

IV. NERACA MASSA DAN NERACA ENERGI

Perhitungan neraca massa dilakukan berdasarkan kapasitas produksi yang telah ditetapkan.

Kapasitas Produksi	: 30.000 ton/tahun
Waktu Operasi	: 330 hari
Basis Perhitungan	: 1 jam operasi
Konversi Digester	: 64,4% terhadap tandan kosong kelapa sawit
Bahan Baku	: Tandan Kosong Kelapa Sawit
Produk	: Pulp Unbleached
Kapasitas Produksi	$= \frac{30.000 \text{ ton}}{\text{tahun}} \times \frac{1000 \text{ kg}}{1 \text{ ton}} \times \frac{1 \text{ tahun}}{330 \text{ hari}} \times \frac{1 \text{ hari}}{24 \text{ jam}}$ $= 3787.8788 \text{ kg/jam}$

NERACA MASSA

1. Neraca Massa Komponen Tiap Alat

1. Digester 201 A/E (D-201 A/E)

Tabel 4.1. Neraca Massa Digester-201 (D-201 A/E)

Komponen	Reaksi (Kg/jam)	Akumulasi (Kg/jam)
TKKS	5.415,0000	
Etanol	10.681,0875	640,8653
Air	13.416,6914	308,0025
NaOH	162,4500	
Pulp		3.487,2600
Black Liquor		25.239,1011
Total	29.675,2289	29.675,2289

2. Rotary Drum Vacuum Filter (RDVF-301/3)

Tabel 4.2. Neraca Massa Rotary Drum Vacuum Filter (RDVF-301/3)

Komponen	Input (kg/jam)		Output (kg/jam)	
	Aliran 6	Aliran 8	Aliran 7	Aliran 9
Pulp	3.846,0000			3.846,0000
Black Liquor	28.908,8425		26.975,5283	1.933,3142
Air		5.155,5045	4.511,0664	644,4381
Total	32.754,8425	5.155,5045	31.486,5947	6.423,7523
	37.910,3470		37.910,3470	

3. Mixing Tank (MT-501)

Tabel 4.3. Neraca Massa Mixing Tank (MT-501)

Komponen	Input (kg/jam)		Output (kg/jam)
	Aliran 9	Aliran 10	Aliran 11
Pulp	3.487,2600		3.487,2600
Air	17.026,0341	23.077,4559	40.103,4900
Total	20.513,2941	23.077,4559	43.590,7500
	43.590,7500		43.590,7500

4. Fourdriener (FD-501)

Tabel 4.4. Neraca Massa Fourdriener (FD-501)

Komponen	Input (kg/jam)	Output (kg/jam)	
	Aliran 11	Aliran 12	Aliran 13
Pulp	3.487,2600		3.487,2600
Air	40.103,4900	26.154,4500	13.949,0400
Total	43.590,7500	26.154,4500	17.436,3000
		43.590,7500	

5. Press Machine (PM-501)

Tabel 4.5. Neraca Massa Mesin Press (PM-501)

Komponen	Input (kg/jam)	Output (kg/jam)	
	Aliran 13	Aliran 14	Aliran 15
Pulp	3.487,2600		3.487,2600
Air	13.949,0400	10.461,7800	3.487,2600
Total	17.436,3000	10.461,7800	6.974,5200
		17.436,3000	

6. Dryer (DR-501)

Tabel 4.6. Neraca Massa Dryer (DR-501)

Komponen	Input (kg/jam)	Output (kg/jam)	
	Aliran 15	Aliran 16	Aliran 17
Pulp	3.487,2600		3.487,2600
Air	3.487,2600	3.184,0200	303,2400
Total	6.974,5200	3.184,0200	3.790,5000
		6.974,5200	

7. Distillation Column (MD-401)

Tabel 4.7. Neraca Massa Distillation Column (DC-401)

Komponen	Input (kg/jam)	Output (kg/jam)	
	Aliran 9	Aliran 18	Aliran 19
Etanol	10040,2223	8734,9934	1305,2289
Air	31271,8730	7146,8127	24125,0603
NaOH	162,4500		162,4500
Padatan Non-selulosa	790,5900		790,5900
Total	42265,1353	15881,8061	26383,3292
		42265,1353	

8. Condenser (CD-401)

Tabel 4.8. Neraca Massa Condenser (CD-401)

Komponen	Masuk	
	Kmol/jam	kg/jam
Etanol	412,6723	19011,4022
Air	863,4351	15554,7836
NaOH	0,0000	0,0000
Total	1276,1074	34566,1858

Tabel 4.8. (lanjutan)

Komponen	Keluar			
	Aliran D		Aliran 18	
	kmol/jam	kg/jam	kmol/jam	kg/jam
Etanol	223,0656	10276,4089	189,6067	8734,9934
Air	466,7206	8407,9709	396,7145	7146,8127
NaOH	0,0000	0,0000	0,0000	
Total	689,7862	18684,3797	586,3212	15881,8061

9. Reboiler (RB-401)

Tabel 4.9. Neraca Massa Reboiler (RB-401)

Komponen	Masuk	
	Aliran F	
	Kmol/jam	kg/jam
Etanol	54,6924	2519,6229
Air	2585,1336	46571,1831
NaOH	7,8399	313,5946
Total	2647,6659	49404,4006

Tabel 4.9. (lanjutan)

Komponen	Keluar			
	Aliran G		Aliran 19	
	kmol/jam	kg/jam	kmol/jam	kg/jam
Etanol	26,3603	1214,3940	28,3320	1305,2289
Air	1245,9685	22446,1228	1339,1652G	24125,0603
NaOH	3,7786	151,1446	4,0613	162,45
Total	1276,1075	23811,6614	1371,5584	25592,7392
	2647,6659 kmol/jam		49404,4006 kg/jam	

10. Storage Tank (ST-401)

Tabel 4.10. Neraca Massa Storage Tank (ST-401)

Komponen	Input (kg/jam)				Output (kg/jam)
	Aliran 24	Aliran 4	Aliran 28	Aliran 29	Aliran 2
Etanol	8734,9934	640,8653		1305,2289	10681,0875
Air	7146,8127	308,0025	5893,5405	68,3357	13416,6914
Total	15881,8061	948,8678	5893,5405	1373,5645	24097,7789
	24097,7789				24097,7789

2. Neraca Massa Keseluruhan

Tabel 4.11. Neraca Massa Keseluruhan

Komponen	Input				Output			
	ST-401 kg/jam	Digester kg/jam	RDVF Kg/jam	Mixing Tank kg/jam	Fourdriener kg/jam	Press Machine kg/jam	Dryer kg/jam	DC-401 Kg/jam
TKKS		5.415,0000						
Pulp							3.487,2600	
Etanol	1.305,2289							1305,2289
Air	5.961,8762		34.052,0682	23.077,4559	26.154,4500	10.461,7800	3.487,2600	24.125,0603
NaOH		162,4500						162,4500
Padatan non								790,5900
Total	7.267,1051	5.577,4500	34.052,0682	23.077,4559	26.154,4500	10.461,7800	6.974,5200	26.383,3292
		69.974,0792				69.974,0792		

B. NERACA ENERGI

1. Digester 201 (D 201 A/E)

Tabel 4.12. Neraca energi pada Digester (D-201 A/E)

Komponen	Q masuk (kJ/Jam)	Q keluar (kJ/Jam)
Q ¹	113.361,5341	
Q ²	4.124.290,6387	
Q ³	1.770,1127	
Q ⁴		504.228,6280
Q ⁵		14.785.307,9338
Q _{steam in}	15.563.958,5084	
Q _{steam out}		4.513.844,2321
Total	19.803.380,7939	19.803.380,7939

2. Condenser (CD-201)

Tabel 4.13. Neraca energi pada Condenser (CD-201)

Komponen	Q masuk (kJ/Jam)	Q keluar (kJ/Jam)
Q ³²	1.902.903,6476	
Q serap		1.729.115,2072
Q ³³		173.788,4403
Total	1.902.903,6476	1.902.903,6476

3. Rotary Drum Vacuum Filter (RDVF-301/3)

Tabel 4.14. Neraca energi pada Rotary Drum Vacuum Filter (RDVF-301/3)

Komponen	Q masuk (kJ/Jam)	Q keluar (kJ/Jam)
Q ⁶	14.697.342,0301	
Q ¹⁰	717.871,1751	
Q ¹³		11.170.475,4010
Q ⁹		4.244.737,8042
Total	15.415.213,2052	15.415.213,2052

4. Mixing Tank (MT-501)

Tabel 4.15. Neraca energi pada Mixing Tank (MT-501)

Komponen	Q masuk (kJ/Jam)	Q keluar (kJ/jam)
Q ⁹	4.244.737,8090	
Q ¹⁴	486.509,0795	
Q ¹⁵		4.731.246,8885
Total	4.731.246,8885	4.731.246,8885

5. Dryer (DR-501)

Tabel 4.16. Neraca energi pada Dryer (DR-501)

Komponen	Q masuk (kJ/Jam)	Q keluar (kJ/Jam)
Q_{22}	457.859,8697	
Q_{23}	11.515.791,7815	
Q_{24}		3.339.798,8233
$Q_{S \text{ in}}$		8.198.204,9552
$Q_{S \text{ out}}$		435.647,8728
Total	11.973.651,6512	11.973.651,6512

6. Air Heater (AH-501)

Tabel 4.17. Neraca energi pada Air Heater (AH-501)

Komponen	Q masuk (KJ/Jam)	Q keluar (KJ/Jam)
Q_{in}	3.288.414,0984	
Q_{out}		5.196.477,2311
$Q_{S \text{ in}}$	2.687.484,9153	
$Q_{S \text{ out}}$		779.421,7825
Total	5.975.899,0137	5.975.899,0137

7. Condenser (CD-401)

Tabel 4.18 Neraca energi pada Condenser (CD-401)

Komponen	Q masuk (KJ/Jam)	Q keluar (KJ/Jam)
Q^{22}	56.580.261,0288	
Q^{23}		4.480.846,0658
Q^{24}		3.808.739,1387
Q_{serap}		48.290.675,8243
Total	56.580.261,0288	56.580.261,0288

8. Reboiler (RB-401)

Tabel 4.19. Neraca energi Reboiler (RB-401)

Komponen	Q masuk (KJ/Jam)	Q keluar (KJ/Jam)
Q_{in}	60.160.938,9644	
Q_{out}		8.289.585,2045
Q_{steam}		51.871.353,7599
Total	60.160.938,9644	60.160.938,9644

10. Storage Tank (ST-401)

Tabel 4.20. Neraca Energi Storage Tank (ST-401)

Komponen	Q masuk (kJ/Jam)	Q keluar (kJ/Jam)
Q^{30}	173.788,4403	
Q^{24}	3.808.739,1387	
Q^{28}	124.245,1063	
Q^{29}	17.517,9534	
Q^2		4.124.290,6387
Total	4.124.290,6387	4.124.290,6387