg} \times 2,2424 \text{ kJ/kg}^\circ\text{C} \times (40,2 - 30,7)^\circ\text{C}) + ((1,0297 - 1,0174) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0123 \text{ kg} \times 2,2424 \text{ kJ/kg}^\circ\text{C} \times 9,5^\circ\text{C}) + (0,0123 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2620 \text{ kJ} + 28,9997 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{29,2617 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001322 \times 100\%$$

$$\eta = 0,1322\%$$

10) Interval 10 (Jam ke 54 hingga jam ke 60)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1287)$$

$$c_p = 2,2340 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0174 - 1,0069) \text{ kg} \times 2,2340 \text{ kJ/kg}^\circ\text{C} \times (40,7 - 31,2)^\circ\text{C}) + ((1,0174 - 1,0069) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0105 \text{ kg} \times 2,2340 \text{ kJ/kg}^\circ\text{C} \times 9,5^\circ\text{C}) + (0,0105 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2228 \text{ kJ} + 24,7559 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{24,9787 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001128 \times 100\%$$

$$\eta = 0,1128\%$$

11) Interval 11 (Jam ke 60 hingga jam ke 66)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1252)$$

$$c_p = 2,2278 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0069 - 0,9975) \text{ kg} \times 2,2278 \text{ kJ/kg}^\circ\text{C} \times (40,9 - 31,4)^\circ\text{C}) + ((1,0069 - 0,9975) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0094 \text{ kg} \times 2,2278 \text{ kJ/kg}^\circ\text{C} \times 9,5^\circ\text{C}) + (0,0094 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1989 \text{ kJ} + 22,1624 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{22,3613 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001010 \times 100\%$$

$$\eta = 0,1010\%$$

12) Interval 10 (Jam ke 66 hingga jam ke 72)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1245)$$

$$cp = 2,2248 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9975 - 0,9891)\text{kg} \times 2,2248\text{kJ/kg}^\circ\text{C} \times (40,6 - 31,2)^\circ\text{C}) + ((0,9975 - 0,9891)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0084 \text{ kg} \times 2,2248 \text{ kJ/kg}^\circ\text{C} \times 9,4^\circ\text{C}) + (0,0084 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1757 \text{ kJ} + 19,8047 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{19,9804 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000902 \times 100\%$$

$$\eta = 0,0902\%$$

13) Interval 13 (Jam ke 72 hingga jam ke 78)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1239)$$

$$cp = 2,2223 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9891 - 0,9829)\text{kg} \times 2,2223\text{kJ/kg}^\circ\text{C} \times (40,3 - 30,9)^\circ\text{C}) + ((0,9891 - 0,9829)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0062 \text{ kg} \times 2,2223 \text{ kJ/kg}^\circ\text{C} \times 9,4^\circ\text{C}) + (0,0062 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1295 \text{ kJ} + 14,6177 \text{ kJ}) + 54,9343 \text{ W}}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{14,7472 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000666 \times 100\%$$

$$\eta = 0,0666\%$$

c. U3 Fermentor F40

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1794)$$

$$cp = 2,4547 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1980 - 1,1673)\text{kg} \times 2,4547\text{kJ/kg}^\circ\text{C} \times (41,3 - 31,3)^\circ\text{C}) + ((1,1980 - 1,1673)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0307 \text{ kg} \times 2,4547 \text{ kJ/kg}^\circ\text{C} \times 10^\circ\text{C}) + (0,0307 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,7536 \text{ kJ} + 72,3814 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{73,1350 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003303 \times 100\%$$

$$\eta = 0,3303\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1696)$$

$$c_p = 2,4137 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1673 - 1,1396)\text{kg} \times 2,4137 \text{ kJ/kg}^\circ\text{C} \times (41,2 - 31,2)^\circ\text{C}) + ((1,1673 - 1,1396)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0277 \text{ kg} \times 2,4137 \text{ kJ/kg}^\circ\text{C} \times 10^\circ\text{C}) + (0,0277 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,6686 \text{ kJ} + 65,3083 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{65,9769 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002980 \times 100\%$$

$$\eta = 0,2980\%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1615)$$

$$c_p = 2,3797 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1396 - 1,1142)\text{kg} \times 2,3797 \text{ kJ/kg}^\circ\text{C} \times (40,9 - 31)^\circ\text{C}) + ((1,1396 - 1,1142)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0254 \text{ kg} \times 2,3797 \text{ kJ/kg}^\circ\text{C} \times 9,9^\circ\text{C}) + (0,0254 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,5984 \text{ kJ} + 59,8856 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{60,4840 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002732 \times 100\%$$

$$\eta = 0,2732\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1535)$$

$$c_p = 2,3462 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1142 - 1,0911)\text{kg} \times 2,3462 \text{ kJ/kg}^\circ\text{C} \times (40,7 - 30,8)^\circ\text{C}) + ((1,1142 - 1,0911)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0231 \text{ kg} \times 2,3462 \text{ kJ/kg}^\circ\text{C} \times 9,9^\circ\text{C}) + (0,0231 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,5366 \text{ kJ} + 54,4629 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{54,9994 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002484 \times 100\%$$

$$\eta = 0,2484\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1474)$$

$$c_p = 2,3207 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0911 - 1,0716)\text{kg} \times 2,3207 \text{ kJ/kg}^\circ\text{C} \times (41 - 31,2)^\circ\text{C}) + ((1,0911 - 1,0716)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0195 \text{ kg} \times 2,3207 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0195 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,4435 \text{ kJ} + 45,9752 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{46,4186 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002097 \times 100\%$$

$$\eta = 0,2097\%$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1419)$$

$$c_p = 2,2977 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0716 - 1,0528)\text{kg} \times 2,2977 \text{ kJ/kg}^\circ\text{C} \times (41,1 - 31,3)^\circ\text{C}) + ((1,0716 - 1,0528)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0188 \text{ kg} \times 2,2977 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0188 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,4233 \text{ kJ} + 44,3248 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{44,7481 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002021 \times 100\%$$

$$\eta = 0,2021\%$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1374)$$

$$c_p = 2,2788 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0532 - 1,0358)\text{kg} \times 2,2788 \text{ kJ/kg}^\circ\text{C} \times (40,2 - 30,4)^\circ\text{C}) + ((1,0532 - 1,0358)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0170 \text{ kg} \times 2,2788 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0170 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3796 \text{ kJ} + 40,0809 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{40,4605 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001827 \times 100\%$$

$$\eta = 0,1827\%$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1335)$$

$$c_p = 2,2625 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0358 - 1,0207)\text{kg} \times 2,2625\text{kJ/kg}^\circ\text{C} \times (40,6 - 30,8)^\circ\text{C}) + ((1,0358 - 1,0207)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0151 \text{ kg} \times 2,2625 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0151 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3348 \text{ kJ} + 35,6013 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{35,9361 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001623 \times 100\%$$

$$\eta = 0,1623\%$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1305)$$

$$c_p = 2,2499 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0207 - 1,0069)\text{kg} \times 2,2499\text{kJ/kg}^\circ\text{C} \times (40,4 - 30,6)^\circ\text{C}) + ((1,0207 - 1,0069)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0138 \text{ kg} \times 2,2499 \text{ kJ/kg}^\circ\text{C} \times 9,8^\circ\text{C}) + (0,0138 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3043 \text{ kJ} + 32,5363 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{32,8405 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001483 \times 100\%$$

$$\eta = 0,1483\%$$

10) Interval 10 (Jam ke 54 hingga jam ke 60)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1277)$$

$$c_p = 2,2382 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0069 - 0,9944)\text{kg} \times 2,2382\text{kJ/kg}^\circ\text{C} \times (40,9 - 31,2)^\circ\text{C}) + ((1,0069 - 0,9944)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0125 \text{ kg} \times 2,2382 \text{ kJ/kg}^\circ\text{C} \times 9,7^\circ\text{C}) + (0,0125 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2714 \text{ kJ} + 29,4713 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{29,7426 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001343 \times 100\%$$

$$\eta = 0,1343\%$$

11) Interval 11 (Jam ke 60 hingga jam ke 66)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1259)$$

$$cp = 2,2307 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9944 - 0,9862)\text{kg} \times 2,2307 \text{ kJ/kg}^\circ\text{C} \times (40,9 - 31,2)^\circ\text{C}) + ((0,9944 - 0,9862)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0082 \text{ kg} \times 2,2307 \text{ kJ/kg}^\circ\text{C} \times 9,7^\circ\text{C}) + (0,0082 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1774 \text{ kJ} + 19,3331\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{19,5106 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000881 \times 100\%$$

$$\eta = 0,0881\%$$

12) Interval 12 (Jam ke 66 hingga jam ke 72)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1244)$$

$$cp = 2,2244 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9862 - 0,9843)\text{kg} \times 2,2244 \text{ kJ/kg}^\circ\text{C} \times (40,5 - 31,2)^\circ\text{C}) + ((0,9862 - 0,9843)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0019 \text{ kg} \times 2,2244 \text{ kJ/kg}^\circ\text{C} \times 9,4^\circ\text{C}) + (0,0397 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,0397 \text{ kJ} + 4,4796 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{4,5194 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000204 \times 100\%$$

$$\eta = 0,0204\%$$

13) Interval 13 (Jam ke 72 hingga jam ke 78)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1238)$$

$$cp = 2,2219 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9843 - 0,9827)\text{kg} \times 2,2219 \text{ kJ/kg}^\circ\text{C} \times (40,1 - 31,2)^\circ\text{C}) + ((0,9843 - 0,9827)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0016 \text{ kg} \times 2,2219 \text{ kJ/kg}^\circ\text{C} \times 8,9^\circ\text{C}) + (0,0016 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,0316 \text{ kJ} + 3,7723 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{3,8040 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000172 \times 100\%$$

$$\eta = 0,0172\%$$

d. Rata-rata F40

1. Pra-fermentor

$$\begin{aligned}\bar{x} &= \frac{0,8146\% + 0,8419\% + 0,7630\%}{3} \\ &= 0,8065\%\end{aligned}$$

2. Interval 1 (Jam ke 5,4 hingga jam ke 11,4)

$$\begin{aligned}\bar{x} &= \frac{0,2927\% + 0,3142\% + 0,3303\%}{3} \\ &= 0,3124\%\end{aligned}$$

3. Interval 2 (Jam ke 11,4 hingga jam ke 17,4)

$$\begin{aligned}\bar{x} &= \frac{0,2593\% + 0,2754\% + 0,2980\%}{3} \\ &= 0,2776\%\end{aligned}$$

4. Interval 3 (Jam ke 17,4 hingga jam ke 23,4)

$$\begin{aligned}\bar{x} &= \frac{0,2269\% + 0,2517\% + 0,2732\%}{3} \\ &= 0,2506\%\end{aligned}$$

5. Interval 4 (Jam ke 23,4 hingga jam ke 29,4)

$$\begin{aligned}\bar{x} &= \frac{0,2107\% + 0,2226\% + 0,2484\%}{3} \\ &= 0,2272\%\end{aligned}$$

6. Interval 5 (Jam ke 29,4 hingga jam ke 35,4)

$$\begin{aligned}\bar{x} &= \frac{0,1838\% + 0,2064\% + 0,2097\%}{3} \\ &= 0,2000\%\end{aligned}$$

7. Interval 6 (Jam ke 35,4 hingga jam ke 41,4)

$$\begin{aligned}\bar{x} &= \frac{0,1763\% + 0,1849\% + 0,2021\%}{3} \\ &= 0,1878\%\end{aligned}$$

8. Interval 7 (Jam ke 41,4 hingga jam ke 47,4)

$$\begin{aligned}\bar{x} &= \frac{0,1516\% + 0,1634\% + 0,1827\%}{3} \\ &= 0,1659\%\end{aligned}$$

9. Interval 8 (Jam ke 47,4 hingga jam ke 53,4)

$$\begin{aligned}\bar{x} &= \frac{0,1301\% + 0,1333\% + 0,1623\%}{3} \\ &= 0,1419\%\end{aligned}$$

10. Interval 9 (Jam ke 53,4 hingga jam ke 59,4)

$$\bar{x} = \frac{0,1161\% + 0,1322\% + 0,1483\%}{3}$$

$$= 0,1322\%$$

11. Interval 10 (Jam ke 65,4 hingga jam ke 71,4)

$$\bar{x} = \frac{0,1302\% + 0,1128\% + 0,1343\%}{3}$$

$$= 0,1168\%$$

12. Interval 11 (Jam ke 71,4 hingga jam ke 77,4)

$$\bar{x} = \frac{0,0838\% + 0,1010\% + 0,0881\%}{3}$$

$$= 0,0910\%$$

13. Interval 12 (Jam ke 77,4 hingga jam ke 83,4)

$$\bar{x} = \frac{0,0698\% + 0,0902\% + 0,0204\%}{3}$$

$$= 0,0601\%$$

14. Interval 13 (Jam ke 72 hingga jam ke 78)

$$\bar{x} = \frac{0,0559\% + 0,0666\% + 0,0172\%}{3}$$

$$= 0,0466\%$$

3.1.3 Fermentor F50

a. U1 Fermentor F50

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1681)$$

$$cp = 2,4704 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1745 - 1,1395)\text{kg} \times 2,4704 \text{ kJ/kg}^\circ\text{C} \times (50,9 - 33,6)^\circ\text{C}) + ((1,1745 - 1,1395)\text{kg} \times 2357,7\text{kJ/kg}))}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0350 \text{ kg} \times 2,4704 \text{ kJ/kg}^\circ\text{C} \times 17,3^\circ\text{C}) + (0,0350 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,4577 \text{ kJ} + 82,5195 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{83,9772 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003793 \times 100\%$$

$$\eta = 0,03793\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1597)$$

$$c_p = 2,3722 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1395 - 1,1085)\text{kg} \times 2,3722 \text{ kJ/kg}^\circ\text{C} \times (50,3 - 33,2)^\circ\text{C}) + ((1,1395 - 1,1085)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0310 \text{ kg} \times 2,3722 \text{ kJ/kg}^\circ\text{C} \times 17,1^\circ\text{C}) + (0,0310 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,2575 \text{ kJ} + 73,0887 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{74,3462 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003358 \times 100\%$$

$$\eta = 0,3358\%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1515)$$

$$c_p = 2,3379 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1085 - 1,0812)\text{kg} \times 2,3379 \text{ kJ/kg}^\circ\text{C} \times (50,3 - 33,2)^\circ\text{C}) + ((1,1085 - 1,0812)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0273 \text{ kg} \times 2,3379 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0273 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,0786 \text{ kJ} + 64,3652 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{65,4438 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002956 \times 100\%$$

$$\eta = 0,2956\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1456)$$

$$c_p = 2,3132 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0812 - 1,0573)\text{kg} \times 2,3132 \text{ kJ/kg}^\circ\text{C} \times (50,6 - 33,7)^\circ\text{C}) + ((1,0812 - 1,0573)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0239 \text{ kg} \times 2,3132 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0239 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,9343 \text{ kJ} + 56,3490 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{57,2833 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002587 \times 100\%$$

$$\eta = 0,2587\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1400)$$

$$cp = 2,2897 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0573 - 1,0365)\text{kg} \times 2,2897 \text{ kJ/kg}^\circ\text{C} \times (50,0 - 33,5)^\circ\text{C}) + ((1,0573 - 1,0365)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0208 \text{ kg} \times 2,2897 \text{ kJ/kg}^\circ\text{C} \times 16,5^\circ\text{C}) + (0,0208 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,7858 \text{ kJ} + 49,0402\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{49,8260 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002250 \times 100\%$$

$$\eta = 0,2250\%$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1345)$$

$$cp = 2,2667 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0365 - 1,0186)\text{kg} \times 2,2667 \text{ kJ/kg}^\circ\text{C} \times (50,1 - 33,6)^\circ\text{C}) + ((1,0365 - 1,0186)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0179 \text{ kg} \times 2,2667 \text{ kJ/kg}^\circ\text{C} \times 16,5^\circ\text{C}) + (0,0179 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,6695 \text{ kJ} + 42,2028 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{42,8723 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001936 \times 100\%$$

$$\eta = 0,1936 \%$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1300)$$

$$cp = 2,2479 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0186 - 1,0037)\text{kg} \times 2,2479 \text{ kJ/kg}^\circ\text{C} \times (50,3 - 33,8)^\circ\text{C}) + ((1,0186 - 1,0037)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0149 \text{ kg} \times 2,2479 \text{ kJ/kg}^\circ\text{C} \times 16,5^\circ\text{C}) + (0,0149 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,5526 \text{ kJ} + 35,1297 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{35,6823 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001612 \times 100\%$$

$$\eta = 0,1612\%$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1265)$$

$$cp = 2,2332 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0037 - 0,9915)\text{kg} \times 2,2332 \text{ kJ/kg}^\circ\text{C} \times (50,2 - 33,7)^\circ\text{C}) + ((1,0037 - 0,9915)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0122 \text{ kg} \times 2,2332 \text{ kJ/kg}^\circ\text{C} \times 16,5^\circ\text{C}) + (0,0122 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,4495 \text{ kJ} + 28,7639 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{29,2134 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001319 \times 100\%$$

$$\eta = 0,1319 \%$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1247)$$

$$cp = 2,2257 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9915 - 0,9843)\text{kg} \times 2,2257 \text{ kJ/kg}^\circ\text{C} \times (50,3 - 33,8)^\circ\text{C}) + ((0,9915 - 0,9843)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0072 \text{ kg} \times 2,2257\text{kJ/kg}^\circ\text{C} \times 16,5^\circ\text{C}) + (0,0072 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2644 \text{ kJ} + 16,9754 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{17,2398 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000779 \times 100\%$$

$$\eta = 0,0779\%$$

b. U2 Fermentor F50

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1673)$$

$$cp = 2,4040 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1730 - 1,1345)\text{kg} \times 2,4040\text{kJ/kg}^\circ\text{C} \times (50,5 - 33,6)^\circ\text{C}) + ((1,1730 - 1,1345)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0385 \text{ kg} \times 2,4040\text{kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0385 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,5642 \text{ kJ} + 90,7715 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{92,3357 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,004171 \times 100\%$$

$$\eta = 0,4171\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1588)$$

$$c_p = 2,3684 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1345 - 1,1006)\text{kg} \times 2,3684 \text{ kJ/kg}^\circ\text{C} \times (50,7 - 33,8)^\circ\text{C}) + ((1,1345 - 1,1006)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0339 \text{ kg} \times 2,3684 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0339 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,3569 \text{ kJ} + 79,9260 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{81,2829 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003671 \times 100\%$$

$$\eta = 0,3671\%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1509)$$

$$c_p = 2,3354 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1006 - 1,0713)\text{kg} \times 2,3354 \text{ kJ/kg}^\circ\text{C} \times (50,6 - 33,7)^\circ\text{C}) + ((1,1006 - 1,0713)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0293 \text{ kg} \times 2,3354 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0293 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,1564 \text{ kJ} + 69,0806\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{70,2370 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003172 \times 100\%$$

$$\eta = 0,3172\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1449)$$

$$c_p = 2,3102 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0713 - 1,0460)\text{kg} \times 2,3102 \text{ kJ/kg}^\circ\text{C} \times (50,4 - 33,6)^\circ\text{C}) + ((1,0713 - 1,0460)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0253 \text{ kg} \times 2,3102 \text{ kJ/kg}^\circ\text{C} \times 16,8^\circ\text{C}) + (0,0253 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,9819 \text{ kJ} + 59,6498 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{60,6317 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002739 \times 100\%$$

$$\eta = 0,2739\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1395)$$

$$c_p = 2,2876 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0460 - 1,0255)\text{kg} \times 2,2876 \text{ kJ/kg}^\circ\text{C} \times (51,0 - 34,2)^\circ\text{C}) + ((1,0460 - 1,0255)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0205 \text{ kg} \times 2,2876 \text{ kJ/kg}^\circ\text{C} \times 16,8^\circ\text{C}) + (0,0205 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,7878 \text{ kJ} + 48,3329 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{49,1207 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002219 \times 100\%$$

$$\eta = 0,2219\%$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1344)$$

$$c_p = 2,2663 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0255 - 1,0088)\text{kg} \times 2,2663 \text{ kJ/kg}^\circ\text{C} \times (50,7 - 33,9)^\circ\text{C}) + ((1,0255 - 1,0088)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0167 \text{ kg} \times 2,2663 \text{ kJ/kg}^\circ\text{C} \times 16,8^\circ\text{C}) + (0,0167 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,6358 \text{ kJ} + 39,3736 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{40,0094 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,0976 \times 100\%$$

$$\eta = 9,76\%$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1295)$$

$$c_p = 2,2458 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0088 - 0,9950)\text{kg} \times 2,2458 \text{ kJ/kg}^\circ\text{C} \times (50,8 - 34,0)^\circ\text{C}) + ((1,0088 - 0,9950)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0138 \text{ kg} \times 2,2458 \text{ kJ/kg}^\circ\text{C} \times 16,8^\circ\text{C}) + (0,0138 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,5207\text{kJ} + 32,5363 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{33,0570 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001493 \times 100\%$$

$$\eta = 0,1493 \%$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1265)$$

$$cp = 2,2332 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9950 - 0,9868)\text{kg} \times 2,2332 \text{ kJ/kg}^\circ\text{C} \times (50,0 - 33,8)^\circ\text{C}) + ((0,9950 - 0,9868)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0082 \text{ kg} \times 2,2332 \text{ kJ/kg}^\circ\text{C} \times 16,2^\circ\text{C}) + (0,0082 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,2967 \text{ kJ} + 19,3331\text{kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{19,3331 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000887 \times 100\%$$

$$\eta = 0,0887\%$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1241)$$

$$cp = 2,2231 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9868 - 0,9831)\text{kg} \times 2,2231 \text{ kJ/kg}^\circ\text{C} \times (50,2 - 34,0)^\circ\text{C}) + ((0,9868 - 0,9831)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0037 \text{ kg} \times 2,2231 \text{ kJ/kg}^\circ\text{C} \times 16,2^\circ\text{C}) + (0,0037 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1333 \text{ kJ} + 8,7235 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{8,8568 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000400 \times 100\%$$

$$\eta = 0,0400\%$$

b. U3 Fermentor F50

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1673)$$

$$cp = 2,4040 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1687 - 1,1324)\text{kg} \times 2,4040 \text{ kJ/kg}^\circ\text{C} \times (50,7 - 33,8)^\circ\text{C}) + ((1,1687 - 1,1324)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0363 \text{ kg} \times 2,4040 \text{ kJ/kg}^\circ\text{C} \times 50,7^\circ\text{C}) + (0,0363 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,4748 \text{ kJ} + 85,5845 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{87,0593 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003932 \times 100\%$$

$$\eta = 0,3932\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1588)$$

$$cp = 2,3684 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,1324 - 1,0991)\text{kg} \times 2,3684 \text{ kJ/kg}^\circ\text{C} \times (50,8 - 33,9)^\circ\text{C}) + ((1,1324 - 1,0991)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0333 \text{ kg} \times 2,3684 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0333 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,3329 \text{ kJ} + 78,5114 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{79,8443 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003603 \times 100\%$$

$$\eta = 0,3603\%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1509)$$

$$cp = 2,3354 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0991 - 1,0704)\text{kg} \times 2,3354 \text{ kJ/kg}^\circ\text{C} \times (50,5 - 33,6)^\circ\text{C}) + ((1,0991 - 1,0704)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0287 \text{ kg} \times 2,3354 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0287 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,1327 \text{ kJ} + 67,6660 \text{ kJ}) + 98,7648 \text{ W}}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{68,7987 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003107 \times 100\%$$

$$\eta = 0,3107\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1459)$$

$$cp = 2,3144 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0704 - 1,0455)\text{kg} \times 2,3144 \text{ kJ/kg}^\circ\text{C} \times (50,4 - 33,5)^\circ\text{C}) + ((1,0704 - 1,0455)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0249 \text{ kg} \times 2,3144 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0249 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,9739 \text{ kJ} + 58,7067 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{59,6807 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002696 \times 100\%$$

$$\eta = 0,2696\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1409)$$

$$c_p = 2,2935 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0455 - 1,0247)\text{kg} \times 2,2935 \text{ kJ/kg}^\circ\text{C} \times (50,3 - 33,4)^\circ\text{C}) + ((1,0455 - 1,0247)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0208 \text{ kg} \times 2,2935 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0208 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,8062 \text{ kJ} + 49,0402 \text{ kJ}) + 98,7648 \text{ W}}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{49,8464 \text{ kJ} + 98,7648 \text{ W}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002251 \times 100\%$$

$$\eta = 0,2251\%$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1365)$$

$$c_p = 2,2751 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0247 - 1,0078)\text{kg} \times 2,2751 \text{ kJ/kg}^\circ\text{C} \times (50,3 - 33,4)^\circ\text{C}) + ((1,0247 - 1,0078)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0169 \text{ kg} \times 2,2751 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0169 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,6498 \text{ kJ} + 39,8451 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{40,4949 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001829 \times 100\%$$

$$\eta = 0,1829\%$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$c_p = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1321)$$

$$c_p = 2,2566 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((1,0078 - 0,9929)\text{kg} \times 2,2566 \text{ kJ/kg}^\circ\text{C} \times (50,6 - 33,7)^\circ\text{C}) + ((1,0078 - 0,9929)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0149 \text{ kg} \times 2,2566 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0149 \text{ kg} \times 2357,7\text{kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,5682 \text{ kJ} + 35,1297 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{35,6980 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001612 \times 100\%$$

$$\eta = 0,1612\%$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1277)$$

$$cp = 2,2382 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9929 - 0,9880) \text{ kg} \times 2,2382 \text{ kJ/kg}^\circ\text{C} \times (50,8 - 33,9)^\circ\text{C}) + ((0,9929 - 0,9880) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0049 \text{ kg} \times 2,2382 \text{ kJ/kg}^\circ\text{C} \times 16,9^\circ\text{C}) + (0,0049 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1853 \text{ kJ} + 11,5527 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{11,7381 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000530 \times 100\%$$

$$\eta = 0,0530\%$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1241)$$

$$cp = 2,2231 \text{ kJ/kg}^\circ\text{C}$$

$$\eta = \frac{((0,9880 - 0,9834) \text{ kg} \times 2,2231 \text{ kJ/kg}^\circ\text{C} \times (50,5 - 33,8)^\circ\text{C}) + ((0,9880 - 0,9834) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0046 \text{ kg} \times 2,2231 \text{ kJ/kg}^\circ\text{C} \times 16,7^\circ\text{C}) + (0,0046 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1708 \text{ kJ} + 10,8454 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{11,0162 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000498 \times 100\%$$

$$\eta = 0,0498\%$$

d. Rata-rata F50

1. Pra-fermentor

$$\bar{x} = \frac{0,7982\% + 0,8225\% + 0,7298\%}{3}$$

$$= 0,7607\%$$

2. Interval 1 (Jam ke 5,4 hingga jam ke 11,4)

$$\bar{x} = \frac{0,3793\% + 0,4171\% + 0,3932\%}{3}$$

$$= 0,3965\%$$

3. Interval 2 (Jam ke 11,4 hingga jam ke 17,4)

$$\bar{x} = \frac{0,3358\% + 0,3671\% + 0,3606\%}{3}$$

$$= 0,3545\%$$

4. Interval 3 (Jam ke 17,4 hingga jam ke 23,4)

$$\bar{x} = \frac{0,2956\% + 0,3172\% + 0,3107\%}{3}$$

$$= 0,3078\%$$

5. Interval 4 (Jam ke 23,4 hingga jam ke 29,4)

$$\bar{x} = \frac{0,2587\% + 0,2739\% + 0,2696\%}{3}$$

$$= 0,2674\%$$

6. Interval 5 (Jam ke 29,4 hingga jam ke 35,4)

$$\bar{x} = \frac{0,2250\% + 0,2219\% + 0,2251\%}{3}$$

$$= 0,2240\%$$

7. Interval 6 (Jam ke 35,4 hingga jam ke 41,4)

$$\bar{x} = \frac{0,1936\% + 0,1807\% + 0,1892\%}{3}$$

$$= 0,1857\%$$

8. Interval 7 (Jam ke 41,4 hingga jam ke 47,4)

$$\bar{x} = \frac{0,1612\% + 0,1493\% + 0,1612\%}{3}$$

$$= 0,1572\%$$

9. Interval 8 (Jam ke 47,4 hingga jam ke 53,4)

$$\bar{x} = \frac{0,1319\% + 0,0887\% + 0,0530\%}{3}$$

$$= 0,0912\%$$

10. Interval 9 (Jam ke 53,4 hingga jam ke 59,4)

$$\bar{x} = \frac{0,0779\% + 0,0400\% + 0,0498\%}{3}$$

$$= 0,0559\%$$

3.1.4 Fermentor F60

a. U1 Fermentor F60

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1514)$$

$$cp = 2,3375 \text{ kJ/kg}$$

$$\eta = \frac{((1,1897 - 1,0890) \text{ kg} \times 2,3178 \text{ kJ/kg} \times (61,5 - 36,4)^\circ\text{C}) + ((1,1897 - 1,0890) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,1007 \text{ kg} \times 2,3178 \text{ kJ/kg} \times 25,1^\circ\text{C}) + (25,1 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.14000 \text{ w}} \times 100\%$$

$$= \frac{(5,9082 \text{ kJ} + 237,4204 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{243,3286 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,010990 \times 100\%$$

$$\eta = 1,0990\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1424)$$

$$cp = 2,2998 \text{ kJ/kg}$$

$$\eta = \frac{((1,0890 - 1,0390) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,1 - 36,2)^\circ\text{C}) + ((1,0890 - 1,0390) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0500 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 24,9^\circ\text{C}) + (0,0500 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(5,9082 \text{ kJ} + 237,4204 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{243,3286 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,005454 \times 100\%$$

$$\eta = 0,5454 \%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1335)$$

$$cp = 2,2625 \text{ kJ/kg}$$

$$\eta = \frac{((1,0390 - 1,0090) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,3 - 36,3)^\circ\text{C}) + ((1,0390 - 1,0090) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0300 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 25,0^\circ\text{C}) + (0,0300 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,6969 \text{ kJ} + 70,7310 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{72,4279 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003271 \times 100\%$$

$$\eta = 0,3271\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1285)$$

$$cp = 2,2416 \text{ kJ/kg}$$

$$\eta = \frac{((1,0090 - 0,9930) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,9 - 36,7)^\circ\text{C}) + ((1,0090 - 0,9930) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0160 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 25,2^\circ\text{C}) + (0,0160 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,9038 \text{ kJ} + 37,7232 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{38,6270 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001745 \times 100\%$$

$$\eta = 0,1745\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1246)$$

$$cp = 2,2252 \text{ kJ/kg}$$

$$\eta = \frac{((0,9930 - 0,9837) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,3 - 36,4)^\circ\text{C}) + ((0,9930 - 0,9837) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0160 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 24,9^\circ\text{C}) + (0,0160 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,5153 \text{ kJ} + 21,9266 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{22,4419 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,001014 \times 100\%$$

$$\eta = 0,1014\%$$

b. U2 Fermentor F60

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1494)$$

$$cp = 2,3291 \text{ kJ/kg}$$

$$\eta = \frac{((1,1760 - 1,0692) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,9 - 37,0)^\circ\text{C}) + ((1,1760 - 1,0692) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,1068 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 24,9^\circ\text{C}) + (0,1068 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(6,1938 \text{ kJ} + 251,8024 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{257,9962 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,013581 \times 100\%$$

$$\eta = 1,3581\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1409)$$

$$cp = 2,2935 \text{ kJ/kg}$$

$$\eta = \frac{((1,0692 - 1,0220) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,6 - 36,6)^\circ\text{C}) + ((1,0692 - 1,0220) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0472 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 25,0^\circ\text{C}) + (0,0472 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(2,7063 \text{ kJ} + 111,2834 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{113,9897 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,006004 \times 100\%$$

$$\eta = 0,6004\%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1333)$$

$$cp = 2,2617 \text{ kJ/kg}$$

$$\eta = \frac{((1,0220 - 0,9970) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,5 - 36,4)^\circ\text{C}) + ((1,0220 - 0,9970) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0250 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 25,1^\circ\text{C}) + (0,0250 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,4192 \text{ kJ} + 58,9425 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{60,3617 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,003182 \times 100\%$$

$$\eta = 0,3182\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1279)$$

$$cp = 2,2391 \text{ kJ/kg}$$

$$\eta = \frac{((0,9970 - 0,9895) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,8 - 36,9)^\circ\text{C}) + ((0,9970 - 0,9895) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0075 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 24,9^\circ\text{C}) + (0,0075 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,4182 \text{ kJ} + 17,6828 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{18,1010 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000953 \times 100\%$$

$$\eta = 0,0953\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1246)$$

$$cp = 2,2252 \text{ kJ/kg}$$

$$\eta = \frac{((0,9895 - 0,9839) \text{ kg} \times 2,2834 \text{ kJ/kg} \times (61,4 - 36,5)^\circ\text{C}) + ((0,9895 - 0,9839) \text{ kg} \times 2357,7 \text{ kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0056 \text{ kg} \times 2,2834 \text{ kJ/kg} \times 24,9^\circ\text{C}) + (0,0056 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3103 \text{ kJ} + 13,2031 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{13,5134 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000711 \times 100\%$$

$$\eta = 0,0711\%$$

c. U3 Fermentor F60

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1467)$$

$$cp = 2,3178 \text{ kJ/kg}$$

$$\eta = \frac{((1,1657 - 1,0515)\text{kg} \times 2,2834\text{kJ/kg} \times (61,9 - 36,8)^\circ\text{C}) + ((1,1657 - 1,0515)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,1142\text{kg} \times 2,2834 \text{ kJ/kg}^\circ\text{C} \times 25,1^\circ\text{C}) + (0,1142\text{kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(6,6438 \text{ kJ} + 269,2493 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{275,8931 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,014542 \times 100\%$$

$$\eta = 1,4542\%$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1385)$$

$$cp = 2,2834 \text{ kJ/kg}$$

$$\eta = \frac{((1,0515 - 1,0115)\text{kg} \times 2,2834\text{kJ/kg} \times (61,4 - 36,6)^\circ\text{C}) + ((1,0515 - 1,0115)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0400 \text{ kg} \times 2,2834 \text{ kJ/kg}^\circ\text{C} \times 24,8^\circ\text{C}) + (0,0400 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(2,2651 \text{ kJ} + 94,3080 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{96,5731 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,005080 \times 100\%$$

$$\eta = 0,5080\%$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1309)$$

$$cp = 2,2516 \text{ kJ/kg}$$

$$\eta = \frac{((1,0115 - 0,9915)\text{kg} \times 2,2516\text{kJ/kg} \times (61,4 - 36,7)^\circ\text{C}) + ((1,0115 - 0,9915)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0200 \text{ kg} \times 2,2516 \text{ kJ/kg}^\circ\text{C} \times 24,7^\circ\text{C}) + (0,0200\text{kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(1,1123 \text{ kJ} + 47,1540 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{48,2663 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,002537 \times 100\%$$

$$\eta = 0,002573\%$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1268)$$

$$cp = 2,2345 \text{ kJ/kg}$$

$$\eta = \frac{((0,9915 - 0,9855)\text{kg} \times 2,2345\text{kJ/kg} \times (61,6 - 36,6)^\circ\text{C}) + ((0,9915 - 0,9855)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0060 \text{ kg} \times 2,2345 \text{ kJ/kg}^\circ\text{C} \times 25,0^\circ\text{C}) + (0,0060 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,3352 \text{ kJ} + 14,1462 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{14,4814 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000763 \times 100\%$$

$$\eta = 0,0763\%$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$cp = (1,424 \times 0,5259) + (1,549 \times 0,1403) + (1,675 \times 0,1897) + (0,837 \times 0,5013) + (4,187 \times 0,1236)$$

$$cp = 2,2211 \text{ kJ/kg}$$

$$\eta = \frac{((0,9855 - 0,9826)\text{kg} \times 2,2211\text{kJ/kg} \times (61,1 - 36,2)^\circ\text{C}) + ((0,9855 - 0,9826)\text{kg} \times 2357,7\text{kJ/kg})}{1025 \text{ w} \times 21600 \text{ s}} \times 100\%$$

$$= \frac{((0,0029 \text{ kg} \times 2,2211 \text{ kJ/kg}^\circ\text{C} \times 24,9^\circ\text{C}) + (0,0029 \text{ kg} \times 2357,7 \text{ kJ/kg}))}{22.140.000 \text{ Ws}} \times 100\%$$

$$= \frac{(0,1604 \text{ kJ} + 6,8373 \text{ kJ})}{22.140.000 \text{ J}} \times 100\%$$

$$= \frac{6,9977 \text{ kJ}}{22.140 \text{ kJ}} \times 100\%$$

$$= 0,000368 \times 100\%$$

$$\eta = 0,0368\%$$

d. Rata-rata efisiensi F60

1. Pra-fermentor

$$\bar{x} = \frac{0,8523\% + 0,7975\% + 0,9004\%}{3}$$

$$= 0,8501\%$$

2. Interval 1 (Jam ke 5,4 hingga jam ke 11,4)

$$\bar{x} = \frac{1,0990\% + 1,3581\% + 1,4542\%}{3}$$

$$= 1,3038\%$$

3. Interval 2 (Jam ke 11,4 hingga jam ke 17,4)

$$\bar{x} = \frac{0,5454\% + 0,6004\% + 0,5080\%}{3}$$

$$= 0,5513\%$$

4. Interval 3 (Jam ke 17,4 hingga jam ke 23,4)

$$\bar{x} = \frac{0,3271\% + 0,3182\% + 0,2537\%}{3}$$

$$= 0,2997\%$$

5. Interval 4 (Jam ke 23,4 hingga jam ke 29,4)

$$\bar{x} = \frac{0,1745\% + 0,0953\% + 0,0763\%}{3}$$

$$= 0,1154\%$$

6. Interval 5 (Jam ke 29,4 hingga jam ke 35,4)

$$\bar{x} = \frac{0,1014\% + 0,0711\% + 0,0368}{3}$$

$$= 0,0698\%$$

Lampiran 3.2 Laju pengeringan

3.2.1 Laju pengeringan SD

a. U1 *sun drying*

1. Interval 1 (hari ke 0 hingga hari ke 1)

$$\eta = \frac{(1,7512 - 1,1184)}{5,6}$$

$$= \frac{0,6328}{5,6}$$

$$= 0,1130 \text{ kg/Jam}$$

2. Interval 2 (hari ke 1 hingga hari ke 2)

$$m_p = \frac{(1,1184 \text{ kg} - 1,0287 \text{ kg})}{6}$$

$$= \frac{0,0897}{6}$$

$$= 0,0150 \text{ kg/Jam}$$

3. Interval 3 (hari ke 2 hingga hari ke 3)

$$m_p = \frac{(1,0287 \text{ kg} - 1,0143 \text{ kg})}{5,4}$$

$$= \frac{0,0144}{5,4}$$

$$= 0,0027 \text{ kg/Jam}$$

4. Interval 4 (hari ke 3 hingga hari ke 4)

$$\begin{aligned} m_p &= \frac{(1,0143 \text{ kg} - 1,0018 \text{ kg})}{4,4} \\ &= \frac{0,0125}{4,4} \\ &= 0,0028 \text{ kg/Jam} \end{aligned}$$

5. Interval 5 (hari ke 4 hingga hari ke 5)

$$\begin{aligned} m_p &= \frac{(1,0018 \text{ kg} - 0,9889 \text{ kg})}{5,5} \\ &= \frac{0,0129}{5,5} \\ &= 0,0023 \text{ kg/Jam} \end{aligned}$$

b. U2 *sun drying*

1. Interval 1 (hari ke 0 hingga hari ke 1)

$$\begin{aligned} m_p &= \frac{(1,7621 \text{ kg} - 1,0998 \text{ kg})}{6,5} \\ &= \frac{0,6623}{6,5} \\ &= 0,1019 \text{ kg/Jam} \end{aligned}$$

2. Interval 2 (hari ke 1 hingga hari ke 2)

$$\begin{aligned} m_p &= \frac{(1,0998 \text{ kg} - 1,0244 \text{ kg})}{4,8} \\ &= \frac{0,0754}{4,8} \\ &= 0,0157 \text{ kg/Jam} \end{aligned}$$

3. Interval 3 (hari ke 2 hingga hari ke 3)

$$\begin{aligned} m_p &= \frac{(1,0244 \text{ kg} - 1,0105 \text{ kg})}{5} \\ &= \frac{0,0139}{5} \\ &= 0,0028 \text{ kg/Jam} \end{aligned}$$

4. Interval 4 (hari ke 3 hingga hari ke 4)

$$\begin{aligned} m_p &= \frac{(1,0105 \text{ kg} - 0,9985 \text{ kg})}{4} \\ &= \frac{0,0120}{4} \times 100\% \\ &= 0,0030 \text{ kg/Jam} \end{aligned}$$

5. Interval 5 (hari ke 4 hingga hari ke 5)

$$\begin{aligned} m_p &= \frac{(0,9985 \text{ kg} - 0,9873 \text{ kg})}{5} \\ &= \frac{0,0112}{5} \times 100\% \\ &= 0,0022 \text{ kg/Jam} \end{aligned}$$

c. U3 *sun drying*

1. Interval 1 (hari ke 0 hingga hari ke 1)

$$\begin{aligned} m_p &= \frac{(1,7281 \text{ kg} - 1,1584 \text{ kg})}{4,1} \\ &= \frac{0,5697}{4,1} \\ &= 0,1390 \text{ kg/Jam} \end{aligned}$$

2. Interval 2 (hari ke 1 hingga hari ke 2)

$$\begin{aligned} m_p &= \frac{(1,1584 \text{ kg} - 1,0435 \text{ kg})}{6} \\ &= \frac{0,1149}{6} \\ &= 0,0192 \text{ kg/Jam} \end{aligned}$$

3. Interval 3 (hari ke 2 hingga hari ke 3)

$$\begin{aligned} m_p &= \frac{(1,0435 \text{ kg} - 1,0088 \text{ kg})}{6,4} \\ &= \frac{0,0347}{6,4} \\ &= 0,0054 \text{ kg/Jam} \end{aligned}$$

4. Interval 4 (hari ke 3 hingga hari ke 4)

$$\begin{aligned} m_p &= \frac{(1,0088 \text{ kg} - 0,9939 \text{ kg})}{7,2} \\ &= \frac{0,0149}{7,2} \\ &= 0,0021 \text{ kg/Jam} \end{aligned}$$

5. Interval 5 (hari ke 4 hingga hari ke 5)

$$\begin{aligned} m_p &= \frac{(0,9939 \text{ kg} - 0,9826 \text{ kg})}{6,6} \\ &= \frac{0,0113}{6,6} \\ &= 0,0017 \text{ kg/Jam} \end{aligned}$$

d. Rata-rata SD

1. Interval 1 (hari ke 0 hingga ke 1)

$$\begin{aligned}\bar{x} &= \frac{0,1130 + 0,1019 + 0,1390}{3} \\ &= 0,1180 \text{ kg/Jam}\end{aligned}$$

2. Interval 2 (hari ke 1 hingga ke 2)

$$\begin{aligned}\bar{x} &= \frac{0,0150 + 0,0157 + 0,0192}{3} \\ &= 0,00166\end{aligned}$$

3. Interval 3 (hari ke 2 hingga ke 3)

$$\begin{aligned}\bar{x} &= \frac{0,0027 + 0,0028 + 0,0054}{3} \\ &= 0,0036\end{aligned}$$

4. Interval 4 (hari ke 3 hingga ke 4)

$$\begin{aligned}\bar{x} &= \frac{0,0028 + 0,0030 + 0,0021}{3} \\ &= 0,0026 \text{ kg/Jam}\end{aligned}$$

5. Interval 5 (hari ke 4 hingga ke 5)

$$\begin{aligned}\bar{x} &= \frac{0,0023 + 0,0022 + 0,0017}{3} \\ &= 0,0021 \text{ kg/Jam}\end{aligned}$$

3.2.2 Laju pengeringan F40

a. Laju pengeringan F40 U1

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$\begin{aligned}m_p &= \frac{(1,1758 - 1,1486)}{6} \\ &= \frac{0,0272}{6} \\ &= 0,0020 \text{ kg/Jam}\end{aligned}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$\begin{aligned}m_p &= \frac{(1,1486 - 1,1245)}{6} \\ &= \frac{0,0241}{6} \\ &= 0,0040 \text{ kg/Jam}\end{aligned}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$\begin{aligned}m_p &= \frac{(1,1245 - 1,1034)}{6} \\&= \frac{0,0211}{6} \\&= 0,0035 \text{ kg/Jam}\end{aligned}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$\begin{aligned}m_p &= \frac{(1,1034 - 1,0838)}{6} \\&= \frac{0,0196}{6} \\&= 0,0015 \text{ kg/Jam}\end{aligned}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$\begin{aligned}m_p &= \frac{(1,0838 - 1,0667)}{6} \\&= \frac{0,0171}{6} \\&= 0,0015 \text{ kg/Jam}\end{aligned}$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$\begin{aligned}m_p &= \frac{(1,0667 - 1,0503)}{6} \\&= \frac{0,0164}{6} \\&= 0,0027 \text{ kg/Jam}\end{aligned}$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$\begin{aligned}m_p &= \frac{(1,0503 - 1,0362)}{6} \\&= \frac{0,0141}{6} \\&= 0,0024 \text{ kg/Jam}\end{aligned}$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$\begin{aligned}m_p &= \frac{(1,0362 - 1,0241)}{6} \\&= \frac{0,0121}{6} \\&= 0,0020 \text{ kg/Jam}\end{aligned}$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$\begin{aligned} m_p &= \frac{(1,0241 - 1,0133)}{6} \\ &= \frac{0,0108}{6} \\ &= 0,0018 \text{ kg/Jam} \end{aligned}$$

10) Interval 10 (Jam ke 54 hingga jam ke 60)

$$\begin{aligned} m_p &= \frac{(1,0133 - 1,0037)}{6} \\ &= \frac{0,0096}{6} \\ &= 0,0016 \text{ kg/Jam} \end{aligned}$$

11) Interval 11 (Jam ke 60 hingga jam ke 66)

$$\begin{aligned} m_p &= \frac{(1,0037 - 0,9959)}{6} \\ &= \frac{0,0078}{6} \\ &= 0,0013 \text{ kg/Jam} \end{aligned}$$

12) Interval 12 (Jam ke 66 hingga jam ke 72)

$$\begin{aligned} m_p &= \frac{(0,9959 - 0,9894)}{6} \\ &= \frac{0,0065}{6} \\ &= 0,0011 \text{ kg/Jam} \end{aligned}$$

13) Interval 13 (Jam ke 72 hingga jam ke 78)

$$\begin{aligned} m_p &= \frac{(0,9894 - 0,9842)}{6} \\ &= \frac{0,0052}{6} \\ &= 0,0009 \text{ kg/Jam} \end{aligned}$$

b. U2 Fermentor F40

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$\begin{aligned} m_p &= \frac{(1,1926 - 1,1634)}{6} \\ &= \frac{0,0292}{6} \end{aligned}$$

$$= 0,0049 \text{ kg/Jam}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$m_p = \frac{(1,1634 - 1,1378)}{6}$$

$$= \frac{0,6154}{6}$$

$$= 0,0043 \text{ kg/Jam}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$m_p = \frac{(1,1378 - 1,1144)}{6}$$

$$= \frac{0,0234}{6}$$

$$= 0,0039 \text{ kg/Jam}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$m_p = \frac{(1,1144 - 1,0937)}{6}$$

$$= \frac{0,0207}{6}$$

$$= 0,0035 \text{ kg/Jam}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$m_p = \frac{(1,0937 - 1,0745)}{6}$$

$$= \frac{0,0192}{6}$$

$$= 0,0032 \text{ kg/Jam}$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$m_p = \frac{(1,0745 - 1,0537)}{6}$$

$$= \frac{0,0172}{6}$$

$$= 0,0029 \text{ kg/Jam}$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$m_p = \frac{(1,0573 - 1,0421)}{6}$$

$$= \frac{0,0152}{6}$$

$$= 0,0025 \text{ kg/Jam}$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$\begin{aligned}m_p &= \frac{(1,0421 - 1,0297)}{6} \\&= \frac{0,0124}{6} \\&= 0,0021 \text{ kg/Jam}\end{aligned}$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$\begin{aligned}m_p &= \frac{(1,0297 - 1,0174)}{6} \\&= \frac{0,0123}{6} \\&= 0,0021 \text{ kg/Jam}\end{aligned}$$

10) Interval 10 (Jam ke 54 hingga jam ke 60)

$$\begin{aligned}m_p &= \frac{(1,0174 - 1,0069)}{6} \\&= \frac{0,0105}{6} \\&= 0,0018 \text{ kg/Jam}\end{aligned}$$

11) Interval 11 (Jam ke 60 hingga jam ke 66)

$$\begin{aligned}m_p &= \frac{(1,0069 - 0,9975)}{6} \\&= \frac{0,0094}{6} \\&= 0,0016 \text{ kg/Jam}\end{aligned}$$

12) Interval 10 (Jam ke 66 hingga jam ke 72)

$$\begin{aligned}m_p &= \frac{(0,9975 - 0,9891)}{6} \\&= \frac{0,0084}{6} \\&= 0,0014 \text{ kg/Jam}\end{aligned}$$

13) Interval 13 (Jam ke 72 hingga jam ke 78)

$$\begin{aligned}m_p &= \frac{(0,9891 - 0,9829)}{6} \\&= \frac{0,0062}{6} \\&= 0,0010 \text{ kg/Jam}\end{aligned}$$

c. U3 Fermentor F40

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$\begin{aligned}m_p &= \frac{(1,1980 - 1,1673)}{6} \\&= \frac{0,0307}{6} \\&= 0,0051 \text{ kg/Jam}\end{aligned}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$\begin{aligned}m_p &= \frac{(1,1673 - 1,1396)}{6} \\&= \frac{0,0277}{6} \\&= 0,0046 \text{ kg/Jam}\end{aligned}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$\begin{aligned}m_p &= \frac{(1,1396 - 1,1142)}{6} \\&= \frac{0,0254}{6} \\&= 0,0042 \text{ kg/Jam}\end{aligned}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$\begin{aligned}m_p &= \frac{(1,1142 - 1,0911)}{6} \\&= \frac{0,0231}{6} \\&= 0,0039 \text{ kg/Jam}\end{aligned}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$\begin{aligned}m_p &= \frac{(1,0911 - 1,0716)}{6} \\&= \frac{0,0195}{6} \\&= 0,0033 \text{ kg/Jam}\end{aligned}$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$\begin{aligned}m_p &= \frac{(1,0716 - 1,0528)}{6} \\&= \frac{0,0188}{6}\end{aligned}$$

$$= 0,0031 \text{ kg/Jam}$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$\begin{aligned} m_p &= \frac{(1,0532 - 1,0358)}{6} \\ &= \frac{0,0170}{6} \\ &= 0,0028 \text{ kg/Jam} \end{aligned}$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$\begin{aligned} m_p &= \frac{(1,0358 - 1,0207)}{6} \\ &= \frac{0,0151}{6} \\ &= 0,0025 \text{ kg/Jam} \end{aligned}$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$\begin{aligned} m_p &= \frac{(1,0207 - 1,0069)}{6} \\ &= \frac{0,0138}{6} \\ &= 0,0023 \text{ kg/Jam} \end{aligned}$$

10) Interval 10 (Jam ke 54 hingga jam ke 60)

$$\begin{aligned} m_p &= \frac{(1,0069 - 0,9944)}{6} \\ &= \frac{0,0125}{6} \\ &= 0,0021 \text{ kg/Jam} \end{aligned}$$

11) Interval 11 (Jam ke 60 hingga jam ke 66)

$$\begin{aligned} m_p &= \frac{(0,9944 - 0,9862)}{6} \\ &= \frac{0,0082}{6} \\ &= 0,0014 \text{ kg/Jam} \end{aligned}$$

12) Interval 12 (Jam ke 66 hingga jam ke 72)

$$\begin{aligned} m_p &= \frac{(0,9862 - 0,9843)}{6} \\ &= \frac{0,0019}{6} \end{aligned}$$

$$= 0,0003 \text{ kg/Jam}$$

13) Interval 13 (Jam ke 72 hingga jam ke 78)

$$\begin{aligned} m_p &= \frac{(0,9843 - 0,9827)}{6} \\ &= \frac{0,0016}{6} \\ &= 0,0003 \text{ kg/Jam} \end{aligned}$$

d. Rata-rata laju pengeringan F40

1. Interval 1 (Jam ke 0 hingga jam ke 6)

$$\begin{aligned} \bar{x} &= \frac{0,0045 + 0,0049 + 0,0051}{3} \\ &= 0,0048 \text{ kg/jam} \end{aligned}$$

2. Interval 2 (Jam ke 6 hingga jam ke 12)

$$\begin{aligned} \bar{x} &= \frac{0,0040 + 0,0043 + 0,0046}{3} \\ &= 0,0043 \text{ kg/jam} \end{aligned}$$

3. Interval 3 (Jam ke 12 hingga jam ke 18)

$$\begin{aligned} \bar{x} &= \frac{0,0035 + 0,0039 + 0,0042}{3} \\ &= 0,0039 \text{ kg/jam} \end{aligned}$$

4. Interval 4 (Jam ke 18 hingga jam ke 24)

$$\begin{aligned} \bar{x} &= \frac{0,0033 + 0,0035 + 0,0039}{3} \\ &= 0,0036 \text{ kg/jam} \end{aligned}$$

5. Interval 5 (Jam ke 24 hingga jam ke 30)

$$\begin{aligned} \bar{x} &= \frac{0,0029 + 0,0032 + 0,0033}{3} \\ &= 0,0031 \text{ kg/jam} \end{aligned}$$

6. Interval 6 (Jam ke 30 hingga jam ke 36)

$$\begin{aligned} \bar{x} &= \frac{0,0027 + 0,0029 + 0,0031}{3} \\ &= 0,0029 \text{ kg/jam} \end{aligned}$$

7. Interval 7 (Jam ke 36 hingga jam ke 42)

$$\begin{aligned} \bar{x} &= \frac{0,0024 + 0,0025 + 0,0028}{3} \\ &= 0,0026 \text{ kg/jam} \end{aligned}$$

8. Interval 8 (Jam ke 42 hingga jam ke 48)

$$\begin{aligned}\bar{x} &= \frac{0,0020 + 0,0021 + 0,0025}{3} \\ &= 0,0022 \text{ kg/jam}\end{aligned}$$

9. Interval 9 (Jam ke 48 hingga jam ke 54)

$$\begin{aligned}\bar{x} &= \frac{0,0018 + 0,0021 + 0,0023}{3} \\ &= 0,0021 \text{ kg/jam}\end{aligned}$$

10. Interval 10 (Jam ke 54 hingga jam ke 60)

$$\begin{aligned}\bar{x} &= \frac{0,0016 + 0,0018 + 0,0021}{3} \\ &= 0,0018 \text{ kg/jam}\end{aligned}$$

11. Interval 11 (Jam ke 60 hingga jam ke 66)

$$\begin{aligned}\bar{x} &= \frac{0,0013 + 0,0016 + 0,0014}{3} \\ &= 0,0014 \text{ kg/jam}\end{aligned}$$

12. Interval 12 (Jam ke 66 hingga jam ke 72)

$$\begin{aligned}\bar{x} &= \frac{0,0011 + 0,0014 + 0,0003}{3} \\ &= 0,0009 \text{ kg/jam}\end{aligned}$$

13. Interval 13 (Jam ke 72 hingga jam ke 78)

$$\begin{aligned}\bar{x} &= \frac{0,0009 + 0,0010 + 0,0003}{3} \\ &= 0,0007 \text{ kg/jam}\end{aligned}$$

3.2.2 Laju pengeringan F50

a. U1 Fermentor F50

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$\begin{aligned}m_p &= \frac{1,1745 - 1,1395}{6} \\ &= \frac{0,0350}{6} \\ &= 0,0058 \text{ kg/Jam}\end{aligned}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$m_p = \frac{(1,1395 - 1,1085)}{6}$$

$$= \frac{0,0310}{6}$$

$$= 0,0052 \text{ kg/Jam}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$m_p = \frac{(1,1085 - 1,0812)}{6}$$

$$= \frac{0,0273}{6}$$

$$= 0,0046 \text{ kg/Jam}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$m_p = \frac{(1,0812 - 1,0573)}{6}$$

$$= \frac{0,0239}{6}$$

$$= 0,0040 \text{ kg/Jam}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$m_p = \frac{(1,0573 - 1,0365)}{6}$$

$$= \frac{0,0208}{6} \times 100\%$$

$$= 0,0035 \text{ kg/Jam}$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$m_p = \frac{(1,0365 - 1,0186)}{6}$$

$$= \frac{0,0179}{6}$$

$$= 0,0030 \text{ kg/Jam}$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$m_p = \frac{(1,0186 - 1,0037)}{6}$$

$$= \frac{0,0149}{6}$$

$$= 0,0025 \text{ kg/Jam}$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$m_p = \frac{(1,0037 - 0,9915)}{6}$$

$$= \frac{0,0122}{6}$$

$$= 0,0020 \text{ kg/Jam}$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$m_p = \frac{(0,9915 - 0,9843)}{6}$$

$$= \frac{0,0072}{6}$$

$$= 0,0012 \text{ kg/Jam}$$

b. U2 Fermentor F50

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$m_p = \frac{(1,1730 - 1,1345)}{6}$$

$$= \frac{0,0385}{6}$$

$$= 0,0064 \text{ kg/Jam}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$m_p = \frac{(1,1345 - 1,1006)}{6}$$

$$= \frac{0,0339}{6}$$

$$= 0,0057 \text{ kg/Jam}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$m_p = \frac{(1,1006 - 1,0713)}{6}$$

$$= \frac{0,0293}{6}$$

$$= 0,0049 \text{ kg/Jam}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$m_p = \frac{(1,0713 - 1,0460)}{6}$$

$$= \frac{0,0253}{6}$$

$$= 0,0042 \text{ kg/Jam}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$m_p = \frac{((1,0460 - 1,0255))}{6}$$

$$= \frac{0,0205}{6}$$

$$= 0,0034 \text{ kg/Jam}$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$m_p = \frac{(1,0255 - 1,0088)}{6}$$

$$= \frac{0,0167}{6}$$

$$= 0,0028 \text{ kg/Jam}$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$m_p = \frac{(1,0088 - 0,9950)}{6}$$

$$= \frac{0,0138}{6}$$

$$= 0,0023 \text{ kg/Jam}$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$m_p = \frac{(0,9950 - 0,9868)}{6}$$

$$= \frac{0,0082}{6}$$

$$= 0,0014 \text{ kg/Jam}$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$m_p = \frac{(0,9868 - 0,9831)}{6}$$

$$= \frac{0,0037}{6}$$

$$= 0,0006 \text{ kg/Jam}$$

b. U3 Fermentor F50

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$m_p = \frac{(1,1687 - 1,1324)}{6}$$

$$= \frac{0,0363}{6}$$

$$= 0,0061 \text{ kg/Jam}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$m_p = \frac{(1,1324 - 1,0991)}{6}$$

$$= \frac{0,0333}{6}$$

$$= 0,0056 \text{ kg/Jam}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$m_p = \frac{(1,0991 - 1,0704)}{6}$$

$$= \frac{0,0287}{6}$$

$$= 0,0048 \text{ kg/Jam}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$m_p = \frac{(1,0704 - 1,0455)}{6}$$

$$= \frac{0,0249}{6}$$

$$= 0,0042 \text{ kg/Jam}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$m_p = \frac{(1,0455 - 1,0247)}{6}$$

$$= \frac{0,0208}{6}$$

$$= 0,0035 \text{ kg/Jam}$$

6) Interval 6 (Jam ke 30 hingga jam ke 36)

$$m_p = \frac{(1,0247 - 1,0078)}{6}$$

$$= \frac{0,0169}{6}$$

$$= 0,0028 \text{ kg/Jam}$$

7) Interval 7 (Jam ke 36 hingga jam ke 42)

$$m_p = \frac{(1,0078 - 0,9929)}{6}$$

$$= \frac{0,0149}{6}$$

$$= 0,0025 \text{ kg/Jam}$$

8) Interval 8 (Jam ke 42 hingga jam ke 48)

$$m_p = \frac{(0,9929 - 0,9880)}{6}$$

$$= \frac{0,0049}{6}$$

$$= 0,0008 \text{ kg/Jam}$$

9) Interval 9 (Jam ke 48 hingga jam ke 54)

$$m_p = \frac{(0,9880 - 0,9834)}{6}$$

$$= \frac{0,0046}{6}$$

$$= 0,0008 \text{ kg/Jam}$$

d. Rata-rata laju pengeringan F50

1. Interval 1 (Jam ke 0 hingga jam ke 6)

$$\bar{x} = \frac{0,0058 + 0,0064 + 0,0061}{3}$$

$$= 0,0061 \text{ kg/jam}$$

2. Interval 2 (Jam ke 6 hingga jam ke 12)

$$\bar{x} = \frac{0,0052 + 0,0057 + 0,0055}{3}$$

$$= 0,0055 \text{ kg/jam}$$

3. Interval 3 (Jam ke 12 hingga jam ke 18)

$$\bar{x} = \frac{0,0046 + 0,0049 + 0,0048}{3}$$

$$= 0,0048 \text{ kg/jam}$$

4. Interval 4 (Jam ke 18 hingga jam ke 24)

$$\bar{x} = \frac{0,0040 + 0,0042 + 0,0042}{3}$$

$$= 0,0041 \text{ kg/jam}$$

5. Interval 5 (Jam ke 24 hingga jam ke 30)

$$\bar{x} = \frac{0,0035 + 0,0034 + 0,0035}{3}$$

$$= 0,0035 \text{ kg/jam}$$

6. Interval 6 (Jam ke 30 hingga jam ke 36)

$$\bar{x} = \frac{0,0030 + 0,0028 + 0,0028}{3}$$

$$= 0,0029 \text{ kg/jam}$$

7. Interval 7 (Jam ke 36 hingga jam ke 42)

$$\bar{x} = \frac{0,0025 + 0,0023 + 0,0025}{3}$$

$$= 0,0024 \text{ kg/jam}$$

8. Interval 8 (Jam ke 42 hingga jam ke 48)

$$\bar{x} = \frac{0,0020 + 0,0014 + 0,0008}{3}$$

$$= 0,0014 \text{ kg/jam}$$

9. Interval 9 (Jam ke 48 hingga jam ke 54)

$$\bar{x} = \frac{0,0012 + 0,0006 + 0,0008}{3}$$

$$= 0,0009 \text{ kg/jam}$$

3.2.3 Laju pengering F60

a. U1 Fermentor F60

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$m_p = \frac{(1,1897 - 1,0890)}{6}$$

$$= \frac{0,1007}{6}$$

$$= 0,0168 \text{ kg/jam}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$m_p = \frac{(1,0890 - 1,0390)}{6}$$

$$= \frac{0,0500}{6}$$

$$= 0,0083 \text{ kg/jam}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$m_p = \frac{(1,0390 - 1,0090)}{6}$$

$$= \frac{0,0300}{6}$$

$$= 0,0050 \text{ kg/Jam}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$m_p = \frac{(1,0090 - 0,9930)}{6}$$

$$= \frac{0,0160}{6}$$

$$= 0,0027 \text{ kg/Jam}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$\begin{aligned}m_p &= \frac{(0,9930 - 0,9837)}{6} \\&= \frac{0,0160}{6} \\&= 0,0016 \text{ kg/Jam}\end{aligned}$$

b. U2 Fermentor F60

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$\begin{aligned}m_p &= \frac{(1,1760 - 1,0692)}{6} \\&= \frac{0,1068}{6} \\&= 0,0178 \text{ kg/Jam}\end{aligned}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$\begin{aligned}m_p &= \frac{(1,0692 - 1,0220)}{6} \\&= \frac{0,0472}{6} \\&= 0,0079 \text{ kg/Jam}\end{aligned}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$\begin{aligned}m_p &= \frac{(1,0220 - 0,9970)}{6} \\&= \frac{0,0250}{6} \\&= 0,0042 \text{ kg/Jam}\end{aligned}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$\begin{aligned}m_p &= \frac{(0,9970 - 0,9895)}{6} \\&= \frac{0,0075}{6} \\&= 0,0013 \text{ kg/Jam}\end{aligned}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$\begin{aligned}m_p &= \frac{(0,9895 - 0,9839)}{6} \\&= \frac{0,0056}{6} \\&= 0,0009 \text{ kg/Jam}\end{aligned}$$

c. U3 Fermentor F60

1) Interval 1 (Jam ke 0 hingga jam ke 6)

$$\begin{aligned}
 m_p &= \frac{(1,1657 - 1,0515)}{6} \\
 &= \frac{0,1142}{6} \\
 &= 0,0190 \text{ kg/Jam}
 \end{aligned}$$

2) Interval 2 (Jam ke 6 hingga jam ke 12)

$$\begin{aligned}
 m_p &= \frac{(1,0515 - 1,0115)}{6} \\
 &= \frac{0,0400}{6} \\
 &= 0,0067 \text{ kg/Jam}
 \end{aligned}$$

3) Interval 3 (Jam ke 12 hingga jam ke 18)

$$\begin{aligned}
 m_p &= \frac{(1,0115 - 0,9915)}{6} \\
 &= \frac{0,0200}{6} \\
 &= 0,0033 \text{ kg/Jam}
 \end{aligned}$$

4) Interval 4 (Jam ke 18 hingga jam ke 24)

$$\begin{aligned}
 m_p &= \frac{(0,9915 - 0,9855)}{6} \\
 &= \frac{0,0060}{6} \\
 &= 0,0010 \text{ kg/Jam}
 \end{aligned}$$

5) Interval 5 (Jam ke 24 hingga jam ke 30)

$$\begin{aligned}
 m_p &= \frac{(0,9855 - 0,9826)}{6} \\
 &= \frac{0,0029}{6} \\
 &= 0,0005 \text{ kg/jam}
 \end{aligned}$$

d. Rata-rata laju pengeringan F50

1. Interval 1 (Jam ke 0 hingga jam ke 6)

$$\bar{x} = \frac{0,0168 + 0,0178 + 0,0190}{3}$$

$$= 0,0179 \text{ kg/jam}$$

2. Interval 2 (Jam ke 6 hingga jam ke 12)

$$\bar{x} = \frac{0,0083 + 0,0079 + 0,0067}{3}$$

$$= 0,0076 \text{ kg/jam}$$

3. Interval 3 (Jam ke 12 hingga jam ke 18)

$$\bar{x} = \frac{0,0050 + 0,0042 + 0,0033}{3}$$

$$= 0,0042 \text{ kg/jam}$$

4. Interval 4 (Jam ke 18 hingga jam ke 24)

$$\bar{x} = \frac{0,0027 + 0,0013 + 0,0010}{3}$$

$$= 0,0017 \text{ kg/jam}$$

5. Interval 5 (Jam ke 24 hingga jam ke 30)

$$\bar{x} = \frac{0,0016 + 0,0009 + 0,0005}{3}$$

$$= 0,0010 \text{ kg/Jam}$$

Lampiran 4. Dokumentasi

