

## LAMPIRAN PERHITUNGAN ANALISA FILTRASI

Data hasil analisa pada proses filtrasi dapat dilihat pada Tabel 4.

### A. Lampiran Perhitungan

#### 1. Densitas ( $\rho$ )

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

Dimana ;  $\rho$  = massa jenis / densitas (gr/ml)

Tabel 5. Data Perhitungan Densitas

Uji	Massa Piknometer Isi (gr)	Massa Piknometer Kosong (gr)	Volume Piknometer (ml)
1.	41,51	16,84	25
2.	41,52	16,84	25
3.	41,75	16,84	25
4.	41,52	16,84	25
5.	41,68	16,84	25
6.	41,69	16,84	25

$$\text{a.) } \rho_1 (t=30 \text{ s}) = \rho = \frac{(41,51-16,84) \text{ gr}}{25 \text{ ml}} = 0,9868 \text{ gr/ml}$$

$$\text{b.) } \rho_2 (t=30 \text{ s}) = \rho = \frac{(41,52-16,84) \text{ gr}}{25 \text{ ml}} = 0,9872 \text{ gr/ml}$$

$$\text{c.) } \rho_3 (t=30 \text{ s}) = \rho = \frac{(41,75-16,84) \text{ gr}}{25 \text{ ml}} = 0,9964 \text{ gr/ml}$$

$$\text{d.) } \rho_4 (t=30 \text{ s}) = \rho = \frac{(41,52-16,84) \text{ gr}}{25 \text{ ml}} = 0,9872 \text{ gr/ml}$$

$$\text{e.) } \rho_5 (t=30 \text{ s}) = \rho = \frac{(41,68-16,84) \text{ gr}}{25 \text{ ml}} = 0,9936 \text{ gr/ml}$$

$$\text{f.) } \rho_6 (t=30 \text{ s}) = \rho = \frac{(41,69-16,84) \text{ gr}}{25 \text{ ml}} = 0,994 \text{ gr/ml}$$

## 2. Viskositas ( $\mu$ )

$$\mu = \frac{t_x \times \rho_x}{t_0 \times \rho_0} \times \mu_0$$

Keterangan :

- $\mu_x$  : viskositas sampel (Cp)
- $\mu_0$  : viskositas air (Cp)
- $t_x$  : waktu sampel (s)
- $t_0$  : waktu air (s)
- $\rho_x$  : densitas sampel (g/ml)
- $\rho_0$  : densitas air (g/ml)

Tabel 6. Data Perhitungan Viskositas

Uji	Densitas sampel (gr/ml)	Densitas air (gr/ml)	Waktu sampel (s)	Waktu air (s)
1.	0,9868	1	0,91	0,8
2.	0,9872	1	0,94	0,8
3.	0,9964	1	0,85	0,8
4.	0,9872	1	0,93	0,8
5.	0,9936	1	0,95	0,8
6.	0,994	1	0,83	0,8

$$\text{a.) } \mu_1 (t=30 \text{ s}) = \frac{0,91 \times 0,9869 \text{ gr/ml}}{0,8 \times 1 \text{ gr/ml}} \times 1,002 \text{ cp} = 0,7392 \text{ cp} = 0,0007392 \text{ Ns/m}^2$$

$$\text{b.) } \mu_2 (t=30 \text{ s}) = \frac{0,94 \times 0,9872 \text{ gr/ml}}{0,8 \times 1 \text{ gr/ml}} \times 1,002 \text{ cp} = 0,7633 \text{ cp} = 0,0007633 \text{ Ns/m}^2$$

$$\text{c.) } \mu_3 (t=30 \text{ s}) = \frac{0,85 \times 0,9964 \text{ gr/ml}}{0,8 \times 1 \text{ gr/ml}} \times 1,002 \text{ cp} = 0,6838 \text{ cp} = 0,0006838 \text{ Ns/m}^2$$

$$\text{d.) } \mu_4 (t=30 \text{ s}) = \frac{0,93 \times 0,9872 \text{ gr/ml}}{0,8 \times 1 \text{ gr/ml}} \times 1,002 \text{ cp} = 0,7552 \text{ cp} = 0,0007552 \text{ Ns/m}^2$$

$$\text{e.) } \mu_5 (t=30 \text{ s}) = \frac{0,95 \times 0,9936 \text{ gr/ml}}{0,8 \times 1 \text{ gr/ml}} \times 1,002 \text{ cp} = 0,7664 \text{ cp} = 0,0007664 \text{ Ns/m}^2$$

$$\text{f.) } \mu_6 (t=30 \text{ s}) = \frac{0,83 \times 0,994 \text{ gr/ml}}{0,8 \times 1 \text{ gr/ml}} \times 1,002 \text{ cp} = 0,6693 \text{ cp} = 0,0006693 \text{ Ns/m}^2$$

### 3. Tahanan Medium Filter (Rm)

$$R_m = \frac{B A (-\Delta P)}{\mu} \dots\dots\dots (4)$$

Dimana :

$R_m$  = tahanan medium filter ( $m^{-1}$ )                       $\mu$  = viskositas ( Pa.s )

$C_s$  ( kg solid/ $m^3$  )

$\Delta P$  = *pressure drop* (  $N/m^2$  )                       $K_p$  ( $S/m^6$ )

$A$  = luas filter (  $m^2$  )                                       $B$  ( $S/m^3$ )

Tabel 7. Data Perhitungan Tahanan Medium Filter (Rm)

Uji	B ( $S/m^6$ )	A ( $m^2$ )	$\Delta P$ ( $N/m^2$ )	$\mu$ ( $N.s/m^2$ )
1.	2288,6	0,2209	5884E+03	0,739E-03
2.	2973,5	0,2209	6865E+03	0,763E-03
3.	2333,9	0,2209	5884E+03	0,6838E-03
4.	2952	0,2209	6865E+03	0,755E-03
5.	2422,4	0,2209	5492E+03	0,766E-03
6.	2977	0,2209	6865E+03	0,6693E-03

$$a.) R_{m1} = \frac{(2288,6 S/m^6) \times (0,2209 m^2) \times (5884000 N/m^2)}{(0,000739 N.s/m^2)} = 4,02 E+12 \text{ 1/m}$$

$$b.) R_{m2} = \frac{(2973,5 S/m^6) \times (0,2209 m^2) \times (6865000 N/m^2)}{(0,000763 N.s/m^2)} = 5,91 E+12 \text{ 1/m}$$

$$c.) R_{m3} = \frac{(2333,9 S/m^6) \times (0,2209 m^2) \times (5884000 N/m^2)}{(0,0006838 N.s/m^2)} = 4,44 E+12 \text{ 1/m}$$

$$d.) R_{m4} = \frac{(2952 S/m^6) \times (0,2209 m^2) \times (6865000 N/m^2)}{(0,000755 N.s/m^2)} = 5,93 E+12 \text{ 1/m}$$

$$e.) R_{m5} = \frac{(2422,4 S/m^6) \times (0,2209 m^2) \times (5492000 N/m^2)}{(0,000766 N.s/m^2)} = 3,83 E+12 \text{ 1/m}$$

$$f.) R_{m6} = \frac{(2977 S/m^6) \times (0,2209 m^2) \times (6865000 N/m^2)}{(0,0006693 N.s/m^2)} = 6,75 E+12 \text{ 1/m}$$

#### 4. Specific Resistance to Filtration (SRF)

$$SRF = \frac{2 \cdot b \cdot P \cdot A^2}{\mu \cdot c} \quad \dots\dots\dots(3)$$

Dimana :

- t = waktu filtrasi (detik) V = volume filtrat (m<sup>3</sup>)  
 $\mu$  = viskositas dinamis filtrat (Ndet/m<sup>2</sup>) P = tekanan filtrasi (N/m<sup>2</sup>)  
 SRF = *specific resistance to filtration* (m/kg) A = luas filter (m<sup>2</sup>)  
 c = konsentrasi solid total (lumpur awal + bahan pengkondisi) (kg/m<sup>3</sup>)  
 Rm = resistensi medium filter (1/m) b =  $\left(\frac{\mu \cdot SRF \cdot c}{2 \cdot P \cdot A^2}\right)$  (s/m<sup>6</sup>)

- Menghitung nilai konsentrasi solid total + koagulan (c)

$$\text{Volume lumpur} = 9 \text{ Liter} = 9 \text{ dm}^3 = 0,009 \text{ m}^3$$

$$\text{Massa jenis lumpur } (\rho) = 721 \text{ kg/ m}^3 \text{ (Anonim, 2016)}$$

$$\text{Volume pelarut} = 25 \text{ lt} = 0,0025 \text{ m}^3$$

Massa lumpur (kg)

$$m = \rho \times v$$

$$= 721 \text{ kg/ m}^3 \times 0,009 \text{ m}^3 = 6,489 \text{ kg}$$

$$c = \frac{\text{massa lumpur (kg)}}{\text{volume pelarut (m}^3)} = \frac{6,489 \text{ kg}}{0,025 \text{ m}^3} = 259,56 \text{ kg/m}^3$$

Tabel 8. Data Perhitungan *Specific Resistance to Filtration* (SRF)

Uji	b (s/m <sup>6</sup> )	A (m <sup>2</sup> )	P (N/m <sup>2</sup> )	$\mu$ (N.s/m <sup>2</sup> )	c (kg/m <sup>3</sup> )
1.	2288,6	0,2209	5884E+03	0,739E-03	259,56
2.	2973,5	0,2209	6865E+03	0,763E-03	259,56
3.	2333,9	0,2209	5884E+03	0,6838E-03	259,56
4.	2952	0,2209	6865E+03	0,755E-03	259,56
5.	2422,4	0,2209	5492E+03	0,766E-03	259,56
6.	2977	0,2209	6865E+03	0,6693E-03	259,56

$$a. \text{SRF1} = \frac{(2288,6 \text{ } ^S/m^6) \times (0,2209 \text{ m}^2)^2 \times (5884000 \text{ N/m}^2)}{(0,0007392 \text{ N.s/m}^2) \times (259,56 \text{ kg/m}^3)} = 6,85\text{E}+09 \text{ m/kg}$$

$$b. \text{SRF2} = \frac{(2973,5 \text{ } ^S/m^6) \times (0,2209 \text{ m}^2)^2 \times (6865000 \text{ N/m}^2)}{(0,0007633 \text{ N.s/m}^2) \times (259,56 \text{ kg/m}^3)} = 1,01\text{E}+10 \text{ m/kg}$$

$$c. \text{SRF3} = \frac{(2333,9 \text{ } ^S/m^6) \times (0,2209 \text{ m}^2)^2 \times (5884000 \text{ N/m}^2)}{(0,0006838 \text{ N.s/m}^2) \times (259,56 \text{ kg/m}^3)} = 7,551\text{E}+09 \text{ m/kg}$$

$$d. \text{SRF4} = \frac{(2952 \text{ } ^S/m^6) \times (0,2209 \text{ m}^2)^2 \times (6865000 \text{ N/m}^2)}{(0,0007552 \text{ N.s/m}^2) \times (259,56 \text{ kg/m}^3)} = 1,01\text{E}+10 \text{ m/kg}$$

$$e. \text{SRF5} = \frac{(2422,4 \text{ } ^S/m^6) \times (0,2209 \text{ m}^2)^2 \times (5492000 \text{ N/m}^2)}{(0,0007664 \text{ N.s/m}^2) \times (259,56 \text{ kg/m}^3)} = 6,53\text{E}+09 \text{ m/kg}$$

$$f. \text{SRF6} = \frac{(2977 \text{ } ^S/m^6) \times (0,2209 \text{ m}^2)^2 \times (6865000 \text{ N/m}^2)}{(0,0006693 \text{ N.s/m}^2) \times (259,56 \text{ kg/m}^3)} = 1,148\text{E}+10 \text{ m/kg}$$

### 5. Kadar Air (*Moisture Content*)

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

Dengan keterangan berikut :

B = berat cawan + sampel awal (mg)

C = berat awan + sampel setelah dioven 1 jam (mg)

Tabel 9. Data Perhitungan Kadar Air (*Moisture Content*)

Uji	Koagulan	Plate	B (gr)	C (gr)
1.	Tawas	1	500	320
		2	650	500
		3	600	400
2.	Tawas	1	710	500
		2	620	470
		3	540	420
3.	Tawas	1	740	550
		2	700	530
		3	640	490
4.	PAC	1	800	580
		2	780	570
		3	700	560
5.	PAC	1	860	630
		2	780	600
		3	700	560
6.	PAC	1	910	680
		2	840	630
		3	780	600

a.)MC1

$$\text{Platte 1} = \frac{(500 - 320) \text{ gram}}{500 \text{ gram}} \times 100 \% = 36 \%$$

$$\text{Platte 2} = \frac{(650 - 500) \text{ gram}}{650 \text{ gram}} \times 100 \% = 23,1 \%$$

$$\text{Platte 3} = \frac{(500 - 400) \text{ gram}}{500 \text{ gram}} \times 100 \% = 20 \%$$

b.)MC2

$$\text{Platte 1} = \frac{(710 - 530) \text{ gram}}{710 \text{ gram}} \times 100 \% = 29,6 \%$$

$$\text{Platte 2} = \frac{(620 - 470) \text{ gram}}{620 \text{ gram}} \times 100 \% = 24,6 \%$$

$$\text{Platte 3} = \frac{(540 - 420) \text{ gram}}{540 \text{ gram}} \times 100 \% = 22,2 \%$$

c.)MC3

$$\text{Platte 1} = \frac{(740 - 550) \text{ gram}}{740 \text{ gram}} \times 100 \% = 25,7 \%$$

$$\text{Platte 2} = \frac{(700 - 530) \text{ gram}}{700 \text{ gram}} \times 100 \% = 24,3 \%$$

$$\text{Platte 3} = \frac{(640 - 490) \text{ gram}}{640 \text{ gram}} \times 100 \% = 23,4 \%$$

d.)MC4

$$\text{Platte 1} = \frac{(800 - 580) \text{ gram}}{800 \text{ gram}} \times 100 \% = 27,5 \%$$

$$\text{Platte 2} = \frac{(750 - 570) \text{ gram}}{750 \text{ gram}} \times 100 \% = 24 \%$$

$$\text{Platte 3} = \frac{(700 - 560) \text{ gram}}{7000 \text{ gram}} \times 100 \% = 20 \%$$

e.)MC5

$$\text{Platte 1} = \frac{(860 - 630) \text{ gram}}{860 \text{ gram}} \times 100 \% = 26,7 \%$$

$$\text{Platte 2} = \frac{(780 - 600) \text{ gram}}{780 \text{ gram}} \times 100 \% = 23,1 \%$$

$$\text{Platte 3} = \frac{(700 - 560) \text{ gram}}{700 \text{ gram}} \times 100 \% = 20 \%$$

f.)MC6

$$\text{Platte 1} = \frac{(910 - 680) \text{ gram}}{910 \text{ gram}} \times 100 \% = 25,3 \%$$

$$\text{Platte 2} = \frac{(840 - 630) \text{ gram}}{840 \text{ gram}} \times 100 \% = 25 \%$$

$$\text{Platte 3} = \frac{(780 - 600) \text{ gram}}{780 \text{ gram}} \times 100 \% = 23,1 \%$$

## 6. Yield

$$Y = \frac{w \cdot V}{t \cdot A} \dots\dots\dots (9)$$

Dimana :

Y = Nilai Yield (kg/m<sup>2</sup>h)

A = luas filter (m<sup>2</sup>)

w = massa cake yang tertahan di filter (kg/m<sup>3</sup>)

t = waktu per volume filtrat (s)

V = volume filtrat (m<sup>3</sup>)

- Menghitung nilai w (massa yang tertahan difilter)

$$w = \frac{\text{massa cake (kg)}}{\text{volume pelarut (m<sup>3</sup>)}}$$

- Menghitung nilai volume filtrate (V)

Volume filtrate (V) = 30 Liter = 0,03 m<sup>3</sup>

Tabel 10. Data Perhitungan masaa cake tertahan difilter (w)

Uji	Massa cake (gr)	Massa cake (kg)	V (m <sup>3</sup> )
1.	1650	1,65	0,03
2.	1870	1,87	0,03
3.	2080	2,08	0,03
4.	2250	2,25	0,03
5.	2340	2,34	0,03
6.	2530	2,53	0,03

$$1) w = \frac{1,65 \text{ (kg)}}{0,03 \text{ (m<sup>3</sup>)}} = 61,11 \text{ kg/m}^3$$

$$2) w = \frac{1,87 \text{ (kg)}}{0,03 \text{ (m<sup>3</sup>)}} = 69,26 \text{ kg/m}^3$$

$$3) w = \frac{2,08 \text{ (kg)}}{0,03 \text{ (m<sup>3</sup>)}} = 77,04 \text{ kg/m}^3$$

$$4) w = \frac{2,25 \text{ (kg)}}{0,03 \text{ (m<sup>3</sup>)}} = 83,33 \text{ kg/m}^3$$

$$5) w = \frac{2,34 \text{ (kg)}}{0,03 \text{ (m<sup>3</sup>)}} = 86,67 \text{ kg/m}^3$$

$$6) w = \frac{2,53 \text{ (kg)}}{0,03 \text{ (m<sup>3</sup>)}} = 93,70 \text{ kg/m}^3$$

Tabel 11. Data Perhitungan Yield

Uji	w (kg/m <sup>3</sup> )	V (m <sup>3</sup> )	t (s)	A (m <sup>2</sup> )
1.	61,11	0,03	0,1921	0,2209
2.	69,26	0,03	0,2285	0,2209
3.	77,04	0,03	0,1915	0,2209
4.	83,33	0,03	0,2293	0,2209
5.	86,67	0,03	0,1898	0,2209
6.	93,70	0,03	0,2282	0,2209

$$a.) Y1 = \frac{(20,3704 \text{ kg/m}^3) \times (0,03 \text{ m}^3)}{(0,1921 \text{ h}) \times (3 \times 0,2209 \text{ m}^2)} = 14,40 \text{ kg/m}^2\text{h}$$

$$b.) Y2 = \frac{(23,0864 \text{ kg/m}^3) \times (0,03 \text{ m}^3)}{(0,2285 \text{ h}) \times (3 \times 0,2209 \text{ m}^2)} = 13,72 \text{ kg/m}^2\text{h}$$

$$c.) Y3 = \frac{(25,5556 \text{ kg/m}^3) \times (0,03 \text{ m}^3)}{(0,1915 \text{ h}) \times (3 \times 0,2209 \text{ m}^2)} = 18,21 \text{ kg/m}^2\text{h}$$

$$d.) Y4 = \frac{(16,4198 \text{ kg/m}^3) \times (0,03 \text{ m}^3)}{(0,2293 \text{ h}) \times (3 \times 0,2209 \text{ m}^2)} = 16,45 \text{ kg/m}^2\text{h}$$

$$e.) Y5 = \frac{(23,2099 \text{ kg/m}^3) \times (0,03 \text{ m}^3)}{(0,1898 \text{ h}) \times (3 \times 0,2209 \text{ m}^2)} = 20,68 \text{ kg/m}^2\text{h}$$

$$f.) Y6 = \frac{(30,4938 \text{ kg/m}^3) \times (0,03 \text{ m}^3)}{(0,2282 \text{ h}) \times (3 \times 0,2209 \text{ m}^2)} = 18,59 \text{ kg/m}^2\text{h}$$



**B. Lampiran Foto**



Gambar 8. Pengukuran lumpur baku



Gambar 9. Proses Filtrasi dengan alat Filter Press Plate and Frame



Gambar 10. Cake yang tertahan pada Filter



Gambar 11. Hasil Filtrat





Gambar 12. Cake Setelah Dioven



Gambar 13. Alat Untuk Uji Hasil Praktikum Filtrasi