LAMPIRAN

A. Lampiran Perhitungan

1. Densitas

$$\rho = \frac{\text{massa piknometer isi} - \text{massa piknometer kosong}}{\text{volume piknometer}}$$

Dimana ;ρ = massa jenis / densitas (gr/ml)

1.1 Percobaan 1 (Tekanan 75 kg/cm^2)

Tabel 5. Data Perhitungan Densitas Percobaan 1

Uji	Massa Piknometer Isi (gr)	Massa Piknometer Kosong (gr)	Volume Piknometer (ml)
1	42,56	16,9	25
2	42,51	16,9	25
3	42,44	16,9	25
4	42,38	16,9	25
5	42,31	16,9	25
6	42,26	16,9	25
7	41,76	16,9	25
8	41,76	16,9	25
9	41,72	16,9	25
10	41,7	16,9	25

$$\rho = \frac{(41{,}7 - 16{,}9)\ \text{gr}}{25\ \text{ml}} = 0{,}9916\ \text{gr/ml}$$

1.2 Percobaan 2 (Tekanan 90 kg/cm^2)

Tabel 6. Data Perhitungan Densitas Percobaan 2

Uji	Massa Piknometer Isi (gr)	Massa Piknometer Kosong (gr)	Volume Piknometer (ml)
1	42,99	16,9	25
2	42,57	16,9	25
3	42,5	16,9	25
4	42,45	16,9	25
5	42,26	16,9	25
6	42,13	16,9	25
7	42,03	16,9	25
8	41,71	16,9	25
9	41,5	16,9	25
10	40,99	16,9	25

$$\rho = \frac{(40{,}99 - 16{,}9)\ \text{gr}}{25\ \text{ml}} = 0{,}957\ \text{gr/ml}$$

1.3 Percobaan 3 (Tekanan 104 kg/cm^2)

Tabel 7. Data Perhitungan Densitas Percobaan 3

Uji	Massa Piknometer Isi (gr)	Massa Piknometer Kosong (gr)	Volume Piknometer (ml)
1	42,59	16,9	25
2	42,28	16,9	25
3	42,14	16,9	25
4	41,9	16,9	25
5	41,84	16,9	25
6	41,8	16,9	25
7	41,72	16,9	25
8	41,68	16,9	25
9	41,28	16,9	25
10	40,92	16,9	25

$$\rho = \frac{(40{,}92 - 16{,}9)\ \text{gr}}{25\ \text{ml}} = 0{,}960\ \text{gr/ml}$$

2. Viskositas

$$\mu = \frac{tx \times \rho x}{t0 \times \rho 0} \times \mu_0$$

Keterangan :

- μ_x : viskositas sampel (Cp)
- μ_0 : viskositas air (Cp)
- t_x: waktu sampel (s)
- t_0: waktu air (s)
- ρ_x : densitas sampel (g/ml)
- ρ_0 : densitas air (g/ml)

Tabel 8. Data waktu (tx) filtrat pada analisa viskositas

Pengambilan filtrat menit ke-	tx (s)		
	Percobaan I P=75 kg/m3	Percobaan II P=90 kg/m3	Percobaan III P= 104 kg/m3
0	-	-	-
3	1.92	1.97	1.49
6	1.88	1.91	1.45
9	1.74	1.76	1.44
12	1.73	1.63	1.41
15	1.62	1.61	1.38
18	1.54	1.63	1.36
21	1.51	1.56	1.36
24	1.49	1.53	1.33
27	1.49	1.44	1.33
30	1.47	1.44	1.31

2.1 Viskositas Percobaan 1

$$\mu = \frac{1{,}47 \text{ x } 0{,}9916 \text{ gr/ml}}{0{,}8 \text{ x } 1 \text{ gr/ml}} \text{ x } 1{,}002 \text{ cp} = 1{,}8257 \text{ cp}$$

2.2 Viskositas Percobaan 2

$$\mu = \frac{1{,}44 \text{ x } 0{,}957 \text{ gr/ml}}{0{,}8 \text{ x } 1 \text{ gr/ml}} \text{ x } 1{,}002 \text{ cp} = 1{,}737 \text{ cp}$$

2.3 Viskositas Percobaan 3

$$\mu = \frac{1{,}31 \text{ x } 0{,}960 \text{ gr/ml}}{0{,}8 \text{ x } 1 \text{ gr/ml}} \text{ x } 1{,}002 \text{ cp} = 1.575 \text{ cp}$$

3. Nilai Tahanan Cake (α)

$$\alpha = \frac{Kp\ A^2(-\Delta P)}{\mu Cs}$$

Dimana:

α = tahanan spesifik cake ($^{m}/_{kg}$)

ΔP = *pressure drop* (N/m^2)

A = luas filter (m^2)

μ = viskositas (Pa.s)

C_s = Konsentrasi *Sludge* (kg solid/m^3)

K_p ($^{s}/_{m^6}$)

3.1 Percobaan 1 (Tekanan 75 kg/m^2)

a) Menghitung Konsentrasi Sludge (Cs)

- Volume Lumpur : 15 liter = 15 dm^3 = 0,015 m^3

Dik : ρ_{lumpur} = 721 kg/m^3

- $\rho = \frac{m}{V}$

  $m = \rho$ x v

  = 721 kg/m^3 x 0,015 m^3

  = 5,047 kg

Volume Air : 12,23 liter = 12,23 dm3 = 0,01223 m^3

- $Cs = \frac{\text{massa lumpur}}{\text{Volume air}}$

  $= \frac{10{,}815 \text{ kg}}{0{,}01223 \text{ m3}}$

  $= 884{,}3 \text{ kg/m}^3$

b) Menghitung Luas Filter (A)

Panjang sisi : 47 cm

$A = (47 \times 47) \text{ cm}^2$

$= 2209 \text{ cm}^2$

$= 0{,}2209 \text{ m}^2$

c) Menghitung Pressure Drop ($-\Delta P$)

Dik : $1 \text{ kg/cm}^2 = 98.066{,}5 \text{ N/m}^2$

$\Delta P = 75 \text{ kg/ cm}^2$

$= 75 \times 98.066{,}5 \text{ N/m}^2$

$= 7.354.987{,}5 \text{ N/m}^2$

d) Menghitung Kp

Dari grafik Hubungan t/V vs V pada percobaan 1, didapat persamaan sebagai berikut :

$y = 1E+07x - 17867$

berdasarkan persamaan didapat slope (a) = 1E+07 dan intersept (b) = 17867

- Slope = Kp / 2

  Kp = Slope x 2

  $= (1E+07) \times 2$

  $= 2E+07 \text{ s/m}^6$

e) Menghitung Densitas

$$\rho = \frac{\text{massa piknometer isi} - \text{massa piknometer kosong}}{\text{volume piknometer}}$$

$$\rho = \frac{(41{,}7 - 16{,}9) \text{ gr}}{25 \text{ ml}} = 0{,}9916 \text{ gr/ml}$$

f) Menghitung Viskositas

$$\mu = \frac{tx \times \rho x}{t0 \times \rho 0} \times \mu_0$$

$$\mu = \frac{1{,}47 \text{ x } 0{,}9916 \text{ gr/ml}}{0{,}8 \text{ x } 1 \text{ gr/ml}} \text{ x } 1{,}002 \text{ cp}$$

$\mu = 1{,}8257 \text{ cp} = 0{,}0182 \text{ Pa.s}$

g) Menghitung Nilai α

$$\alpha = \frac{Kp\ A^2(-\Delta P)}{\mu Cs}$$

$$\alpha = \frac{(2E{+}07)\ (0{,}2209\ )^2(7.354.987{,}5\ )}{(1{,}8257)(884{,}3\ )}$$

α= 4,42E+11 m/kg

3.2 Percobaan 2 (Tekanan 90 kg/m^2)

a) Menghitung Konsentrasi Sludge (Cs)

- Volume Lumpur : 15 liter = 15 dm^3 = 0,015 m^3

Dik : ρ_{lumpur} = 721 kg/m^3

- $\rho = \frac{\text{m}}{\text{V}}$

  $m = \rho$ x v

  = 721 kg/m^3 x 0,015 m^3

  = 10,815 kg

Volume Air : 12,2 liter = 12,2 dm3 = 0,0122 m^3

- Cs = $\frac{\text{massa lumpur}}{\text{Volume air}}$

  = $\frac{10{,}815\ \text{kg}}{0{,}0122\ \text{m}3}$

  = 879,268 kg/m^3

b) Menghitung Luas Filter (A)

Panjang sisi : 47 cm

A = (47 x 47) cm^2

= 2209 cm^2

= 0,2209 m^2

c) Menghitung Pressure Drop (-ΔP)

Dik : 1 kg/cm^2 = 98.066,5 N/m^2

ΔP = 90 kg/ cm^2

= 90 x 98.066,5 N/m^2

= 8.825.985 N/m^2

d) Menghitung Kp

Dari grafik Hubungan t/V vs V pada percobaan 1, didapat persamaan sebagai berikut :

y = 1E+07x - 11307

berdasarkan persamaan didapat slope (a) = 1E+07 dan intersept (b) = 11307

- Slope = Kp / 2

  Kp = Slope x 2

  = (1E+07) x 2

  = 2E+07 s/m^6

e) Menghitung Densitas

$$\rho = \frac{\text{massa piknometer isi} - \text{massa piknometer kosong}}{\text{volume piknometer}}$$

$$\rho = \frac{(40{,}99 - 16{,}9)\ \text{gr}}{25\ \text{ml}} = 0{,}957\ \text{gr/ml}$$

f) Menghitung Viskositas

$$\mu = \frac{tx \times \rho x}{t0 \times \rho 0} \times \mu_0$$

$$\mu = \frac{1{,}44 \text{ x } 0{,}957\ \text{gr/ml}}{0{,}8 \text{ x } 1\ \text{gr/ml}} \text{ x } 1{,}002\ \text{cp} = 1{,}737\ \text{cp}$$

μ = 1,737 cp = 0,0173 Pa.s

g) Menghitung Nilai α

$$\alpha = \frac{Kp\ A^2(-\Delta P)}{\mu Cs}$$

$$\alpha = \frac{(2\text{E}+07)\ (0{,}2209)^2(8.825.985)}{(1{,}737)(879{,}268)}$$

α= 5,62E+11 m/kg

3.3 Percobaan 3 (Tekanan 104 kg/m^2)

a) Menghitung Konsentrasi Sludge (Cs)

- Volume Lumpur : 15 liter = 15 dm^3 = 0,015 m^3

Dik : ρ_{lumpur} = 721 kg/m^3

- $\rho = \frac{m}{V}$

  $m = \rho$ x v

  = 721 kg/m^3 x 0,015 m^3

  = 10,815 kg

Volume Air : 11,6 liter = 11,6 dm3 = 0,0116 m^3

- Cs = $\frac{\text{massa lumpur}}{\text{Volume air}}$

  = $\frac{10{,}815\ \text{kg}}{0{,}0116\ \text{m}3}$

  = 932,327 kg/m^3

b) Menghitung Luas Filter (A)

Panjang sisi : 47 cm

A = (47 x 47) cm^2

= 2209 cm^2

= 0,2209 m^2

c) Menghitung Pressure Drop (-Δ*P*)

Dik : 1 kg/cm^2 = 98.066,5 N/m^2

Δ*P* = 104 kg/cm^2

= 104 x 98.066,5 N/m^2

= 10.198.916 N/m^2

d) Menghitung Kp

Dari grafik Hubungan t/V vs V pada percobaan 1, didapat persamaan sebagai berikut :

y = 1E+07x - 11260

berdasarkan persamaan didapat slope (a) = 1E+07 dan intersept (b) = 11260

- Slope = Kp / 2

  Kp = Slope x 2

  = (1E+07) x 2

  = 2E+07 s/m^6

e) Menghitung Densitas

$$\rho = \frac{\text{massa piknometer isi} - \text{massa piknometer kosong}}{\text{volume piknometer}}$$

$$\rho = \frac{(40{,}92 - 16{,}9)\ \text{gr}}{25\ \text{ml}} = 0{,}960\ \text{gr/ml}$$

f) Menghitung Viskositas

$$\mu = \frac{tx \times \rho x}{t0 \times \rho 0} \times \mu_0$$

$$\mu = \frac{1{,}31 \text{ x } 0{,}960\ \text{gr/ml}}{0{,}8 \text{ x } 1\ \text{gr/ml}} \text{ x } 1{,}002\ \text{cp}$$

μ = 1.575 cp = 0.0157

g) Menghitung Nilai α

$$\alpha = \frac{Kp\ A^2(-\Delta P)}{\mu Cs}$$

$$\alpha = \frac{(2\text{E}{+}07)\ (0{,}2209)^2(10.198.916)}{(1.575)(932{,}327)}$$

α = 6,74E+11 m/kg

4. Analisa Nilai Tahanan Medium Filter (Rm)

$$Rm = \frac{B\ A(-\Delta P)}{\mu}$$

Dimana :

R_m = tahanan medium filter (m^{-1})

B ($^{S}/_{m^3}$)

μ = viskositas (Pa.s)

ΔP= *pressure drop* (N/m^2)

A = luas filter (m^2)

4.1 Percobaan 1 (Tekanan 75 kg/m^2)

a) Menghitung Nilai B

Dari grafik Hubungan t/V vs V pada percobaan 1, didapat persamaan sebagai berikut :

y = 1E+07x – 17867

berdasarkan persamaan didapat slope (a) = 1E+07 dan intersept (b) = 17867

b) Menghitung Luas Filter (A)

Panjang sisi : 47 cm

A = (47 x 47) cm^2

= 2209 cm^2

= 0,2209 m^2

c) Menghitung Pressure Drop (-ΔP)

Dik : 1 kg/cm^2 = 98.066,5 N/m^2

ΔP = 75 kg/ cm^2

= 75 x 98.066,5 N/m^2

= 7.354.987,5 N/m^2

d) Menghitung Viskositas

$$\mu = \frac{tx \times \rho x}{t0 \times \rho 0} \times \mu_0$$

$$\mu = \frac{1{,}47\ \text{x}\ 0{,}9916\ \text{gr/ml}}{0{,}8\ \text{x}\ 1\ \text{gr/ml}}\ \text{x}\ 1{,}002\ \text{cp}$$

μ = 1,8257 cp = 0,0182 Pa.s

e) Menghitung Nilai Rm

$$Rm = \frac{B\ A(-\Delta P)}{\mu}$$

$$Rm = \frac{(17867)(0{,}2209)(7.354.987{,}5)}{0{,}0182}$$

$Rm = 1{,}59E{+}12 m^{-1}$

4.2 Percobaan 2 (Tekanan 90 kg/m^2)

a) Menghitung Nilai B

Dari grafik Hubungan t/V vs V pada percobaan 1, didapat persamaan sebagai berikut :

y = 1E+07x - 11307

berdasarkan persamaan didapat slope (a) = 1E+07 dan intersept (b) = 11307

b) Menghitung Luas Filter (A)

Panjang sisi : 47 cm

A = (47 x 47) cm^2

= 2209 cm^2

= 0,2209 m^2

c) Menghitung Pressure Drop (-ΔP)

Dik : 1 kg/cm^2 = 98.066,5 N/m^2

ΔP = 90 kg/ cm^2

= 90 x 98.066,5 N/m^2

= 8.825.985 N/m^2

d) Menghitung Viskositas

$$\mu = \frac{tx \times \rho x}{t0 \times \rho 0} \times \mu_0$$

$$\mu = \frac{1{,}44\ \text{x}\ 0{,}957\ gr/ml}{0{,}8\ \text{x}\ 1\ gr/ml}\ \text{x}\ 1{,}002\ cp = 1{,}737\ cp$$

μ = 1,737 cp = 0,0173 Pa.s

e) Menghitung Nilai Rm

$$Rm = \frac{B\ A(-\Delta P)}{\mu}$$

$$Rm = \frac{(11307)(0{,}2209)(8.825.985\ )}{0{,}0173}$$

$Rm = 1{,}23E{+}12\ m^{-1}$

4.3 Percobaan 3 (Tekanan 104 kg/m^2)

a) Menghitung Nilai B

Dari grafik Hubungan t/V vs V pada percobaan 1, didapat persamaan sebagai berikut :

y = 1E+07x - 11260

berdasarkan persamaan didapat slope (a) = 1E+07 dan intersept (b) = 11260

b) Menghitung Luas Filter (A)

Panjang sisi : 47 cm

A = (47 x 47) cm^2

= 2209 cm^2

= 0,2209 m^2

c) Menghitung Pressure Drop (-Δ*P*)

Dik : 1 kg/cm^2 = 98.066,5 N/m^2

Δ*P* = 104 kg/ cm^2

= 104 x 98.066,5 N/m^2

= 10.198.916 N/m^2

d) Menghitung Viskositas

$$\mu = \frac{tx \times \rho x}{t0 \times \rho 0} \times \mu_0$$

$$\mu = \frac{1{,}31 \text{ x } 0{,}960 \text{ gr/ml}}{0{,}8 \text{ x } 1 \text{ gr/ml}} \text{ x } 1{,}002 \text{ cp}$$

μ = 1.575 cp = 0.0157

e) Menghitung Nilai Rm

$$Rm = \frac{B\,A(-\Delta P)}{\mu}$$

$$Rm = \frac{(11260)(0{,}2209)(10.198.916)}{0.0157}$$

Rm= 1,61E + 12 m^{-1}

5. Analisa Kadar Air (*Moisture Content*)

$$\text{Kadar Air} = \frac{B - C}{B} \text{ x } 100\%$$

Dimana :

B = berat cawan + sampel awal (g)

C = berat cawan + sampel setelah dioven 1 jam (g)

Tabel 9. Data nilai kadar air pada percobaan 1,2 dan 3

Percobaan	Tekanan (kg/cm2)	Plate ke-	Massa Sebelum Oven (gr)	Massa Sesudah Oven (gr)	% kadar air	% kadar air cake total
I	75	1	578,27	338,49	41,465	35,437
		2	464,85	287,37	38,180	
		3	333,38	262,84	21,159	
II	90	1	928,27	598,24	35,553	35,024
		2	828,27	537,59	35,094	
		3	728,27	478,7	34,268	
III	104	1	1.328,27	859,28	35,308	34,024
		2	1.128,27	709,55	37,111	
		3	1.028,27	730,28	28,979	

5.1 Percobaan 1 (Tekanan 75 kg/cm^2)

$$\text{Kadar Air} = \frac{\text{B} - \text{C}}{\text{B}} \text{ x } 100\%$$

$$\text{Kadar Air} = \frac{(578{,}27 + 464{,}85 + 333{,}38) - (338{,}49 + 287{,}37 + 262{,}84)}{(338{,}49 + 287{,}37 + 262{,}84)} \text{ x } 100\%$$

$$\text{Kadar Air} = \frac{(1376{,}5) - (888{,}7)}{(1376{,}5)} \text{ x } 100\%$$

$$\text{Kadar Air} = 35{,}437\ \%$$

5.2 Percobaan 2 (Tekanan 90 kg/cm^2)

$$\text{Kadar Air} = \frac{\text{B} - \text{C}}{\text{B}} \text{ x } 100\%$$

$$\text{Kadar Air} = \frac{(928{,}27 + 828{,}27 + 728{,}27) - (598{,}24 + 537{,}59 + 478{,}7)}{(928{,}27 + 828{,}27 + 728{,}27)} \text{ x } 100\%$$

$$\text{Kadar Air} = \frac{(2.484{,}81) - (1614{,}53)}{(2.484{,}81)} \text{ x } 100\%$$

$$\text{Kadar Air} = 35{,}024\ \%$$

5.3 Percobaan 3 (Tekanan 104 kg/cm^2)

$$\text{Kadar Air} = \frac{\text{B} - \text{C}}{\text{B}} \text{ x } 100\%$$

$$\text{Kadar Air} = \frac{(1.328{,}27 + 1.128{,}27 + 1.028{,}27) - (859{,}28 + 709{,}55 + 730{,}28)}{(1.328{,}27 + 1.128{,}27 + 1.028{,}27)} \text{ x } 100\%$$

$$\text{Kadar Air} = \frac{(3.484{,}81) - (2299{,}11)}{(3.484{,}81)} \text{ x } 100\%$$

$$\text{Kadar Air} = 34{,}024\ \%$$

B. Lampiran Gambar

Gambar 11. Alat Filtrasi *Plate and Frame*

Gambar 12. Sampel Lumpur IPAL

Gambar 13. Cake pada cloth

Gambar 14. Filtrat hasil filtrasi

Gambar 15. Cake dari plate 1, 2 dan 3

Gambar 16. Cake Setelah dikeringkan