LAMPIRAN A
TABEL & GRAFIK

Tabel A.1 Aksesoris Pipa

Diameter Nominal (mm)	Panjang Ekivalen (mm)							
	Belokan 90º	Belokan 45º	T-90º aliran	T-90º aliran	Katup Sorong	Katup bola	Katup sudut	Katup arah
65	2,4	1,5	3,6	0,75	0,48	19,5	10,2	4,6
80	3	1,8	4,5	0,9	0,63	24	12	5,7
100	4,2	2,4	6,3	1,2	0,81	37,5	16,5	7,6
125	5,1	3	7,5	1,5	0,99	42	21	10
150	6,0	3,6	9	1,8	1,2	49,5	24	12
200	6,5	3,7	14	4	1,4	70	33	15
250	8	4,2	20	5	1,7	90	43	19

(Sumber : Soufyan & Morimura, Perancangan dan Pemeliharaan Sistem Plambing, hal: 71)

Tabel A.2 Tipical Koefisien Kinetik untuk Proses *Activated Sludge*

Koefisien	Basis (satuan)	Nilai	
		Range	Typikal
K	Day	2 – 8	4
Kd	Day	0,03 - 0,07	0,05
Ks	Mg/L. BOD_5	40 - 120	80
	Mg/L. COD	20 - 80	40
Y	Vss/BOD_5	0,3 - 0,7	0,5
	Vss/ COD	0,2 - 0,5	0,4

(Sumber : *Metcalf & Eddy, Wastewater Engineering Treatment & Reuse*, hal 308)

Tabel A.3 *Physical Properties of Water*

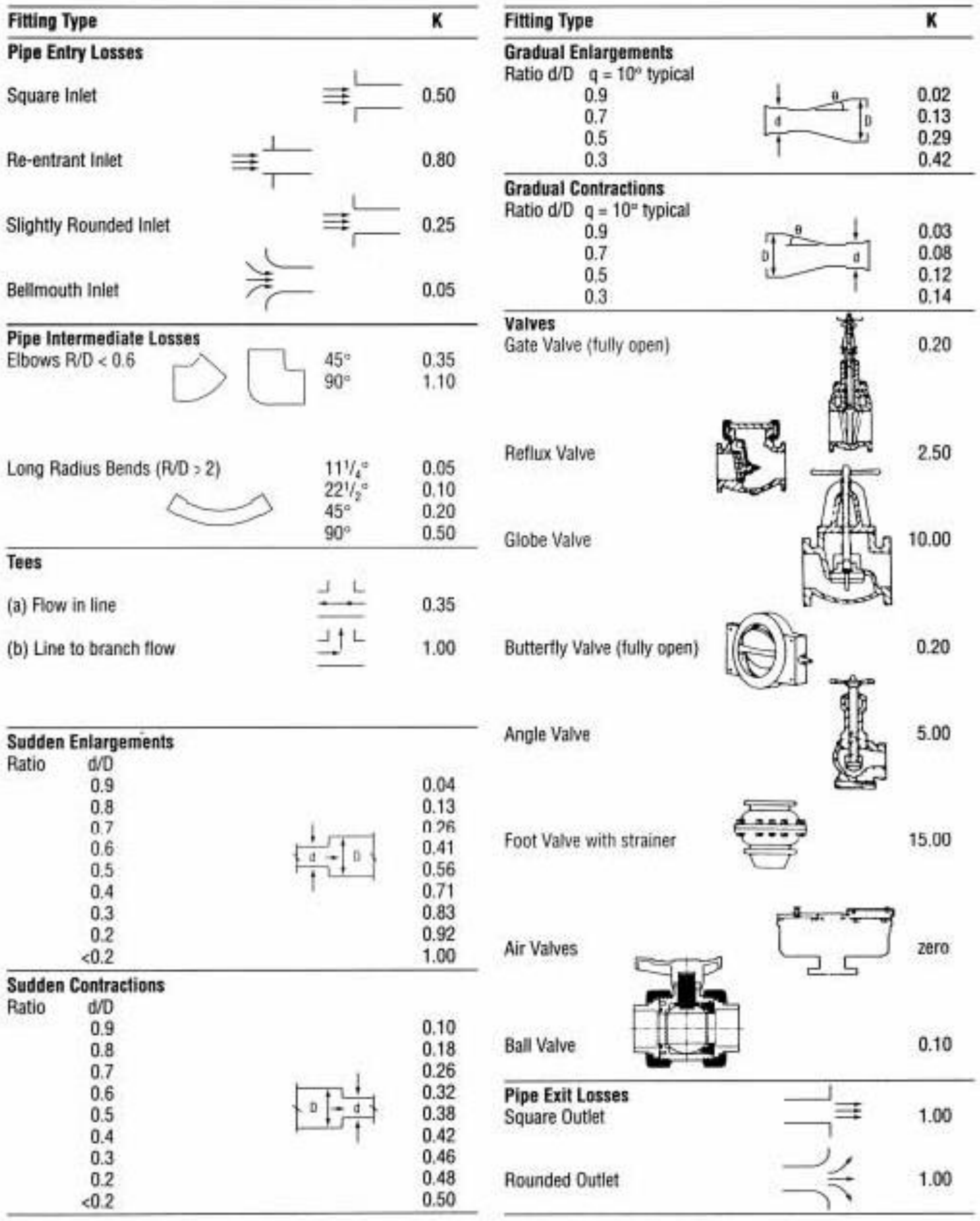
Table C-2
Physical properties of water (U.S. customary units)[a]

Temperature, °F	Specific weight γ, lb/ft^3	Density[b] ρ, $slug/ft^3$	Modulus of elasticity[b] $E/10^3$, lb_f/in^2	Dyamics viscosity, $\mu \times 10^5$, $lb \cdot s/ft^2$	Kinematic viscosity, $\nu \times 10^5$, ft^2/s	Surface tension[c] σ, lb/ft	Vapor pressure P_v, lb_f/in^2
32	62.42	1.940	287	3.746	1.931	0.00518	0.09
40	62.43	1.940	296	3.229	1.664	0.00614	0.12
50	62.41	1.940	305	2.735	1.410	0.00509	0.18
60	62.37	1.938	313	2.359	1.217	0.00504	0.26
70	62.30	1.936	319	2.050	1.059	0.00498	0.36
80	62.22	1.934	324	1.799	0.930	0.00492	0.51
90	62.11	1.931	328	1.595	0.826	0.00486	0.70
100	62.00	1.927	331	1.424	0.739	0.00480	0.95
110	61.86	1.923	332	1.284	0.667	0.00473	1.27
120	61.71	1.918	332	1.168	0.609	0.00467	1.69
130	61.55	1.913	331	1.069	0.558	0.00460	2.22
140	61.38	1.908	330	0.981	0.514	0.00454	2.89
150	61.20	1.902	328	0.905	0.476	0.00447	3.72
160	61.00	1.896	326	0.838	0.442	0.00441	4.74
170	60.80	1.890	322	0.780	0.413	0.00434	5.99
180	60.58	1.883	318	0.726	0.385	0.00427	7.51
190	60.36	1.876	313	0.678	0.362	0.00420	9.34
200	60.12	1.868	308	0.637	0.341	0.00413	11.52
212	59.83	1.860	300	0.593	0.319	0.00404	14.70

[a] Adapted from Vennard and Street (1975)
[b] At atmospheric pressure
[c] In contact with the air.

(Sumber : *Metcalf & Eddy, Wastewater Engineering Treatment & Reuse*, hal 1743)

Gambar A.1 Nilai K pada Aksesoris Pipa

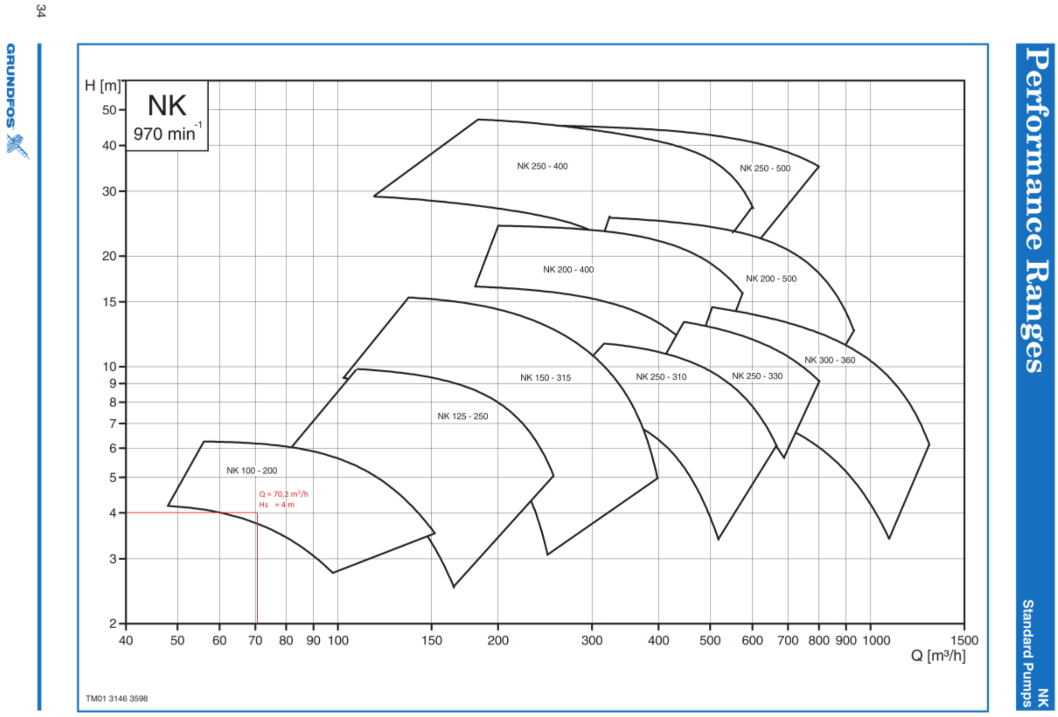


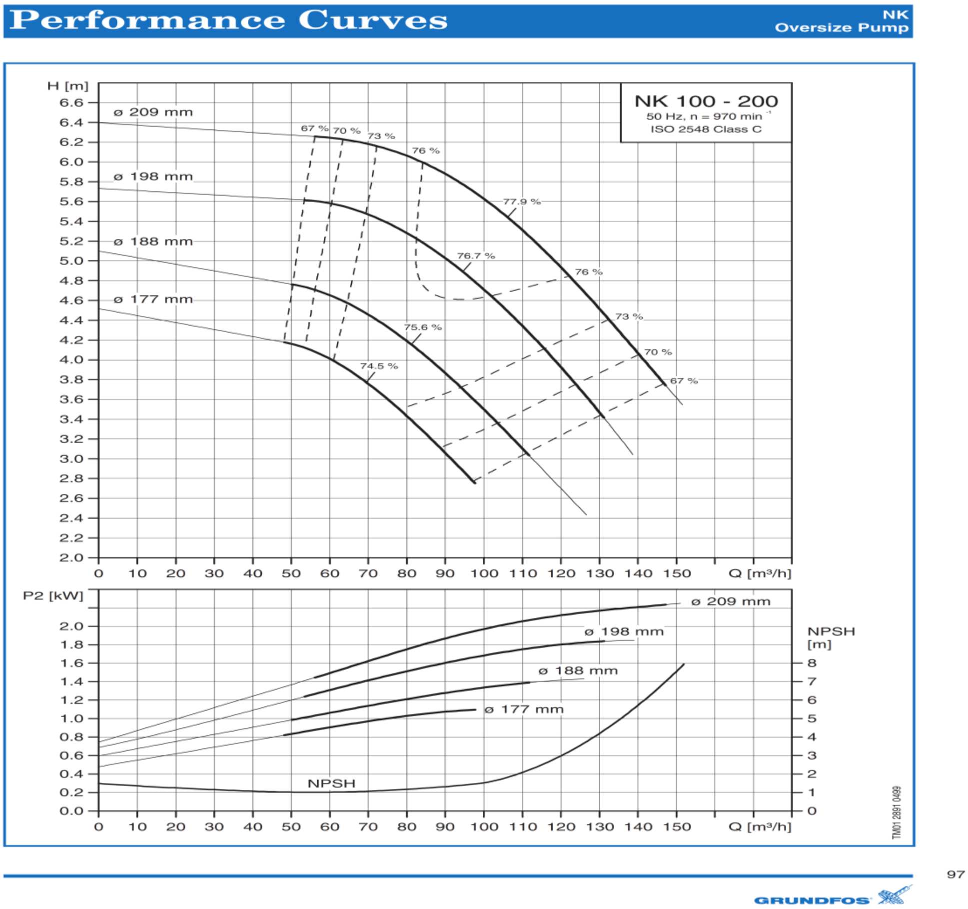
Fitting Type		K
Pipe Entry Losses		
Square Inlet		0.50
Re-entrant Inlet		0.80
Slightly Rounded Inlet		0.25
Bellmouth Inlet		0.05
Pipe Intermediate Losses		
Elbows R/D < 0.6	45°	0.35
	90°	1.10
Long Radius Bends (R/D > 2)	11¼°	0.05
	22½°	0.10
	45°	0.20
	90°	0.50
Tees		
(a) Flow in line		0.35
(b) Line to branch flow		1.00
Sudden Enlargements		
Ratio	d/D	
	0.9	0.04
	0.8	0.13
	0.7	0.26
	0.6	0.41
	0.5	0.56
	0.4	0.71
	0.3	0.83
	0.2	0.92
	<0.2	1.00
Sudden Contractions		
Ratio	d/D	
	0.9	0.10
	0.8	0.18
	0.7	0.26
	0.6	0.32
	0.5	0.38
	0.4	0.42
	0.3	0.46
	0.2	0.48
	<0.2	0.50

Fitting Type		K
Gradual Enlargements		
Ratio d/D q = 10° typical		
	0.9	0.02
	0.7	0.13
	0.5	0.29
	0.3	0.42
Gradual Contractions		
Ratio d/D q = 10° typical		
	0.9	0.03
	0.7	0.08
	0.5	0.12
	0.3	0.14
Valves		
Gate Valve (fully open)		0.20
Reflux Valve		2.50
Globe Valve		10.00
Butterfly Valve (fully open)		0.20
Angle Valve		5.00
Foot Valve with strainer		15.00
Air Valves		zero
Ball Valve		0.10
Pipe Exit Losses		
Square Outlet		1.00
Rounded Outlet		1.00

(Sumber : *Morimura*)

Gambar A.2 Grafik Pompa





(Sumber : Tabel Grunfos, hal 34 & 97)

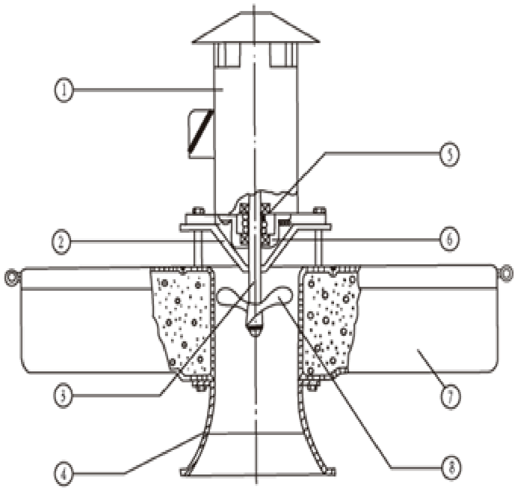
Overview

Quick Details					
Place of origin	Zhejiang, China (Mainland)	Brand name	GSD	Model number	SAR
Power	1,5 - 75kW	Motor speed	1450r/min	Capacity	5 - 120 m^3/min
Oxygenation capacity	3 - 95 kg/H	Diameter of mixing zone	12 - 140 m	Depth in meter of complete mixing	6 - 70 m

Gambar A.3 Spesifikasi *Surface Aerator*

(Sumber : Alibaba.com/SAR floating surface aerator with IE2 motor for A2O)

Gambar A.4 Kontruksi Surface Aerator



NO.	Accessory name	材质 Material GB	材质 Material JIS
1	Motor	-	-
2	Water guide panel	FRP	FRP
3	Shaft	1Cr13	SUS410
4	Water inlet pipe	HT200	FC200
5	Mechanical seal	-	-
6	Seal cover	HT250	FC250
7	Floating	FRP	FRP
8	Impeller	0Cr18Ni9	SUS304

(Sumber : Alibaba.com/SAR floating surface aerator with IE2 motor for A2O)

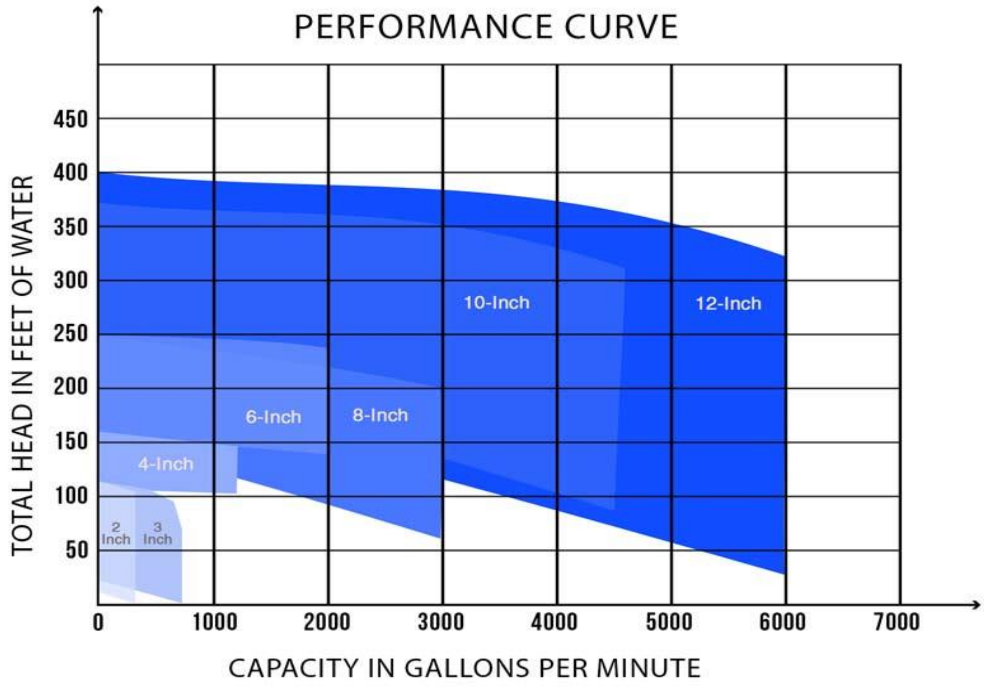
Tabel A.4 Parameter Kinerja

Type	Motor		Surface Aerator				
	Power (hp)	Speed (r/min)	OC-HR (kg/h)	MD (m)	MZ (m)	D (m)	PR (m^3/min)
SAR-32	2	1450	3.0	6	12	2~3	5
SAR-33	3	1450	4.2	9	18	3~4	7
SAR-35	5	1450	6.6	12	24	3~4	9
SAR-37	$7^1/2$	1450	9.6	16	32	3~4	11
SAR-310	10	1450	11.5	19	38	3~4	19
SAR-315	15	1450	16.5	27	54	3~4	24
SAR-320	20	1450	21.0	32	64	3~4	29
SAR-325	25	1450	27.5	36	72	3~4	33
SAR-330	30	1450	31.0	40	80	3~4	37
SAR-340	40	1450	38.0	45	90	5~6	46
SAR-350	50	1450	50	50	100	5~6	55
SAR-360	60	1450	61	56	112	5~6	65
SAR-375	75	1450	73	62.5	125	5~6	80
SAR-3100	100	1450	95	70	140	5~6	120

MZ: Diameter of Mixing Zone. (m)
OC-HR: Kgs Oxygenation Capacity per Hour. (kg/h)
MD: Diameter of Complete Mixing in Meter at minimum average velocity of 1.2 meter per second (approx). (m)
D: Depth in Meter of Complete Mixing, related to MD.
PR: Pumping Rate, m^3 per Minute.

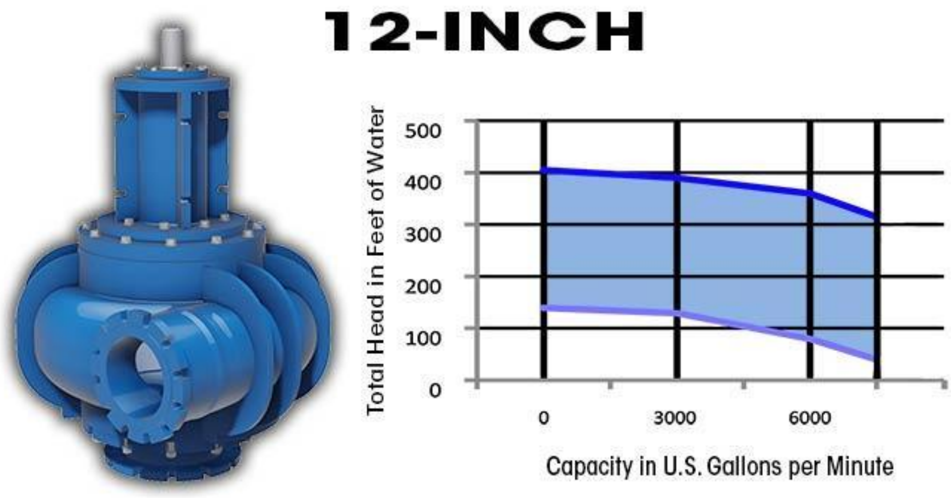
(Sumber : Alibaba.com/SAR floating surface aerator with IE2 motor for A2O)

Gambar A.5 Grafik Pompa Sludge



(Sumber : Eddy pump corporation/[http://eddypump.com/id/produk/pompa-lumpur])

Gambar A.6 Grafik Pompa Sludge

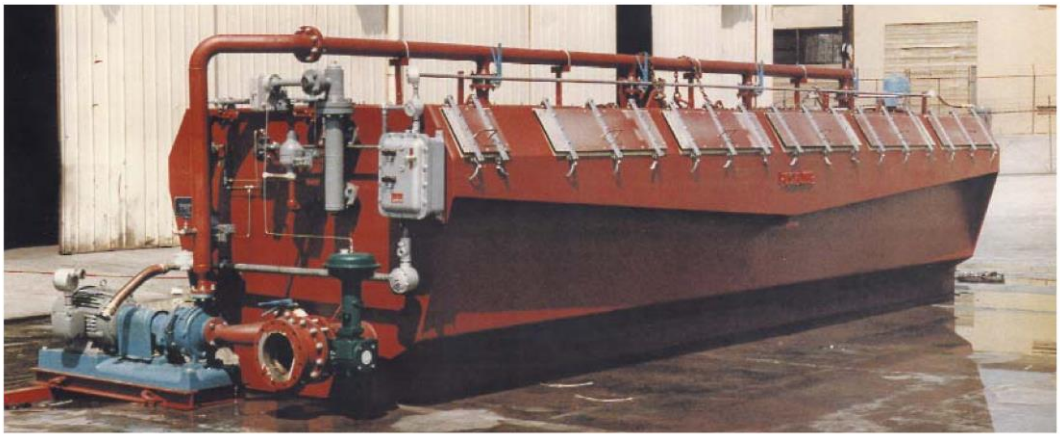


(Sumber : Eddy pump corporation/[http://eddypump.com/id/produk/12-inch-slurry-pump])

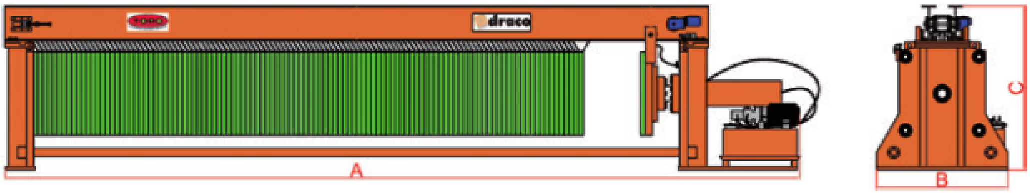
Tabel A.5 Spesifikasi *Induced Gas Flotation*

Design Capacity			Engineering Dimensions			Weight	
Model	GPM (LPM)	B/D	Length Ft.-in. (m)	Width Ft.-in. (m)	Height Ft.-in. (m)	Dry lbs. (kg)	Operating lbs. (kg)
H-3 1/2D	102 (386)	3,500	12'-10" (3.9)	7'-0" (2.1)	5'-6" (1.7)	4,100 (1,860)	8200 (3,719)
H-5D	146 (553)	5,000	16'-0" (4.9)	7'-0" (2.1)	4'-7" (1.4)	5,700 (2,585)	11300 (5,126)
H-7 1/2D	219 (829)	7,500	16'-2" (4.9)	7'-0" (2.1)	5'-8" (1.7)	6,500 (2,948)	15500 (7,031)
H-10D	292 (1,105)	10,000	18'-4" (5.6)	8'-0" (2.4)	7'-0" (2.1)	8,500 (3,856)	19000 (8,618)
H-15D	438 (1,658)	15,000	18'-4" (5.6)	8'-0" (2.4)	7'-0" (2.1)	10,000 (4,536)	26100 (11,839)
H-20D	538 (2,037)	20,000	22'-0" (6.7)	9'-0" (2.7)	7'-0" (2.1)	13,300 (6,033)	35000 (15,876)
H-30D	875 (3,312)	30,000	27'-3" (8.3)	9'-0" (2.7)	7'-0" (2.2)	16,300 (7,394)	39400 (17,872)
H-35D	1021 (3,865)	35,000	32'-0" (9.5)	9'-5" (2.9)	8'-0" (2.4)	17,300 (7,847)	41600 (18,869)
H-40D	1167 (4,418)	40,000	32'-0" (9.5)	10'-3" (3.2)	7'-0" (2.1)	21,300 (9,662)	66800 (30,300)
H-50D	1458 (5,519)	50,000	32'-0" (9.5)	10'-4" (3.2)	8'-0" (2.4)	23,350 (10,591)	80000 (36,287)
H-70D	2042 (7,730)	70,000	37'-6" (11.4)	11'-0" (3.4)	8'-0" (2.4)	27,300 (12,383)	97200 (44,089)
H-1000D	2917 (11,042)	100,000	42'-0" (12.8)	11'-6" (3.5)	9'-1" (2.8)	37,100 (16,828)	130,000 (58,967)

(Sumber : siemens.com/water)



Tabel A.6 Spesifikasi *Filter Press*



MODEL	Maximum number of plates	Maximum length mm (A)	Maximum width mm (B)	Maximum height mm (C)	Maximum filter surface (m²)	Maximum filtered volume (l)
FPA-AR 1000	125	11.000	1.400	2.100	215	3.220
Pump Type: Cylinder of 23 cm³ Power: 7,5 Kw		Tank volume (l): 150				
FPA-AR 1200	125	12.400	1.900	2.400	310	4.445
Pump Type: Cylinder of 23 cm³ Power: 7,5 Kw		Tank volume (l): 150				
Frame: Material ST-52/AISI-304, Finish: Epoxy Paint Operation: Automatic						

(Sumber : Draco®, Filter Press/Toro, *Wastewater Equipment Industries*)

LAMPIRAN B
PERHITUNGAN BANGUNAN

1. Sumur Pengumpul

a) Kriteria Perencanaan

1. Jumlah Bak (n) = 1
2. Waktu Tinggal (Td) = 20 menit
3. Tebal Dinding = ≥ 20 cm
4. Kecepatan aliran (v) = 0,3 – 0,6 m/detik

b) Direncanakan

1. Q = 1680 m^3/ hari
2. Bentuk Rectangular
3. td = 20 menit = 1200 dtk
4. Freeboard = 0,5 m
5. P : L = 2 : 1
6. h = 3 m
7. n = 1 bak
8. v = 0,3 m/detik

c) Perhitungan

1. $Q_b = \frac{Q}{n}$

   $Q_b = \frac{1680\, m^3/h}{1}$

   Q_b = 1680 m^3/h = 0,0195 m^3/dtk

2. $Td = \frac{V}{Q}$

   V = Q x Td

   V = (0,0195 m^3/dtk) x (1200 dtk)

   V = 23,4 m^3

3. V = P x L x h

   23,4 m^3 = (2L) x (L) x 3 m

   $L^2 = \frac{23{,}4 m^3}{2x3m}$

   L^2 = 3,9 m,

L = 1,97 ~ 2 m
P = 2 x 2 = 4 m
H = 3 m + 0,5 m (freeboard) = 3,5 m

2. Bak Equalisasi

a) Kriteria Perencanaan

1. Jumlah Bak (n) = 1 unit
2. Waktu Tinggal (Td) = 1 jam = 3600 detik
3. Tebal Dinding = ≥ 20 cm
4. Kecepatan aliran (v) = 0,3 – 0,6 m/detik

b) Direncanakan

1. Jumlah Bak = 1
2. h = 4 m
3. td = 1 jam = 3600 dtk
4. Freeboard = 0,5 m

c) Perhitungan

1. V = Q x td
   = 0,0195 x 3600
   = 70 m^3
2. V = a x h
   70 = a x 4
   a = 17,55 = 18 m^2
   a = P x L
   18 = 2L x L
   L^2 = 9
   L = 3 m
   P = 2 x 3 = 6 m
   H = 4 m + 0,5 m (freeboard) = 4,5 m

3. Konsentrasi BOD yang mengalir selama periode pemompaan

$$Xoc = \frac{ViC.XiC + Vsp.Xsp}{ViC + Vsp}$$

$$= \frac{70\,x1500 + 70\,x1200}{70 + 70}$$

$$= \frac{105000 + 84000}{140}$$

= 1350 g/m^3

Keterangan :

ViC = Debit awal masuk bak (m^3/jam)

XiC = Konsentrasi parameter awal masuk bak (mg/L)

Vsp = Debit keluar dari bak (m^3/jam)

Xsp = Konsentrasi parameter yang lolos dan keluar dari bak (mg/L)

Xoc = Total konsentrasi parameter yang teremoval di bak (mg/L)

4. Mass loading rate kg/g

$$\text{Kg/jam} = \frac{Xoc.Q.3600}{10^3}$$

$$= \frac{1350 x 0{,}0195 x 3600}{10^3}$$

= 94,77 kg/g = 2274,48 kg/hari

5. Y = $Y_{20} \cdot \Theta^{(T-20)}$

= $0{,}4 \times 1{,}04^{(28-20)}$

= 0,547 mg $^{VSS}/_{mg}$ BOD_5

6. $$Y_{obs} = \frac{Y}{1 + kd.\theta c}$$

kd = $kd_{20} \times \Theta^{(Y-20)}$

= $0{,}05 \times 1{,}04^8$

= 0,07/hari

7. $$Y_{obs} = \frac{0{,}547}{1 + 0{,}07 x 10}$$

= 0,32 mg $^{VSS}/_{mg}$ BOD

8. ρ_x = Y_{obs} x Q (Ca-Cr)

= 0,32 x 1680 (1500 – 1200)

= 161280 x $^{1kg}/_{1000g}$

= 161,28 $^{kg\ VSS}/_{hari}$

Keterangan :

T = Suhu

Y = Biomassa yield

Y_{20} = (Metcalf, Hal 682)

Θ = Temperatur activity coef

Θ_c = Umur lumpur (5 – 15)

Y_{obs} = Kuantitas lumpur/hari

ρ_x = Massa lumpur

9. $$\text{Jumlah Beban} = \frac{Q.(Ca - Cr)}{F}$$

10. BOD $= \frac{1680.(1,5-1,2)}{0,8}$

$= 630\ ^{Kg}/_{Hari}$

$= 26,25\ ^{Kg}/_{Jam}$

11. Keb. Total O_2 = Jumlah beban BOD + (1,42 x ρ_x)

= 630 + (1,42 x 161,28)

= 859,02 kg O_2/hari

12. Keb. O_2 nyata (AOR) $= \frac{Keb.O_2 Total}{F} = \frac{859,02}{0,8}$

$= 107,8\ ^{kg}/_{hari}$

13. Volume udara yang dibutuhkan

a. Direncanakan = • Eff transfer O_2 untuk aerasi = 8%

= • Safety factor = 2

= • Persentase O_2 di udara = 21%

= • ρ udara = 1,2 $^{kg}/_{hari}$

b. Keb. Udara Teoritis $= \frac{AOR}{\rho O_2 .\% O_2 diudara}$

$= \frac{1073,8}{1,2x0,21}$

= 4261,1 m^3/hari

c. Keb. Udara Actual $= \frac{Keb.O_2 Teoritis}{Eff.Transfer O_2}$

$= \frac{0,05}{0,08}$

= 0,625 m^3/dtk

d. Keb. O_2 Desain = Keb. O_2 Act x Safety Factor

= 0,625 x 2

= 1,25 m^3/dtk

e. Keb. Surface Aerator $= \frac{Keb.O_2 Design}{Kapasitas}$

$= \frac{1,25}{0,83}$

= 1,5 ~ 2 buah

Kapasitas = SAR Floating Surface Aerator

3. Induced Gas Flotation

a) Direncanakan :

1. Menggunakan 1 bangunan induced gas flotation
2. Debit (Q) = 0.0195m^3/dt = 1680 m^3 /hari
3. Tekanan yang digunakan = 50 psig

   (Pada tekanan ini, kelarutan gas mencapai 0,5 cuft gas/bbl)
4. Ukuran Flotation Cell = 2 gal / min / ft^2 tanpa koagulan
5. Luas Flotation Cell = 15ft – 250 ft^2 atau dengan kapasitas

   2000 BWPD – 3500 BWPD

Tabel Desain Kapasitas Induced Gas Flotation

Design Capacity			Engineering Dimensions			Weight	
Model	GPM (LPM)	B/D	Length Ft-in (m)	Width Ft-in (m)	Height Ft-in (m)	Dry Lbs. (Kg)	Operating Lbs. (Kg)
H-3 1/2D	102 (386)	3,500	12’-10” (3,9)	7’-0” (2,1)	5’-6” (1,7)	4,100 (1,860)	8200 (3,719)
H-5D	146 (553)	5,000	16’-0” (4,9)	7’-0” (2,1)	4’-7” (1,4)	5,700 (2,585)	11300 (5,126)
H-7 1/2D	219 (829)	7,500	16’-2” (4,9)	7’-0” (2,1)	5’-8” (1,7)	6,500 (2,948)	15500 (7,031)
H-10D	292 (1,105)	10,000	18’-4” (5,6)	8’-0” (2,4)	7’-0” (2,1)	8,500 (3,856)	19000 (8,618)
H-15D	438 (1,658)	15,000	18’-4” (5,6)	8’-0” (2,4)	7’-0” (2,1)	10,000 (4,536)	26100 (11,839)
H-20D	538 (2,037)	20,000	22’-0” (6,7)	9’-0” (2,7)	7’-0” (2,1)	13,300 (6,033)	35000 (15,876)
H-30D	875 (3,312)	30,000	27’-3” (8,3)	9’-0” (2,7)	7’-0” (2,2)	16,300 (7,394)	39400 (17,872)
H-35D	1021 (3,865)	35,000	32’-0” (9,5)	9’-5” (2,9)	8’-0” (2,4)	17,300 (7,847)	41600 (18,869)
H-40D	1167 (4,418)	40,000	32’-0” (9,5)	10’-3” (3,2)	7’-0” (2,1)	21,300 (9,662)	66800 (30,300)
H-50D	1458 (5,519)	50,000	32’-0” (9,5)	10’-4” (3,2)	8’-0” (2,4)	23,350 (10,591)	80000 (36,287)
H-70D	2042 (7,730)	70,000	37’-6” (11,4)	11’-0” (3,4)	8’-0” (2,4)	27,300 (12,383)	97200 (44,089)
H-1000D	2917 (11,042)	100,000	42’-0” (12,8)	11’-6” (3,5)	9’-1” (2,8)	37,100 (16,828)	130,000 (58,967)

(Sumber : siemens.com/water)

Pada tabel di atas terdapat desain kapasitas bangunan Induced Gas Flotation dengan berbagai macam variasi. Model H-20D dipilih sebagai desain perencanaan, karena sesuai dengan jumlah debit yakni 1680 L/Menit Dengan Panjang = 6,7 m, Lebar = 2,7 m, dan Tinggi = 2,1 m.

4. Netralisasi

a) Kriteria Perencanaan

1. pH awal = 3
2. pH = (6 – 9)
3. Diameter Impeller = 30 – 50% diameter bak
4. Kec. Impeller (n) = 400 – 1750 rpm = 500 rpm
5. Gradien Kec. (G) = 700 – 1000 /detik^2
6. Waktu Detensi (td) = 20 – 60 detik
7. Nre = >10.000

b) Direncanakan

1. Q = 0,0195 m^3/detik
2. Menggunakan 1 Bak
3. pH Limbah = 3 (asam)
4. Nilai pH netral yang di butuhkan = 8
5. Bahan penetral = $Ca(OH)_2$ (BM = 74)
6. Densitas $Ca(OH)_2$ = 2,2 $^{kg}/_{L}$
7. td = 30 detik
8. Berbentuk Tabung

c) Perhitungan

Bak Pembubuh

1. Vol. Penetral ($Ca(OH)_2$)
   a) Vol = Q x td
   = 0,0195 x 30
   = 0,6 m^3 = 600 L
   b) Dosis $Ca(OH)_2$

$$= \frac{Y(mg)}{Vol.Air(L)}$$

$$= \frac{1}{BM(gr/gr.mol)}$$

$$= \frac{1}{10}\ mg/gr$$

$$= \frac{Y}{600}\ x\ \frac{1}{74}\ x\ \frac{1}{10^3}$$

$= \dfrac{Y}{4,44x10^7}$

$Ca(OH)_2 \rightarrow Ca^{2+} + 2(OH)^-$

$[OH^-] = \dfrac{Y}{4,44x10^7} x \dfrac{1}{2}$

$= \dfrac{Y}{8,88x10^7}$

pOH = -log OH^-

8 = -log $\dfrac{Y}{8,88x10^7}$

$10^{-8} = \dfrac{Y}{8,88x10^7}$

Y = 8,88 x 10^{-1}

= 0,88 $^{mg}/_{L}$

c) Kadar $Ca(OH)_2$ perhari, konsentrasi larutan 10% dengan densitas 2,2 $^{kg}/_{L}$

Qt = Qbak x dosis $Ca(OH)_2$ yang dibutuhkan

= 168000 $^{L}/_{hari}$ x 0,88 $^{mg}/_{L}$

= 1478400 $^{mg}/_{hari}$ ~ 1,5 $^{kg}/_{hari}$

Q Pembubuh 100% $= \dfrac{1,5kg/hari}{2,2kg/L}$

= 0,68 $^{L}/_{hari}$

Q $Ca(OH)_2$ / 10 L $= \dfrac{100}{10} x\ Q.Pembubuh = 100\%$

$= \dfrac{100}{10} x\ 0,68 = 6,8 L/hari$

d) Direncanakan periode pembubuhan 3 hari

Total Vol. Larutan = (Vol. $Ca(OH)_2$ + Vol. Air) x 3 hari

= (0,68 + 6,8) x 3

= 7,48 x 3

= 22,44 L ~ 0,022 m^3

2. Dimensi bak pembubuh h = 1,5D

Volume = $^1/_4\ \pi\ d^2\ h$

0,022 = $^1/_4$ x 3,14 x d^2 x 1,5D

d^3 = 0,019

d = 0,265

= 0,27 m ~ 0,3 m

H = 0,3 x 1,5

= 0,45 m

H Total = 0,45 + 0,05 (Freeboard)

= 0,45 + 0,05

= 0,5 m

Cek Volume = $^1/_4$ x 3,14 x d^2 x h

= $^1/_4$ x 3,14 x $0,3^2$ x 0,45

= 0,032 m^3

3. Daya motor Impeller (p)

P = G^2 x μ x Vol.

= 1000/$detik^2$ x 0,00089 N $^{detik}/_m$ x 0,032 m^3

= 28,48 watt ~ 28,5 watt

4. Diameter Impeller (Di)

Di = 50% x Diameter pembubuh

= 50% x 0,3

= 0,15 m

5. Cek Nre = $\frac{Di^2.n.p}{\mu}$ $(n = 500rpm \rightarrow 8,3rps)$

= $\frac{0,15^2 x8,3x996,59}{0,00089}$

= $\frac{0,15^2 x8,3x996,59}{0,00089}$

= 209115,9 > 10^5 . . . . (OK!)

6. Jarak Impeller dan dasar

Wi = 0,5 x Di

Wi = 0,5 x 0,15

Wi $= 0{,}075$ m

(Pada bak pembubuh tidak menggunakan pompa injeksi dikarenakan dimensi pipa terlalu kecil, maka dari itu digunakan kran yang dibalut selang dgn waktu periode)

Bak Netralisasi

1. Vol. Bak Netralisasi

$= Q \times td$
$= 0{,}0195 \times 30$
$= 0{,}6\ m^3$

Vol. Total $= \text{Vol. Netralisasi} + \text{Vol. Pembubuh}$
$= 0{,}6 + 0{,}032$
$= 0{,}632\ m^3$

2. Dimensi Bak h = 1,5D

Volume $= {}^{1}/_{4}\ \pi\ d^2\ h$
0,632 $= {}^{1}/_{4} \times 3{,}14 \times d^2 \times 1{,}5D$
$d^3 = 0{,}54$
d $= 0{,}8$ m
h $= 0{,}8 \times 1{,}5$
$= 1{,}2$ m

3. Cek td

Volume $= {}^{1}/_{4}\ \pi\ d\ h$
$= {}^{1}/_{4} \times 3{,}14 \times 0{,}8 \times 1{,}5D$
$= 0{,}75\ m^3$
Volume $= Q \times td$
0,75 $= 0{,}0195 \times td$
Qm $= \dfrac{0{,}75}{0{,}0195}$
$= 38{,}6$ detik ~ 39 detik

4. Daya Motor (p)

P $= G^2 \times \mu \times \text{Volume}$
$= 1000^2 \times 0{,}00089 \times 0{,}75$
$= 667{,}5$ watt

5. Diameter Impeller (Di)

Di = 50% x diameter bak

= 50% x 0,8

= 0,4 m

6. Lebar Baffle

Wi = 0,1 x diameter bak

Wi = 0,1 x 0,8

Wi = 0,08 m

7. Cek Nre

$= \frac{Di^2.n.p}{\mu}$

$= \frac{0,4^2 x 8,3 x 996,59}{0,00089}$

= 1487046 > 10^5 . . . . (OK!)

Pipa Inlet Bak Pembubuh = Pipa Bak Netralisasi

Q = 0,0195 m^3/detik

Kec. Aliran = 1 m/detik

Luas Penampang Pipa

A $= \frac{Q}{V}$

$= \frac{0,0195}{0,6}$

= 0,0325 m^2

D pipa $= (\frac{4.A}{\pi})^{\frac{1}{2}}$

$= (\frac{4x0,0325}{3,14})^{\frac{1}{2}}$

$= \sqrt{(\frac{0,13}{3,14})}$

= 0,2 m

= 20 cm

5. Bak Pengendap I

a) Data

- Debit limbah (Q) = 70 m^3/jam = 0,0195 m^3/detik

b) Kriteria Perencanaan

1. Bentuk circular
2. Overflow rates → Average = 30 – 50 m^3/ m^2 .hari
   → Peak = 70 – 150 m^3/ m^2 .hari
3. Waktu tinggal (td) = 2 – 4 jam
4. Kedalaman (H) = 2 – 4,5 meter
5. Diameter tangki = 3 – 60 meter
6. Diameter inlet = 3 – 6 meter
7. Persen (%) removal = TSS → = 50 – 70%
8. Kecepatan aliran inlet (vp) = 0,3 m/detik
9. Weir Loading = 186 m^2 untuk Q > 441/detik

(Syed R Qasim, "*WWTP Planning, Design and Operation*", 1985, hal 263-293)

10. Koefisien manning (n) = 0,015 (Beton)
11. Sg volatile solid = 1,3 kg/cm^3
12. Sg fixed solid = 2,5 gr/cm^3

(Syed R Qasim, "*WWTP Planning, Design and Operation*",1985,hal 427)

13. Diameter inlet = 15 – 20% dari diameter bak
14. Nre (aliran laminer) = < 2000
15. Nfr (aliran laminer) = < 10^{-5}

c) Direncanakan :

1. Menggunakan 1 tangki clarifier
2. Average overflow rates = 40 m^3/ m^2 .hari
3. Peak overflow rates = 75 m^3/ m^2 .hari
4. Kedalaman = 4 meter
5. Weir loading = 186 m^3/ m
6. Suhu 27 °C, v = $0,8581.10^{-2}$ cm^2/dtk = $0,8581.10^{-6}$ m^2/dtk

(Sumber: Appendix C, Tom D. Reynold,, hal. 762)

d) Kriteria Rumus

1. Luas Surface Area (A) $= \frac{Q}{Overflow\ rate}$ (Qasim, hal. 284)

2. Cek Overflow rate (OFR) $= \frac{Q}{A}$ (Qasim, hal. 285)

3. Cek waktu tinggal (td) $= \frac{(1/4\pi d^2)xh}{Q}$ (Qasim, hal. 285)

4. Panjang Weir $= \frac{Q}{Weir\ loading}$ (Qasim, hal. 288)

5. Head loss (H)

   $Q = \frac{8}{15} Cd\sqrt{2g}.\tan\frac{\theta}{2} H^{5/2}$ (Qasim, hal. 288)

e) Perhitungan

A. Settling Zone

1) Debit Tiap Tangki

   $Q = \frac{0{,}0195 m^3/\det}{1}$ = 0,0195 m^3 / detik= 1680 m^3 / hari

2) Luas Surface Area (A)

   $A = \frac{Q}{Overflow\ rate} = \frac{1680\, m^3/hari}{40 m^3/m^2.hari}$ = 42 m^2

3) Diameter (D)

   $D = \sqrt{\frac{4.A}{\pi}} = \sqrt{\frac{4 \times 42\, m^2}{3{,}14}}$ =7,3 m

4) Diameter Inlet Wall = 15% x diameter tangki

   = 15% x 7,3 m = 1,1 meter

5) Cek Over Flowrate

   $OFR = \frac{Q}{A} = \frac{1680 m^3/hari}{(\frac{1}{4}.\pi.9^2)}$ = 26,4 m^3/m^2.hr

6) Cek Volume

V = ¼ π d^2.h

= ¼ x 3,14 x $(7,3\ m)^2$ x 4 m = 167,33 m^3

7) Cek td

$$Td = \frac{V}{Q} = \frac{167,33 m^3}{0,0195 m^3/\det} = 8581,03 \text{ detik} = 2,4 \text{ jam } (2 – 4 \text{ jam})$$

8) Kecepatan Mengendap Partikel (Vs)

Direncanakan : diameter partikel (d) = 0,001 cm

Spesific gravity partikel (Ss) = 2,65

g = 9,81 m/$detik^2$ = 981 cm/$detik^2$

(**Sumber** : Tom D. Reynold, “Unit operation and Process in Env. Eng ”,1995, hal 226)

$$V_s = \frac{g}{18v}(Ss-1)d^2$$

$$= \frac{981 cm/dtk^2}{18(0,8581x10^{-2} cm^2/dtk)}(2,65-1)(0,001cm)^2$$

= 0,0105 cm/dtk = 1,05 m/dtk

9) Kecepatan Horizontal (Vh)

$$r = \frac{D}{2} = \frac{7,3m}{2} = 3,65 \text{ m}$$

$$Vh = \frac{Q}{2.\pi.r.h}$$

$$= \frac{0,0195 m^3/dt}{2x3,14x3,65mx4m} = 2,13 \times 10^{-4} \text{ m/dt}$$

10) Cek Nre Partikel

$$\text{Nre partikel} = \frac{Vs.d}{v} = \frac{(0,0105cm/dtk)(0,001cm)}{(0,8581x10^{-2} cm^2/dtk)}$$

= 1,2 x 10^{-3} < 1 (Reynold, hal. 224)

11) Jari – Jari Hidrolis

$$R = \frac{r.h}{r+2h} = \frac{3,65x4m}{3,65+(2x4m)} = 1,25 \text{ m}$$

12) Cek Nre

$$Nre = \frac{Vh.R}{v} = \frac{2,13x10^{-4} m/dtk.1,25m}{0,8581x10^{-6} m^2/dtk}$$

= 310,3 < 2000 (laminer)

13) Cek Nfr

$$\text{Nfr} = \frac{Vh^2}{g.R} = \frac{(2{,}5x10^{-4})^2 m/\det}{9{,}81m/\det x1{,}25m}$$

= 5,1 x 10 $^{-9}$ < 10 $^{-5}$ .... OK

14) Slope

$$S = \left[\frac{nxv}{R^{2/3}}\right]^2 = \left[\frac{0.015x0{,}3m/dt}{(1{,}25m)^{2/3}}\right]^2 = 1{,}5 \times 10^{-5} \text{ m/m}$$

15) Headloss (Hf)

Hf = S x D total

= 1,5 x 10^{-5} m/m x 7,3 m = 1,095 x 10^{-4} m

B. Inlet Zone

1) Inlet Pipa

$$A = \frac{Q}{v} = \frac{0{,}0195m^3/\det}{0{,}6m/\det}$$

= 0,0325 m^2

2) Diameter Pipa

$$D = \sqrt{\frac{4.A}{\pi}} = \sqrt{\frac{4\times 0{,}0325m^2}{3{,}14}}$$

= 0,20 meter = 20 cm

3) Headloss Pipa Inlet Zone

$$Hf = \frac{Vp - Vh}{2.g} x \frac{1}{0{,}7}$$

$$= \frac{(0{,}3m/dtk - 2{,}13x10^{-4} m/\det)}{2.x9{,}81m/dtk} x \frac{1}{0{,}7} = 0{,}022$$

Perforated Wall

- Data : Qo = 0,0195 m^3/detik
- Direncanakan :
  a. Diameter lubang = 10 cm = 0,10 m
  b. Kec. melalui lubang (V) = 0,3 m/detik
- Perhitungan :
  a. Luas lubang perforated wall

A $= ¼. \pi .D^2$

$= ¼. 3,14$ m $(0,10)^2$

$= 0,00785$ m^2

b. Luas Lubang Total (A tot)

Dengan : c = faktor konstruksi = 0,6

Qo = c. v. A tot

0,0195m^3/dt = 0,6 x 0,3 m/detik x A to

A tot = 0,11 m^2

c. Jumlah Lubang Perforated Wall (n)

$$n = \frac{\text{A tot}}{\text{A tiap lubang}} = \frac{0{,}11\, m^2}{0{,}00785\, m^2} = 14\, buah$$

d. Spesifikasi Lubang

Lubang perforated wall dibuat zig-zag agar head loss tidak besar

Perforated wall dibagi menjadi 3 deret lubang

- Deret I sebanyak 5 lubang
- Deret II sebanyak 4 lubang
- Derat III sebanyak 5 lubang

e. Jarak lubang perforated wall

- Untuk 5 Lubang :
  - Memanjang $= \dfrac{diameter\ inlet\ wall}{\Sigma \text{lubang1baris} - 1}$

    $= \dfrac{1{,}1m}{5-1}$ = 0,275 m = 27,5 cm
- Untuk 4 Lubang
  - Memanjang $= \dfrac{diameter\ inlet\ wall}{\sum \text{lubang } 1 baris - 1}$

    $= \dfrac{1{,}1m}{4-1}$ = 0,37 m = 37 cm

- Melintang $= \dfrac{\text{kedalaman bak}}{\Sigma\,\text{lubang 1 kolom} + 1}$

$$= \frac{3m}{3+1} = 0{,}75 \text{ m} = 75 \text{ cm}$$

- Head loss perforated wall, dengan k = 0,5

$$\text{Hf} = \text{n . k} \left(\frac{V^2}{2.g}\right) = 14 \times 0{,}5 \left(\frac{0{,}3^2}{2 \times 9{,}81}\right)$$

$$= 0{,}032 \text{ m}$$

C. Outlet Zone

1) Panjang Weir

$$\text{L weir} = \frac{Q}{\textit{Weir loading}} = \frac{1680 m^3/hari}{186 m^3/m} = 9.03 \text{ m}$$

2) Cek volume

Diket : L = 9,03 m

D tangki = 7,3 m

H tangki = 4 m

V = L x D x H = 9,03 m x 7,3 m x 4 m = 263,68 m^3

3) Cek Debit

Diket : td = 8581,03 detik

$$Q = \frac{V}{td} = \frac{263{,}68 m^3}{8581{,}03\ dtk} = 0{,}031 \text{ m}^3 \text{/detik}$$

4) Jumlah V notches (n)

Jarak antar V notch = 30 cm = 0,3 m (Qasim, hal 288)

$$n = \frac{L\ weir}{jarak} = \frac{9{,}03m}{0{,}3m} = 30{,}1 \approx 30 \text{ buah}$$

5) Debit yang mengalir di tiap V notch (Q tiap V notch)

$$\text{Q tiap V notch} = \frac{Q}{n} = \frac{0{,}031 m^3/dtk}{30}$$

$$= 1{,}03 \times 10^{-3} \text{ m}^3\text{/ detik}$$

6) Kedalaman V notch (H)

$$Q = \frac{8}{15} Cd \sqrt{2g}.\tan\frac{\theta}{2} H^{2/3}$$

Dengan : Cd = 0,584; θ = sudut V notch = 45°

$1{,}03 \times 10^{-3}$ m^3/ dtk = $\frac{8}{15}(0{,}584)\sqrt{2(9{,}81 m/dtk^2)}.\tan\frac{45}{2} H^{2/3}$

$H^{2/3}$ = $\frac{1{,}03x10^{-3} m^3/dtk}{0{,}57}$ = 1,81 x 10 $^{-3}$

H = 0,018 m = 1,8 cm

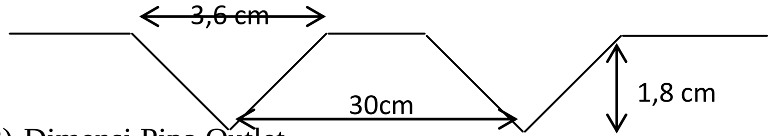
7) Panjang Basah Setiap Pelimpah (Li)

Li = 2 (H. tg 45°)

= 2 (0,018 m x 1)

= 0,036 m = 3,6 cm

Sketsa V notch



8) Dimensi Pipa Outlet

v = 0,6 m/dtk

Luas Penampang (A) = $\frac{Q}{v}$ = $\frac{0{,}0195 m^3/dtk}{0{,}6 m/dtk}$ = 0,0325 m^2

Diameter pipa outlet = $\sqrt{\frac{4A}{\pi}}$ = $\sqrt{\frac{4(0{,}04 m^2)}{3{,}14}}$ = 0,20 m

D. Sludge Zone

a) Diketahui

- Q awal = 0,0195 m^3/detik = 1680 m^3/hari = 1.680.000 L/hari
- TSS Influent = 300 mg/L

b) Direncanakan

- Lumpur dari 95% air dan 5% solid
- Solid terdiri dari = 40% fixed solid dengan Sg = 2,5 gr/cm^3

  = 60% volatile solid dengan Sg = 1,3 gr/cm^3
- % Removal : TSS = 65%
- Removal = 300 mg/L – (65% x 300 mg/L)

  = 105 mg/L

c) Perhitungan

1. Berat Solid

   Berat Solid = removal TSS x Q

   = 105 mg/L x 1.680.000 L/hari

= 176.400.000 mg/hari

= 176,4 kg/hari

2. Berat Jenis Solid (Ss)

$$\frac{1}{Ss} = \frac{\%volatile\ solid}{bj\ volatile\ solid} + \frac{\%\ fixed\ \ solid}{bj\ \ fixed\ \ solid}$$

$$\frac{1}{Ss} = \frac{0.6}{1.3} + \frac{0.4}{2.5}$$

$$\frac{1}{Ss} = \frac{1.5 + 0.52}{3.25} = \frac{2.02}{3.25}$$

Ss = 1.6 gr/cm^3 = 1600 kg/m^3

3. Berat Jenis Sludge (SI)

$$\frac{1}{Sl} = \frac{\%solid}{bj\ \ solid} + \frac{\%air}{bj\ air}$$

$$\frac{1}{SI} = \frac{0.05}{1.44} + \frac{0.95}{1}$$

$$\frac{1}{SI} = \frac{1.418}{1.44}$$

Sl = 1.02 gr/cm^3 = 1020 kg/m^3

4. Volume Solid

Volume solid $= \dfrac{berat\ solid}{berat\ \ jenis\ solid\,(Ss)}$

$$= \frac{176{,}4 kg / hr}{1600 kg / m^3} = 0{,}11 m^3\ / hari$$

5. Berat Air

Berat air $= \dfrac{95\%}{5\%}$ x berat solid

$= \dfrac{95\%}{5\%}$ x 176,4 kg/hari = 3352 kg/hari

6. Volume Air

Volume air $= \dfrac{berat\ air}{berat\ \ jenis\ air}$

$$= \frac{3352 kg / hr}{1000 kg / m^3} = 3{,}352 m^3\ / hari$$

7. Volume Sludge

Volume sludge = volume solid + volume air

= 0,11 m^3/hr + 3,352 m^3/hr

= 3,462 m^3/hr

8. Berat Sludge

Berat sludge = volume sludge x berat jenis sludge

= 3,462 m^3/hr x 1020 kg/m^3

= 3531,24 kg/hr

9. Dimensi Ruang Sludge

Direncanakan :

- Berbentuk Kerucut
- Pengurasan dilakukan 10 hari sekali
- Diameter permukaan atas = D bak = 7,3 m → r = 3,65 m
- Diameter permukaan bawah (direncanakan) = 2 m → r = 1 m

Luas permukaan atas (A) = ¼ . 3,14 . $7,3^2$ = 41,8 m^2

Luas permukaan bawah (A) = ¼ . 3,14 . 2^2 = 3,14 m^2

Volume ruang sludge = volume sludge x waktu pengurasan

= 3,462 m^3/hari x 12 hari

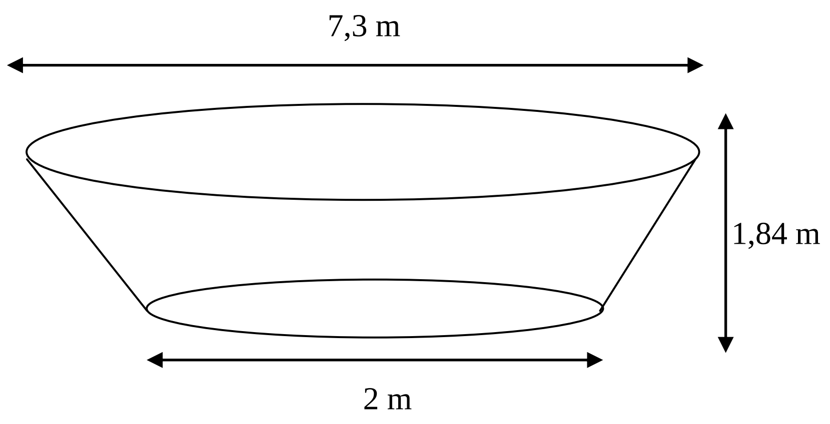
= 34,62 m^3

Volume ruang sludge = volume kerucut terpotong

34,62 m^3 = 1/3 . h . (A + A' + $\sqrt{A.A'}$)

34,62 m^3 = 1/3.h x (41,8 m^2 + 3,14 m^2 + $\sqrt{41{,}8m^2 . 3{,}14m^2}$)

H = 1,84 m



Gambar : *Sketsa Dimensi Zona Sludge*

10. Pipa Outlet Sludge

Direncanakan :

- Waktu tinggal (td) = 1 jam = 3600 detik
- Kecepatan aliran sludge (v) = 0,1 m.detik

Perhitungan :

a. Debit (Qo) selama 1 jam 2 hari sekali

$$Qo = \frac{vol.ruang\ sludge}{td} = \frac{6{,}924 m^3}{3600 dt} = 0{,}00193\ m^3/\ detik$$

b. Luas Penampang Pipa (A)

$$A = \frac{Qo}{v}\ \frac{0{,}00193 m^3 / dtk}{0{,}1 m / dtk} = 0{,}0193\ m^2$$

c. Diameter Pipa (d)

$$D = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{4x0{,}0193 m^2}{3{,}14}} = 0{,}16\ m = 20\ cm$$

6. Activated Sludge (Aerasi)

a) Kriteria Perencanaan

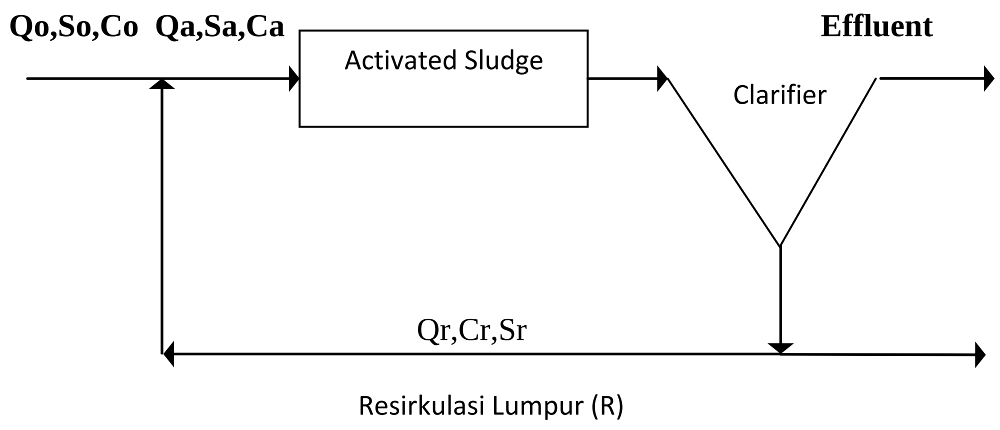
1. Digunakan Surface Aerator
2. Sludge detention time/umur lumpur (θc) = 3 – 15 hari
3. Ratio F/M = 0,2 – 0,6 hari
4. Volumetrik loading = 0,32 – 0,64 kg/m^3 hari
5. MLSS = 1200 – 1400 mg/L (Metcalf & Eddy, hal 683)
6. Koef. Temperatur Aktif (θ) = 1,04 untuk T = 20 – 30 °C (Metcalf & Eddy, hal 681)
7. Resirculation ratio (R) = 0,15 – 0,38
8. Ratio MLSS dan MLVSS = 0,75 – 0,85
9. Safety factor = 1,75 – 2,5
10. Kedalaman Bak Aerasi (H) = 3 – 5 m
11. Freeboard bak = 0,3 – 0,6 m

(Sumber :*Metcalf & Eddy, Wastewater Engineering Treatment Disposal Reuse, Third edition,1991*,hal 686 – 747)

b) Direncanakan

1. Menggunakan 2 Bak Aerasi
2. Q limbah = 70 m^3/jam = 0,0195 m^3/detik
3. Q tiap bak $= \frac{Q}{2} = \frac{0{,}0195 m^3 / dtk}{2}$ = 0,00975 m^3 / detik
4. Umur lumpur (θc) = 7 hari
5. Ratio MLSS/MLVSS = 0,85
6. MLSS = 3000 mg/L
   maka MLVSS = 0,85 x 3000 mg/L
   = 2550 mg/L ~ 2550 gr/m^3
7. Suhu air buangan = 28 °C
8. Safety factor = 2
9. Periode Aerasi (td) = 24 jam
10. BOD Influent = 1200 mg/L (effluent dari BP I)
11. COD Influent = 2000 mg/L (Effluent dari BP I)
12. H2S Influent = 2 mg/L
13. Effluent standart setelah teremoval :
    - BOD Eff = 60 mg/L
    - COD = 100 mg/L
    - H2S = 0,45 mg/L

c) Perhitungan



1. **Nilai koefisien proses pada suhu 28 °C**

Nilai typical pada suhu (T = 20 ˚C) → standart

1. Y = $Y_{20} \cdot \Theta^{(T-20)}$
   = $0{,}4 \times 1{,}04^{(28-20)}$
   = 0,547 mg $^{VSS}/_{mg}$ BOD_5

2. Y_{obs} = $\frac{Y}{1 + kd.\theta c}$

   kd = $kd_{20} \times \Theta^{(T-20)}$
   = $0{,}05 \times 1{,}04^{8}$
   = 0,07/hari

   Keterangan :
   T = Suhu
   Y = Biomassa yield
   Y_{20} = Hal 682, Metcalf
   Θ = Temperatur activity coef
   Θ_c = Umur lumpur (5 – 15)
   Y_{obs} = Kuantitas lumpur/hari

2. **Konsentrasi BOD_5 soluble dalam Effluent**

   BOD_5 yang terlarut dalam effluent dari analisa lab, diketahui :
   - Biological solid = 65% BOD Eff
     = 65% x 60 mg/L = 39 mg/L
   - 1 gr biological solid = 1,42 gr BOD_5
     BOD_5 = 1,42 x 39 mg/L = 55,38 mg/L
   - BOD_5 (Eff) = 0,68 x BOD_5
     = 0,68 x 55,38 mg/L = 37,66 mg/L
   - BOD_5 soluble dari effluient (Se)
     Se = BOD_5 effluent SS – BOD_5 dari effluent SS
     = 60 – 37,66 = 22,34 mg/L

3. **Efisiensi Biological Treatment**

   a. Efisiensi BOD_5 soluble = $\frac{BOD_{influent} - Se}{BOD_{influent}} \cdot 100\%$

   $$= \frac{(1200 \text{ mg/lt} - 22{,}34 \text{ mg/lt})}{1200 \text{ mg/lt}} x 100\%$$

   = 98,1%

   b. Efisiensi total BOD = $\frac{BOD_{influent} - BOD_{effluent}}{BOD_{influent}} x 100\%$

$$= \frac{(1200\ \text{mg/lt} - 60\ \text{mg/lt})}{1200\ \text{mg/lt}} \times 100\%$$

= 95%

4. **Perhitungan Xr**

   Direncanakan dari hasil analisa laboratorium diperoleh volume lumpur yang mengendap selama 30 menit dalam 1 liter sampel = 250 mg/L, maka :

   - SVI $= \frac{\text{Vol}\ .\ 1000}{\text{MLSS}} = \frac{250\ \text{mg/lt}\ .1000}{3000\ \text{mg/lt}}$ = 83,33

   - Xr $= \frac{10^6}{\text{SVI}} = \frac{10^6}{83,33}$ = 12000 mg/L

5. **Debit Recycle (Qr)**

   Ratio recycle (resirkulasi)

   $$R = \frac{X}{Xr - X} = \frac{3000}{13000 - 3000} = 0,33$$

   R = 0,33 . . . . . OK

   (Syarat R = 0,25 – 0,38)

   Maka debit recycle (Qr)

   Qr = Qo x R

   = 842,4 m^3/hari x 0,33

   = 277,9 m^3/hari ~ 0,0032 m^3/detik

6. **Debit Masuk (Qa)**

   Qa = Qo + Qr

   = 842,4 m^3/hari + 277,9 m^3/hari

   = 1120,3 m^3/hari

7. **Konsentrasi COD dalam reaktor (Si)**

   a) BOD influent (So) = 1200 mg/L

   b) Qo = 0,00975 m^3/detik ~ 842,4 m^3/hari

   c) BOD_5 soluble dalam eff (Se) = 22,34 mg/L

   d) Qr = 0,0032 m^3/detik ~ 277,9 m^3/hari

   $$\text{Si} = \frac{(\text{So.Qo}) + (\text{Se.Qr})}{\text{Qo} + \text{Qr}}$$

   $$= \frac{(1200\ \text{mg/lt}\ x\ 842,4\ \text{m}^3/\text{hari}) + (22,34\ \text{mg/lt}\ .x\ 227,9\ \text{m}^3/\text{hari})}{842,4\ \text{m}^3/\text{hari} + 227,9\ \text{m}^3/\text{hari}}$$

   = 965,48 mg/L

8. **Volume Reaktor**

$$Vr = \frac{Qa \cdot \theta c \cdot Y \cdot (si - se)}{X \cdot (1 + kd \cdot \theta c)}$$

$$= \frac{1120{,}4 m^3/hari \ x \ 7 \ hari \ x 0{,}547 mgvss / mgBOD_5 \ x \ (965{,}48 - 22{,}34)}{2550 \ x \ (1 + 0{,}07 \ x \ 7)}$$

$= 1064{,}9 \ m^3$

9. **Kuantitas Lumpur Yang Dihasilkan Setiap Hari ($Y_{observated}$)**

$$Y_{obs} = \frac{Y}{1 + k_d \ .\theta c}$$ (Reuse, hal 481)

$$= Y_{obs} = \frac{0{,}547}{1 + 0{,}07 x 7}$$

$= 0{,}37 \ mgVSS/mgBOD_5$

10. **Pertumbuhan MLVSS (Px)/Massa Lumpur Aktif**

$$Px = \frac{Y_{obs} \ x \ Qa \ .x \ (Si - Se)}{1000 \ (gr/kg)}$$

$$= \frac{0{,}37 \ mgVSS/mgBOD_5 \ x \ 1120{,}4 \ m^3/hari \ x \ (965{,}48 - 22{,}34)}{1000 \ (gr/kg)}$$

$= 390{,}98$ kgVSS/hari

Dalam MLSS (PxSS) $= \frac{MLVSS}{0{,}85} = \frac{390{,}98 \ kgVSS/hari}{0{,}85}$

$= 459{,}98$ kgVSS/hari

11. **Pembuangan Lumpur**

Dari tangki aerasi

$$Qwa = \frac{Vr}{\theta c}$$

$$= \frac{1064{,}9 \ m^3}{7 \ hari} = 152{,}13 \ m^3/hari$$

Dari recycle line

$$Qwr = \frac{Vr \ . \ X}{\theta c \ . \ Xr}$$

$$= \frac{152{,}13 \ m^3 \ x \ 2550 \ mg/L}{7 \ hari \ x \ 12000 \ mg/L} = 4{,}62 \ m^3/hari$$

12. **Kontrol Volumetrik Loading (V_L)**

$$V_L = \frac{Qa \ . \ Si}{Vr}$$

$$= \frac{12{,}97 \text{ L/detik x } 877{,}2 \text{ mg/L x } 86400 \text{ detik/hari}}{1064{,}9 \text{ m}^3 \text{ x } 10^6 \text{ mg/kg}}$$

= 0,92 kg/m^3 hari

13. **Kebutuhan Oksigen (O_2)**

- Massa BOD_L $= \frac{Qa \,.\, (Si - Se) \,.\, 10^{-3}}{f}$

$$= \frac{1120{,}4 \text{ m}^3\text{/hr x } (965{,}48 - 22{,}34) \text{ mg/L x } \frac{10^3 \text{ gr}}{10^6 \text{ kg}}}{0{,}68}$$

= 1553,96 kg/hari

Dengan = Faktor konversi BOD_5 ke BOD_L (0,68)

- Kebutuhan O_2 total

= BOD_L – (1,42 x Px)
= 1553,96 kg/hari – (1,42 x 459,98 kgVSS/hari)
= 900,79 kg O_2/hari
= 37,53 kg O_2/jam

- Kebutuhan O_2 nyata (AOR) untuk BOD removal

AOR $= \frac{O_2 \text{ total}}{f}$

$= \frac{900{,}79 \text{ kg/hari}}{0{,}68}$

= 1324,7 kg/hari

14. **Dimensi Bak Aerasi**

Direncanakan :

1. Kedalaman Bak = 3 m + Freeboard
 = 3,3 m
2. Freeboard = 0,3 m

 Maka,
3. Volume (Vr) = B x L x H
 1064,9 = $2B^2$ x 3 m
 B $= \sqrt{\frac{1064{,}9 \text{ m}^3}{4{,}5 \text{ m}}}$
 = 15,4 m
4. Panjang = 2 x 15,4 m
 = 30,8 m

15. **Volume Udara Yang Dibutuhkan**

Efisiensi transfer O_2 untuk aerasi = 8%
Safety Factor = 2
Udara Mengandung = 20% O_2
ρ udara = 1,2 kg/m^3
maka,

a) Kebutuhan Udara Teoritis

$$\text{Keb. Udara teoritis} = \frac{\text{Kebutuhan } O_2 \text{ total (kg/hari)}}{\rho \text{ udara } \times \%O_2}$$

$$= \frac{1324{,}7 \text{ kg/hari}}{1{,}2 \text{ kg/m}^3 \times 0{,}2}$$

$= 5519{,}6 \text{ m}^3\text{/hari}$

b) Kebutuhan Udara Aktual

$$\text{Keb. Udara aktual} = \frac{\text{Kebutuhan } O_2 \text{ teoritis}}{\text{Efisiensi transfer } O_2}$$

$$= \frac{5519{,}6 \text{ m}^3\text{/hari}}{8\%}$$

$= 68995 \text{ m}^3\text{/hari} = 47{,}91 \text{ m}^3\text{/menit}$

c) Kebutuhan Udara Desain

Keb. Udara desain = kebutuhan O_2 aktual x Faktor pengaman
= 47,91 m^3/menit x 2
= 95,82m^3/menit = 1,6 m^3/detik

Aerator SAR floating surface aerator dengan kapasitas 0,83 m^3/detik adalah sebagai berikut :

16. **Transfer O_2 Di Lapangan**

$$N = No . \left[\frac{\beta . Cw . Cl}{9{,}17} \right] \times 1{,}024^{T-20} \times \alpha$$

Dengan :

N = Kg O_2/Kw jam transfer dibawah kondisi lapangan
No = Kg O_2/Kw jam transfer dibawah kondisi standart (20 °C)
Nilai no. (1,5)
β = Faktor koreksi salinity surface (1)
Cw = Konsentrasi O_2 jenuh (8,16 mg/L)
Cl = Konsentrasi O_2 operasi (2 mg/L)
T = Temperature °C
α = Faktor koreksi O_2 transfer (0,8 – 0,85)
Maka,

$$N = No \times \left[\frac{\beta \times Cw - Cl}{9,17} \right] \times 1,024^{T-20} \times \alpha$$

$$= 1,5 \times \left[\frac{1 \times 8,16 - 2}{9,17} \right] \times 1,024^{28-20} \times 0,8$$

= 1,028 kg O_2/kw jam

17. **Jumlah Aerator (n)**

Kriteria kapasitas aerator = 0,83 m^3/detik

Maka jumlah aerator $= \frac{keb.\ O2\ design}{kapasitas\ aerator}$

$= \frac{1,6\ m^3/detik}{0,83\ m^3/detik}$

= 1,93 = 2 unit

Jumlah aerator per bak = 2 bak x 2 = 4 unit, ditambah dengan cadangan 1 setiap baknya.

18. **Saluran Inlet**

Direncanakan :

V aliran = 0,5 m/detik

H zona inlet = 1 m

Panjang inlet (L) = 27,1 m (2 bak aerasi)

Waktu detensi (td) = 10 menit = 600 detik

Qin = 0,00975 m^3/detik x 2 bak

= 0,0195 m^3/detik

Zona outlet = zone inlet

Maka,

a) Volume

Vol. = Q x td

= 0,0195 m^3/detik x 600 detik

= 11,7 m^3

b) Kedalaman saluran (H)

Vol. = B x L x H

B $= \frac{Vol}{L \times H}$

$= \frac{11,7\ m^3}{27,1\ m \times 1\ m}$

= 0,43 m

H total = H + Freeboard (0,3 m)

= 0,73 m

19. **Pipa Inlet**

Direncanakan :

Kecepatan aliran (v) = 0,6 m/detik

Q total awal = 0,0195 m^3/detik

Maka,

a) Luas permukaan (A)

$$A = \frac{Q}{V}$$

$$= \frac{0{,}0195\ m^3/det}{0{,}6\ m/det} = 0{,}0325\ m^2$$

b) Diameter pipa (D)

$$D = \sqrt{\frac{4 . A}{\pi}}$$

$$= \sqrt{\frac{4\ x\ 0{,}0325\ m^2}{3{,}14}}$$

= 0,20 m ~ 20 cm

20. **Pipa Outlet**

Direncanakan :

Kecepatan aliran (v) = 0,6 m/detik

Qin = 0,0195 m^3/detik

Panjang pipa outlet dari AS ke Clarifier (L) = 10 m

Maka,

a) Luas permukaan (A)

$$A = \frac{Q}{V}$$

$$= \frac{0{,}0195\ m^3/det}{0{,}6\ m/det} = 0{,}0325\ m^2$$

b) Diameter pipa (D)

$$D = \sqrt{\frac{4 . A}{\pi}}$$

$$= \sqrt{\frac{4\ x\ 0{,}0325\ m^2}{3{,}14}}$$

= 0,20 m ~ 20 cm

21. **Pipa Resirkulasi**

Direncanakan :

Kecepatan aliran (v) = 0,8 m/detik

Q total awal = 0,0195 m^3/detik

Q resirkulasi (Qr) = 0,0032 m^3/detik

Maka,

a) Q total resirkulasi = Qr x Σ bak BP II

= 0,0032 m^3/detik x 1

= 0,0032 m^3/detik

b) Luas permukaan (A)

$$A = \frac{Q}{V}$$

$$= \frac{0{,}0032\ m^3/det}{0{,}8\ m/det} = 4 \times 10^{-3}\ m^2$$

c) Diameter pipa (D)

$$D = \sqrt{\frac{4 \,.\, A}{\pi}}$$

$$= \sqrt{\frac{4 \,.\, 0{,}004\ m^2}{3{,}14}}$$

= 0,07 m ~ 7 cm

7. Bak Pengendap II (Secondary Clarifier)

a) KriteriaPerencanaan :

1. Bangunan berbentuk circular
2. Kedalaman (H) = 10 – 15 ft = 3 – 4,6 m
3. Diameter (D) = 10 – 200 ft = 3 – 61 m
4. Slope dasar = ¾ – 2 in/ft = 62,5 – 166,7 mm/menit
5. Flight travel speed = 0,02 – 0,05 m/menit
6. Waktu detensi (td) = 1,5 – 2,5 jam
7. Over rate flow = 600 – 800 gal/ft^2.hari = 24,42 – 32,156 m^3/m^2.hari
8. Peak rate flow = 1200 – 1700 gal/ft^2.hari = 48,84 – 69,19 m^3/m^2.hari
9. Diamater inlet wall = 15 – 20% x D bak
10. Weir loading = 124 – 496 m

(Sumber :Metcalf & Eddy, Wastewater Engineering Treatment Disposal Reuse, Third edition,199, page 396 - 402)

11. Sg volatile solid = 1,3 gr/cm^3
12. Sg fixed solid = 2,5 gr/cm^3

(Syed R Qasim, "WWTP Planning, Design and Operation",1985,hal 427)

b) Direncanakan :

1. Bak berbentuk circular sebanyak 1 bak
2. Suhu = 28 °C
3. Viskositas (ν) = 0,8394 x 10^{-2} cm^2/detik = 0,8394 x 10^{-6} m^2/detik
4. Over rate flow = 30 m^3/m^2.hari
5. D inlet wall = 15% x D bak
6. Px (MLVSS) = 459,98 kgVSS/hari
   = 2 bak = 919,96 kgVSS/hari (total)
7. Nre = <2000 (aliran laminer)

c) Perhitungan

a. Zona Settling

Direncanakan :

1. Waktu detensi (td) = 2 jam = 7200 detik
2. Resirkulasi dari AS (Qr) = 0,0032 m^3/detik = 277,9 m^3/hari
3. MLVSS (Px) = 919,96 kgVSS/hari
4. Berat jenis lumpur = 2,4 kg/m^3
5. Q awal total = 0,0195 m^3/detik

Maka,

1. Debit tiap bak

$$\text{Q bak} = \frac{\text{Qtot}}{\Sigma\,\text{sub bak}}$$

$$= \frac{0{,}0195\ \text{m}^3/\text{sec}}{1}$$

= 0,0195 m^3/detik

= 1680 m^3/hari

MLVSS (Px eff dari Activated Sludge) = 459,98 kgVSS/hari

$$\text{MLVSS} = \frac{459{,}98\ \text{kgVSS/hari}}{2{,}4\ \text{kg/m}^3}$$

MLVSS = 191,66 m^3/hari yang dibuang

Maka,

Qin clarifier = (Qo + Qr) – MLVSS yang dibuang

= (1680 m^3/hari + 277,9 m^3/hari) – 191,66 m^3/hari

= 1766,24 m^3/hari = 0,02 m^3/detik

2. Luas Area Surface (A)

$$A = \frac{Q}{\text{Overflow rate}}$$

$$= \frac{1766{,}24\ m^3 / hari}{30\ m^3 / m^2.hari}$$

= 58,87 m^2

3. Diameter Bak (D)

$$D = \sqrt{\frac{4 . A}{\pi}}$$

$$= \sqrt{\frac{4 \text{ x } 58{,}87}{3{,}14}}$$

= 8,7 m (syarat = 3 – 61 m). . . . . memenuhi

4. Kedalaman Bak (H)

$$H = \frac{Q \text{ x } td}{A}$$

$$= \frac{0{,}0032\ m^3/\text{detik x } 7200 \text{ detik}}{58{,}87\ m^2}$$

= 0,39 m ~ 0,4 m

H total = H + freeboard

= 0,4 m + 0,5 m

= 0,9 m

5. Diameter Inlet Wall (D')

D' inlet wall = 15% x D bak

= 15% x 8,7 m

= 1,3 m

A inlet wall = ¼ . π . D^2

= ¼ x 3,14 x $(1,3)^2$

= 1,33 m

6. Cek Overflow rate

$$OFR = \frac{Q}{A}$$

$$= \frac{Q}{(\frac{1}{4} x 3{,}14 x D^2) + (\frac{1}{4} x 3{,}14 x D'^2)}$$

$$= \frac{1766{,}24 \text{ m}^3 / hari}{(\frac{1}{4} x 3{,}14 x 8{,}7^2) + (\frac{1}{4} x 3{,}14 x 1{,}3^2)}$$

= 29,1 m^3/m^2.hari → (24,42 – 32,156 m^3/m^2.hari) OK!

7. Cek Volume Bak

V = ¼ . π . d^2 . h

= ¼ x 3,14 x $8{,}7^2$ x 0,4 = 23,8 m^3

8. Cek td

$$td = \frac{V}{Q}$$

$$= \frac{23{,}8 \text{ m}^3}{0{,}0032 \text{ m}^3 / \sec}$$

= 7437,5 detik

= 2,07 jam → (1,5 – 2,5 jam) . . . . . OK!

9. Kecepatan Pengendapan Partikel (Vs)

$$Vs = \frac{H}{td}$$

$$= \frac{0{,}4 \text{ m}}{7437{,}5}$$

= 5,38 x 10^{-5} m/detik

10. Kecepatan Horizontal di Bak (Vh)

$$Vh = \frac{Qin}{\pi . D . H}$$

$$= \frac{0{,}0032 \text{ m}^3 / \sec}{3{,}14 \text{ x } 8{,}7 \text{ m x } 0{,}4 \text{ m}}$$

= 2,93 x 10^{-4} m/detik

11. Jari – Jari Hidrolis (R)

$$R = \frac{r . H}{r + 2 H}$$

$$= \frac{4{,}35 \text{ m x } 0{,}4 \text{ m}}{4{,}35 \text{ m} + (2 \text{ x } 0{,}4 \text{ m})}$$

= 0,34 m

12. Headloss Pada Zona Settling (Hf)

$$S = \left[\frac{Vh\,.\,n}{R^{2/3}}\right]^2$$

$$= \left[\frac{2{,}93 \times 10^{-4}\ \text{m/detik} \times 0{,}015}{0{,}34^{\frac{2}{3}}}\right]^2$$

$= 8{,}14 \times 10^{-11}$ m/m

Hf $= S \times D$

$= 8{,}14 \times 10^{-11}$ /m x 10

$= 8{,}14 \times 10^{-10}$ m

13. Cek Aliran

$$Nre = \frac{D.Vs}{\upsilon}$$

$$= \frac{8{,}7\ \text{m} \times 2{,}93 \times 10^{-4}\ \text{m/detik}}{0{,}8394 \times 10^{-5}\ \text{m}^2 / dtk}$$

= 303,7 (syarat : Nre <2000 aliran laminer). . . . . OK!

$$Nfr = \frac{Vh^2}{g.D}$$

$$= \frac{(2{,}93 \times 10^{-4}\ \text{m/dtk})^2}{9{,}81 \times 8{,}7\ \text{m}}$$

$= 1{,}01 \times 10^{-9} \rightarrow$ (syarat : Nfr $< 10^5$). . . . . OK!

b. Zona Inlet

Direncanakan :

1. D pipa inlet = D pipa discharge pompa = 200 mm = 0,2 m

   Maka,

   1. Luas Penampang Pipa (Ap)

   Ap $= \frac{1}{4} \,.\, \pi \,.\, D^2$

   $= \frac{1}{4} \times 3{,}14 \times 0{,}2^2$

   $= 0{,}0314\ \text{m}^2$

   2. Kecepatan Aliran Pipa (Vp)

$$Vp = \frac{Qin}{Ap}$$

$$= \frac{0{,}02\text{m}^3 / dtk}{0{,}0314\ \text{m}^2}$$

= 0,64 m/detik

3. Kecepatan Aliran Pada Inlet Zone (Vin)

$$Vin = \frac{Ap \ . \ Vp}{Ain} \rightarrow \frac{Ap \ . \ Vp}{\frac{1}{4} \ . \ \pi \ . \ D^2}$$

$$= \frac{0{,}0314 \text{ x } 0{,}1 \text{ m/detik}}{1/4 \text{ x } 3{,}14 \text{ x } 0{,}2^2}$$

= 0,1 m/detik

4. Headloss Pada Zona Inlet (Hf)

$$Hf = \frac{(Vin)^2 - (Vh)^2}{2 . g} \times \frac{1}{C}$$

$$= \frac{(0{,}1 \text{ m/dtk})^2 - (2{,}93 \text{ x } 10^{-4} \text{ m/dtk})^2}{2 \text{ x } 9{,}81 \text{m}^2 / dtk^2} \ x \ \frac{1}{0{,}7}$$

= 7,28 x 10^{-4} m

c. Zona Sludge

Direncanakan :

1. Volatile solid 60% dengan Bj = 1,3 gr/cm^3
2. Fixed solid 40% dengan Bj = 2,5 gr/cm^3
3. Sludge terdiri dari 95% air dan 5% solid
4. Q tiap bak clarifier = 0,02 m^3/detik

Maka,

1. Berat Jenis Solid

Sg = (60% . Sg Volatil Solid) + (40% . Sg Fixed Solid)
= (60% x 1,3 gr/cm^3) + (40% x 2,5 gr/cm^3)
= 1,78 gr/cm^3 = 1780 kg/m^3

2. Berat Jenis Sludge (Si)

Si = (5% x 1,78 gr/cm^3) + (95% x 1 gr/cm^3)
= 1,039 gr/cm^3 = 1039 kg/m^3

3. Removal TSS (Output Sludge di Bak Pengendap)

Cn = Co – (Co x (100% - 80%))
= 105 mg/L – (105 mg/L x 20%)
= 84 mg/L

4. Berat Solid

Berat Solid = removal TSS x Q
= 84 mg/L x 0,02 m^3/detik

=84 mg/L x 20 L/detik

= 1680 mg/detik = 145,15 kg/hari

5. Volume Solid

Vol. Solid $= \dfrac{\text{Berat solid}}{\text{Berat jenis solid}}$

$= \dfrac{145{,}15 \text{ kg/hr}}{1780\, kg/m^3} = 0{,}079 \text{ m}^3\text{/hari}$

6. Berat Air

Berat Air $= \dfrac{95\%}{5\%} \cdot \text{Berat solid}$

$= \dfrac{95\%}{5\%}\, x 145{,}15$

= 275,8 kg/hari

7. Volume Air

Vol. Air $= \dfrac{\text{Berat Air}}{\text{Berat Jenis Air}}$

$= \dfrac{275{,}8 \text{ kg/hari}}{1000 \text{ kg/m}^3}$

$= 0{,}2758 \text{ m}^3\text{/hari}$

8. Volume Sludge

Vol. Sludge = volume solid + volume air

$= 0{,}079 \text{ m}^3\text{/hari} + 0{,}2758 \text{ m}^3\text{/hari} = 0{,}355 \text{ m}^3\text{/hari}$

9. Berat Sludge

Berat sludge = volume sludge x berat jenis sludge

$= 0{,}355 \text{ m}^3\text{/hari x } 1039 \text{ kg/m}^3 = 368{,}845 \text{ kg/hari}$

10. Dimensi Ruang Lumpur

Direncanakan :

1. Volume Sludge = $0{,}355 \text{ m}^3\text{/hari}$
2. Waktu pengurasan = 30 hari
3. Waktu tinggal (td) = 10 jam
4. Diameter permukaan atas ruang lumpur = D bak = 8,7 m
5. Asumsi diameter permukaan bawah = 2 m
6. Ruang lumpur berbentuk kerucut terpancung

Maka,

1. **Luas Permukaan Atas (A)**

A = ¼ . 3,14 . D^2
= ¼ x 3,14 x $(8,7)^2$ = 59.42 m^2

2. **Luas Permukaan Bawah (A')**

A' = ¼ x 3,14 x 2^2 = 3,14 m^2

3. **Volume Ruang Lumpur**

Vol. = volume sludge x waktu pengurasan x td
= 0,355 m^3/hari x 30 hari x $\frac{10 \text{ Jam}}{24 \text{ Jam}}$
= 4,4375 m^3

4. **Volume Ruang Lumpur = Volume Kerucut**

4,4375 m^3 = 1/3 x h x (A + A' $\sqrt{AxA'}$)
4,4375 m^3 = ⅓ x h x (59,42 + 3,14 $\sqrt{59,42m^2 x 3,14m^2}$)
4,4375 m^3 = 34,1 m^2 x h
H = 0,13 m

11. **Dimensi Pipa Penguras Lumpur**

Direncanakan :

1. Kecepatan aliran di pipa penguras = 0,5 m/detik
2. Waktu pengurasan = 30 menit = 1800 detik
3. Volume Sludge = 4,4375 m^3

Maka,

1. **Debit Pipa Tiap Penguras (Qp)**

Qp = $\frac{\text{Vol lumpur}}{\text{Waktu pengurasan}}$
= $\frac{4,4375m^2}{1800dtk}$
= 2,46 x 10^{-3} m^3/detik

2. **Luas Permukaan Pipa (A)**

A = $\frac{\text{Q pengurasan}}{\text{V}}$
= $\frac{2,46x10^{-3} m^3 / dtk}{0,5m / dtk}$
= 4,92 x 10^{-3} m^2

3. **Diameter Pipa (D)**

$$D = \sqrt{\frac{4\,.\,A}{\pi}} = \sqrt{\frac{4\,x\,4{,}92x10^{-3}\,m^2}{3{,}14}}$$

= 0,079 m ~ 7,9 cm ~ 8 cm

12. **Dimensi Pipa Penguras Lumpur Gabungan**

Direncanakan :

1. Kecepatan aliran di pipa penguras = 0,5 m/detik
2. Waktu pengurasan = 30 menit = 1800 detik

Maka,

1. **Debit pada pipa sludge gabungan**

$$Q = \frac{\text{Vol lumpur}\ .\ \Sigma\ \text{bak pengendap}}{\text{td}}$$

$$= \frac{4{,}4375m^3 x1}{1800\,dtk}$$

= 2,46 x 10^{-3} m^2

2. **Luas Penampang Pipa**

$$A = \frac{\text{Q sludge gabungan}}{\text{V}}$$

$$= \frac{2{,}46x10^{-3}\,m^3/dtk}{0{,}5m/dtk} = 4{,}92 \times 10^{-3}\ m^2$$

3. **Diameter (D')**

$$D' = \sqrt{\frac{4\,.\,A}{\pi}} = \sqrt{\frac{4\,x\,4{,}92x10^{-3}\,m^2}{3{,}14}}$$

= 0,079 m ~ 7,9 cm ~ 8 cm

d. Zona Thickening

Direncanakan :

1. MLSS dari aerasi (Xr) = 12000 mg/L
2. MLVSS pada bak aerasi = 2550 mg/L
3. Volume bak aerasi (2 bak) = 2129,8 m^3

Maka,

1. **Total Massa Solid Dalam Bak Aerasi**

Massa solid total = MLVSS bak aerasi x Vol. Bak aerasi
= 2550 mg/L x 10^{-6} kg/mg x 2129,8 m^3 x 10^3 L/m^3

= 5430,99 kg

2. Total Massa Solid Dalam BP II

P = % biological yang tetap dalam bak aerasi

P = $1 - \frac{\text{MLVSS}}{\text{MLSS}}$

= $1 - \frac{2550 mg/l}{12000 mg/l}$

= 0,79 ~ 0,8 = 80%

Massa solid total BP II = (1 – P) x massa solid total bak aerasi

= (1 – 80%) x 5430,99 kg

= 1086,2 kg

3. Kedalaman Zona Thickening

H = $\frac{\text{massa solid total BP II}}{\text{Xr . luas surface area}}$

= $\frac{1086,2 kg/bak}{12 kg/m^3 \; x \; 58,87 \; m^2}$

= 1,54 m ~ 154 cm

Jadi, zona settling dan zona air bersih

= H BP II + H Zona Thickening

= 0,4 m + 1,54 m

= 1,94 m

4. Kedalaman Di Tengah – Tengah Bak

Direncanakan :

1. Kedalaman Bak (H) = 0,4 m
2. Kemiringan = 1 : 6

Maka,

Kedalaman di tengah – tengah bak (H')

H' = $H + \left(\frac{1}{2} \text{ . D bak}\right) . \frac{1}{6}$

= $0,4 m + \frac{1}{2} x 8,7 m x \frac{1}{6}$

= 1,125 m

e. Zona Outlet

Direncanakan :

1. Menggunakan V notch dengan α = 45
2. Jarak antar V notch = 50 cm = 0,5 m

3. Qin clarifier = 0,02 m^3/detik

Maka,

1. Pelimpah (Weir) & V Notch

- Panjang tiap weir = π . D bak

  = 3,14 x 8,7 m = 27,3 m

- Jumlah V notch (n)

$$n = \frac{\text{L weir}}{\text{Jarak antar weir}}$$

$$= \frac{27{,}3m}{0{,}5m}$$

= 54,6 ~ 55 buah

- Debit air yang mengalir tiap V notch

$$Q = \frac{\text{Q tiap bak}}{\text{n}}$$

$$= \frac{0{,}02m^3/dtk}{54}$$

= 3,7 x 10^{-4} m^3/detik

- Tinggi peluapan melalui V notch (H)

$$Q = \frac{8}{15} Cd\sqrt{2g}.\tan\frac{\theta}{2} H^{5/2}$$

Dengan : Cd = 0,584 ; θ = sudut V notch = 90°

$$3{,}7 \times 10^{-4}\ m^3/\text{detik} = \frac{8}{15} x\, 0{,}584.\sqrt{2.9{,}81}\tan\frac{90}{2} H^{\frac{5}{2}}$$

$$H^{5/2} = \frac{3{,}7x10^{-4} m^3/dtk}{1{,}38}$$

= 2,68 x 10^{-4}

H = 0,037 m ~ 3,7 cm

- Panjang basah tiap pelimpah

$$Li = \frac{2 \cdot h}{\tan 45°}$$

$$= \frac{2x0{,}037}{\tan 45°}$$

= 0,074 m ~ 7cm

- Panjang basah total

Ln = n x Li

= 55 x 0,074 m

= 4,07 m

- Saluran pelimpah

Direncanakan :

V = 0,5 m/detik

Q = 0,02 m^3/detik

A = $\frac{Q}{v} = \frac{0{,}02 m^3/dtk}{0{,}5 m/dtk}$

= 0,04 m^2

Dengan perbandingan b : h = 2 : 1

A = b x h → b = lebar saluran = 2 x h

H = kedalaman

0,04 m^2 = 2 h^2

H^2 = $\sqrt{\frac{0{,}04 m^3/dtk}{2}}$

= 0,14 m

B = 2 x 0,14 = 0,28 m

2. Pipa Outlet

Direncanakan :

1. Debit (Q) in = 0,02 m^3/detik
2. Kecepatan aliran (v) = 1 m/detik

1. Luas Permukaan (A)

A = $\frac{Qin}{V}$

= $\frac{0{,}02 m^3/dtk}{1 m/dtk}$

= 0,02 m

2. Diameter Pipa (D)

D = $\sqrt{\frac{4 . A}{\pi}}$

= $\sqrt{\frac{4 x 0{,}02 m^2}{3{,}14}}$

= 0,16 m ~ 160 mm

3. Headloss Pipa Outlet

Vh = $\frac{Q}{2 . \pi . r . D}$

$$= \frac{0{,}02 m^3 / dtk}{2\, x\, 3{,}14.x\, 0{,}08 m\, x 0{,}16 m}$$

= 0,25 m/detik

4. Headloss (Hf)

$$Hf = \frac{Vp^2 - Vh^2}{2 . g} \cdot \frac{1}{C}$$

$$= \frac{(1\, m/dtk)^2 - (0{,}25 m/dtk)^2}{2\, x\, 9{,}81 m^2 / dtk^2}\, x \frac{1}{0{,}7}$$

= 0,07 m

8. Filter Press

a) Kriteria Desain :

- Kapasitas : 4445 L = 4,445 m^3
- Model : FPA-AR 1200
- Power : 7,5 kW
- Operation : Otomatis
- Plates : 125 (Maximum)
- Max. Filter Surface : 310 (m^2)

b) Data Perencanaan :

- Lumpur dari Bak Pengendap I
  - Volume Lumpur : 3,462 m^3/hari
  - Berat Lumpur : 3531,25 kg/hari
  - Volume Solid : 0,11 m^3/hari
  - Berat Solid : 176,4 kg/hari
- Lumpur dari bak Pengendap II
  - Volume Lumpur : 0,355 m^3/hari
  - Berat Lumpur : 368,845 kg/hari\
  - Volume Solid : 0,079 m^3/hari
  - Berat Solid : 145,15 kg/hari
- Volume total yang masuk dari BP I dan BP II
  - Volume lumpur : Vol. Lumpur BP I + Vol. Lumpur BP II

    : 3,462 m^3/hari + 0,355 m^3/hari

: 3,817 m^3/hari

- Berat lumpur : Berat lumpur BP I + Berat lumpur BP II

: 3531,25 kg/hari + 368,845 kg/hari

: 3900,095 kg/hari

- Volume Solid : Vol. Solid BP I + Vol. Solid BP II

: 0,11 m^3/hari + 0,079 m^3/hari

: 0,189 m^3/hari

- Berat Solid : Berat Solid BP I + Berat Solid BP II

: 176,4 kg/hari + 145,15 kg/hari

: 321,55 kg/hari

1. **Kebutuhan alat**

Volume total lumpur yang masuk = 3,817 m^3/hari

Berdasarkan total volume lumpur yang masuk dari Bak Pengendap I dan Bak Pengendap 2, total volume yang masuk = 3,817 m^3/hari, maka alat yang di butuhkan untuk pengolahan lumpur adalah 1 unit dikarenakan kapasitas dari alat tersebut masih memenuhi.

LAMPIRAN C

PERHITUNGAN HF & POMPA

1. Sumur Pengumpul ke Bak Equalisasi

- Diameter Pipa

A = $\frac{Q}{V} = \frac{0{,}0195 m^3/\sec}{0{,}95 m/\sec} = 0{,}0205 m^2$

D = $\left[\frac{4\,A}{\pi}\right]^{1/2} = \left[\frac{4x0{,}0205}{3{,}14}\right]^{1/2}$ = 0,16 m ; D pasaran = 20 cm = 8"

- Hf Suction

L = 2,8 + 1,5 = 4,3 m (Panjang pipa sebelum pompa pada gambar Autocad)

K = 1,1 (Elbow 90°,)

- Hf mayor = $\left[\frac{10{,}7 x L x Q^{1{,}857}}{C^{1{,}857} x D^{4{,}87}}\right]$

$= \left[\frac{10{,}7 \times 4{,}3 \times 0{,}0195^{1{,}857}}{110^{1{,}857} \times 0{,}2^{4{,}87}}\right]$

= 0,013 m

- Hf minor = $\frac{K \times V^2}{2 \times g}$

$= \frac{1{,}1 \times 0{,}95^2}{2 \times 9{,}8}$

= 0,051 m

- Hf suction = Hf mayor + Hf minor

= 0,013 + 0,051

= 0,064 m

- Hf Discharge

L = 3 + 3,4 + 0,9 + 0,8 = 7,5 m (Panjang pipa setelah pompa pada gambar Autocad)

K = 1,1 (Elbow 90°,)

- Hf mayor = $\left[\frac{10{,}7 x L x Q^{1{,}857}}{C^{1{,}857} x D^{4{,}87}}\right]$

$$= \left[\frac{10,7x7,5x0,0195^{1,857}}{110^{1,857}x0,02^{4,87}} \right]$$

= 0,022 m

- Hf minor (Elbow 90°) $= 3 \text{ x } \frac{K \times V^2}{2 \times g}$

$= 3 \text{ x } \frac{1,1x0,97^2}{2x9,8}$

= 0,152 m

- Hf discharge = Hf mayor + Hf minor

= 0,022 + 0,152

= 0,174 m

- Hf Pompa

Hf Total = Hf Suction + Hf Discharge

= 0,064 + 0,174

= 0,238 m

Hf Total + Hs ≤ Hf Pompa ; Hs = 4 m (Permukaan Air ke Permukaan Air)

0,238 + 4 ≤ Hf Pompa

4,238 ≤ Hf Pompa, jadi Hf Pompa = 4,5 m

- Spesifikasi Pompa

P = g x Q tiap pompa x Hf pompa x Densitas Air

= 9,8 x 0,0195 x 4,2 x 1000

= 802,62 watt

µ Pompa = 80% x P

= 80% x 802,62

= 642,096 watt

(Nb : Spesifikasi pompa menggunakan tabel grunfos dengan spesifikasi pompa NK 100 – 200)

2. Bak Equalisasi ke Induced Gas Flotation

- Diameter Pipa

$$A = \frac{Q}{V} = \frac{0,0195 m^3/\text{sec}}{0,6 m/\text{sec}} = 0,0325 m^2$$

$$D = \left[\frac{4 \text{ A}}{\pi} \right]^{1/2} = \left[\frac{4x0,0325}{3,14} \right]^{1/2} = 0,2 \text{ m}$$

- Hf Suction

L = 1 m (Panjang pipa sebelum pompa pada gambar Autocad)
K = 1,1 (Elbow 90°,)

- Hf mayor $= \left[\dfrac{10{,}7 \times L \times Q^{1{,}857}}{C^{1{,}857} \times D^{4{,}87}} \right]$

$= \left[\dfrac{10{,}7 \times 1 \times 0{,}0195^{1{,}857}}{110^{1{,}857} \times 0{,}2^{4{,}87}} \right]$

= 0,0029 m

- Hf Suction = Hf mayor + Hf minor

= 0,0029 + 0 (karena tdk ada aksesoris pada pipa)
= 0,0029 m

- Hf Discharge

L = 5 + 3,85 + 2,4 = 11,25 m (Panjang pipa setelah pompa pada gambar Autocad)
K = 1,1 (Elbow 90°,)

- Hf mayor $= \left[\dfrac{10{,}7 \times L \times Q^{1{,}857}}{C^{1{,}857} \times D^{4{,}87}} \right]$

$= \left[\dfrac{10{,}7 \times 11{,}25 \times 0{,}0195^{1{,}857}}{110^{1{,}857} \times 0{,}2^{4{,}87}} \right]$

= 0,033 m

- Hf minor (Elbow 90°) $= 2 \text{ x } \dfrac{K \times V^2}{2g}$

$= 2 \text{ x } \dfrac{1{,}1 \times 0{,}6^2}{2 \times 9{,}8}$

= 0,04 m

- Hf Discharge = Hf mayor + Hf minor

= 0,033 + 0,04
= 0,073 m

- Hf Pompa

Hf Total = Hf Suction + Hf Discharge
= 0,0029 + 0,073
= 0,0759 m

Hf total + Hs ≤ Hf Pompa ; Hs = 2,05 m (Permukaan Air ke Permukaan Air)

0,0759 + 2,05 $\leq$ Hf Pompa

2,1259 $\leq$ Hf Pompa, jadi Hf Pompa = 2,5 m

- Spesifikasi Pompa

P = g x Q tiap pompa x Hf pompa x Densitas Air
= 9,8 x 0,0195 x 2,1259 x 1000
= 406,26 watt

μ Pompa = 80% x P
= 80% x 406,26
= 325,008 watt

(Nb : Spesifikasi pompa menggunakan tabel grunfos dengan spesifikasi pompa NK 100 – 200)

3. Induced Gas Flotation ke Bak Netralisasi

- Diameter Pipa

$$A = \frac{Q}{V} = \frac{0,0195 m^3/\sec}{0,6 m/\sec} = 0,0325 m^2$$

$$D = \left[\frac{4\,A}{\pi}\right]^{1/2} = \left[\frac{4x0,0325}{3,14}\right]^{1/2} = 0,2 \text{ m}$$

- Hf Suction

L = 1,2 + 0,8 + 0,75 = 2,75 m (Panjang pipa pada gambar Autocad)

K = 1,1 (Elbow 90°,)

K = 0,2 (Katub 1 arah,)

- Hf mayor $= \left[\frac{10,7 \times L \times Q^{1,857}}{C^{1,857} \times D^{4,87}}\right]$

$$= \left[\frac{10,7 \times 2,75 \times 0,0195^{1,857}}{110^{1,857} \times 0,2^{4,87}}\right]$$

= 0,0081 m

- Hf minor (Elbow 90° + Katub 1 arah)

$$= (2 \text{ x } \frac{Kelbow \times V^2}{2 \times g}) + \frac{Kkatub \times V^2}{2 \times g}$$

$$= (2 \text{ x } \frac{1,1 \times 0,6^2}{2 \times 9,8}) + \frac{0,2 \times 0,6^2}{2 \times 9,8}$$

= 0,04 + 0,0037

= 0,0437 m

- Hf Pipa = Hf mayor + Hf minor (Elbow 90°) + Hf minor (Katub 1 arah)

  = 0,0081 + 0,0437

  = 0,0518 m

4. Bak Netralisasi ke Bak Pengendap I

- Diameter Pipa

A $= \dfrac{Q}{V} = \dfrac{0{,}0195 m^3/\sec}{0{,}6 m/\sec} = 0{,}0325 m^2$

D $= \left[\dfrac{4\,A}{\pi}\right]^{1/2} = \left[\dfrac{4x0{,}0325}{3{,}14}\right]^{1/2}$ = 0,2 m

- Hf Suction

L = 4,65 + 0,2 = 4,85 m (Panjang pipa pada gambar Autocad)

K = 1,1 (Elbow 90°,)

K = 0,2 (Katub 1 arah,)

- Hf mayor $= \left[\dfrac{10{,}7 \times L \times Q^{1{,}857}}{C^{1{,}857} \times D^{4{,}87}}\right]$

  $= \left[\dfrac{10{,}7 \times 4{,}85 \times 0{,}0195^{1{,}857}}{110^{1{,}857} \times 0{,}2^{4{,}87}}\right]$

  = 0,014 m

- Hf minor (Elbow 90° + katub 1 arah)

  $= \dfrac{Kelbow \times V^2}{2 \times g} + \dfrac{Kkatub \times V^2}{2 \times g}$

  $= \dfrac{1{,}1 \times 0{,}6^2}{2 \times 9{,}8} + \dfrac{0{,}2 \times 0{,}6^2}{2 \times 9{,}8}$

  = 0,02 + 0,0037

  = 0,0237 m

- Hf Pipa = Hf mayor + Hf minor

  = 0,014 + 0,0237

  = 0,0577 m

5. Bak Pengendap I ke Aerasi

- Diameter Pipa

A = $\frac{Q}{V} = \frac{0{,}0195 m^3/\sec}{0{,}6 m/\sec} = 0{,}0325 m^2$

D = $\left[\frac{4\,A}{\pi}\right]^{1/2}$ = $\left[\frac{4x0{,}0325}{3{,}14}\right]^{1/2}$ = 0,2 m

- Hf Suction

L = 0,2 + 2,5 = 2,7 m (Panjang pipa pada gambar Autocad)
K = 1,1 (Elbow 90°,)

- Hf mayor = $\left[\frac{10{,}7 \times L \times Q^{1{,}857}}{C^{1{,}857} \times D^{4{,}87}}\right]$

= $\left[\frac{10{,}7 \times 2{,}7 \times 0{,}0195^{1{,}857}}{110^{1{,}857} \times 0{,}2^{4{,}87}}\right]$

= 0,0079 m

- Hf minor (Elbow 90°) = $\frac{K \times V^2}{2g}$

= $\frac{1{,}1 \times 0{,}6^2}{2 \times 9{,}8}$

= 0,02 m

- Hf Pipa = Hf mayor + Hf minor

= 0,0079 + 0,02
= 0,0279 m

6. Aerasi ke Bak Pengendap II

- Diameter Pipa

A = $\frac{Q}{V} = \frac{0{,}0195 m^3/\sec}{0{,}6 m/\sec} = 0{,}0325 m^2$

D = $\left[\frac{4\,A}{\pi}\right]^{1/2}$ = $\left[\frac{4x0{,}0325}{3{,}14}\right]^{1/2}$ = 0,2 m

- Hf Suction

L = 0,35 + 9,9 + 0,65 = 10,9 m (Panjang pipa pada gambar Autocad)
K = 1,1 (Elbow 90°,)

- Hf mayor = $\left[\frac{10{,}7 \times L \times Q^{1{,}857}}{C^{1{,}857} \times D^{4{,}87}}\right]$

$$= \left[\frac{10,7 \times 10,9 \times 0,0195^{1,857}}{110^{1,857} \times 0,2^{4,87}} \right]$$

= 0,032 m

- Hf minor (Elbow 90°) $= \dfrac{K \times V^2}{2g}$

$$= 2 \text{ x } \frac{1,1 \times 0,6^2}{2 \times 9,8}$$

= 0,04 m

- Hf Pipa = Hf mayor + Hf minor

  = 0,032 + 0,04

  = 0,072 m

LAMPIRAN D
PERHITUNGAN PROFIL HIDROLIS

1. Sumur Pengumpul

Kedalaman (H) = 3 m
Freeboard = 0,5 m
Elevasi Awal = -3 m
Lvl. Muka Air = Elevasi Awal + H
= -3 + 3
= 0 m

2. Bak Equalisasi

Kedalaman (H) = 4 m
Freeboard = 0,5 m
Elevasi Awal = 0 m
Lvl. Muka Air = Elevasi Awal + H – Hf total
= 0 + 4 – 0,238
= +3,762 m

3. Induced Gas Flotation

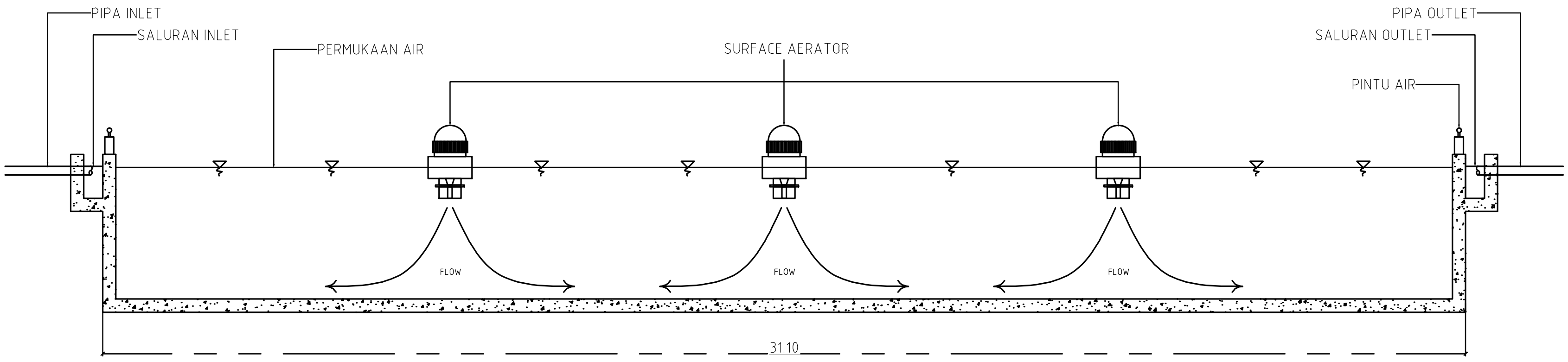
Kedalaman (H) = 2,1 m
Tinggi Menara = 3,45 m
Freeboard = 0 m
Elevasi Awal = 0 m
Lvl. Muka Air = Elevasi Awal + Tinggi Menara + H – Hf total
= 0 + 3,45 + 2,1 - 0,0759
= +5,4741 m

4. Netralisasi

Kedalaman (H) = 1,2 m
Tinggi Menara = 3,45 m
Freeboard = 0 m
Elevasi Awal = 0 m
Lvl. Muka Air = Elevasi Awal + Tinggi Menara + H – Hf total
= 0 + 3,45 + 1,2 - 0,0518
= +4,5982 m

5. Bak Pengendap I

Kedalaman (H) = 5,84 m
Freeboard = 0,3 m
Elevasi Awal = -2,63 m
Lvl. Muka Air = Elevasi Awal + H – Hf total



POTONGAN A-A

1 : 160

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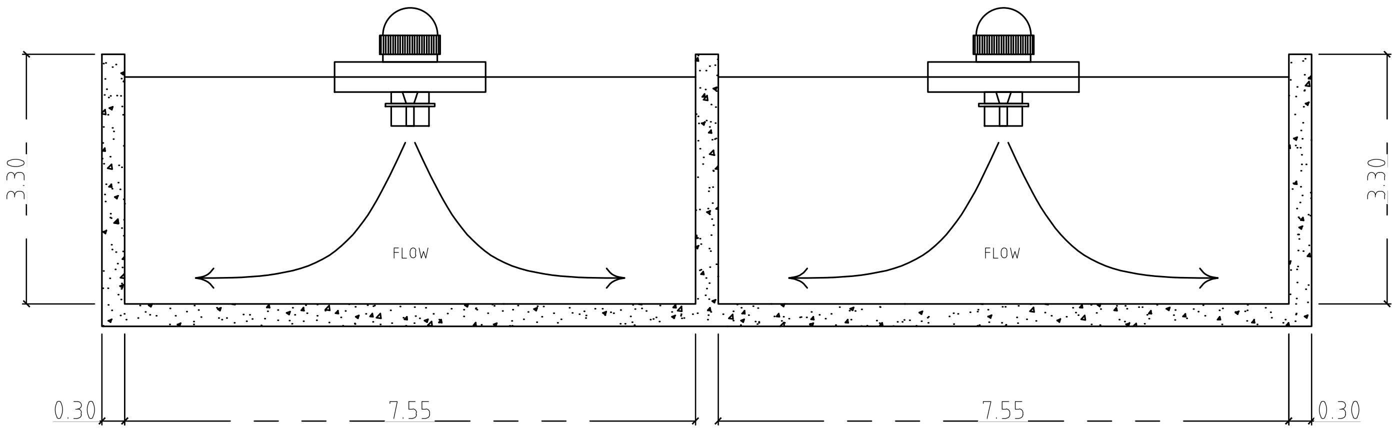
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
BAK AERASI (POTONGAN (A-A)	1 : 160

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
136		



POTONGAN B-B

1 : 100

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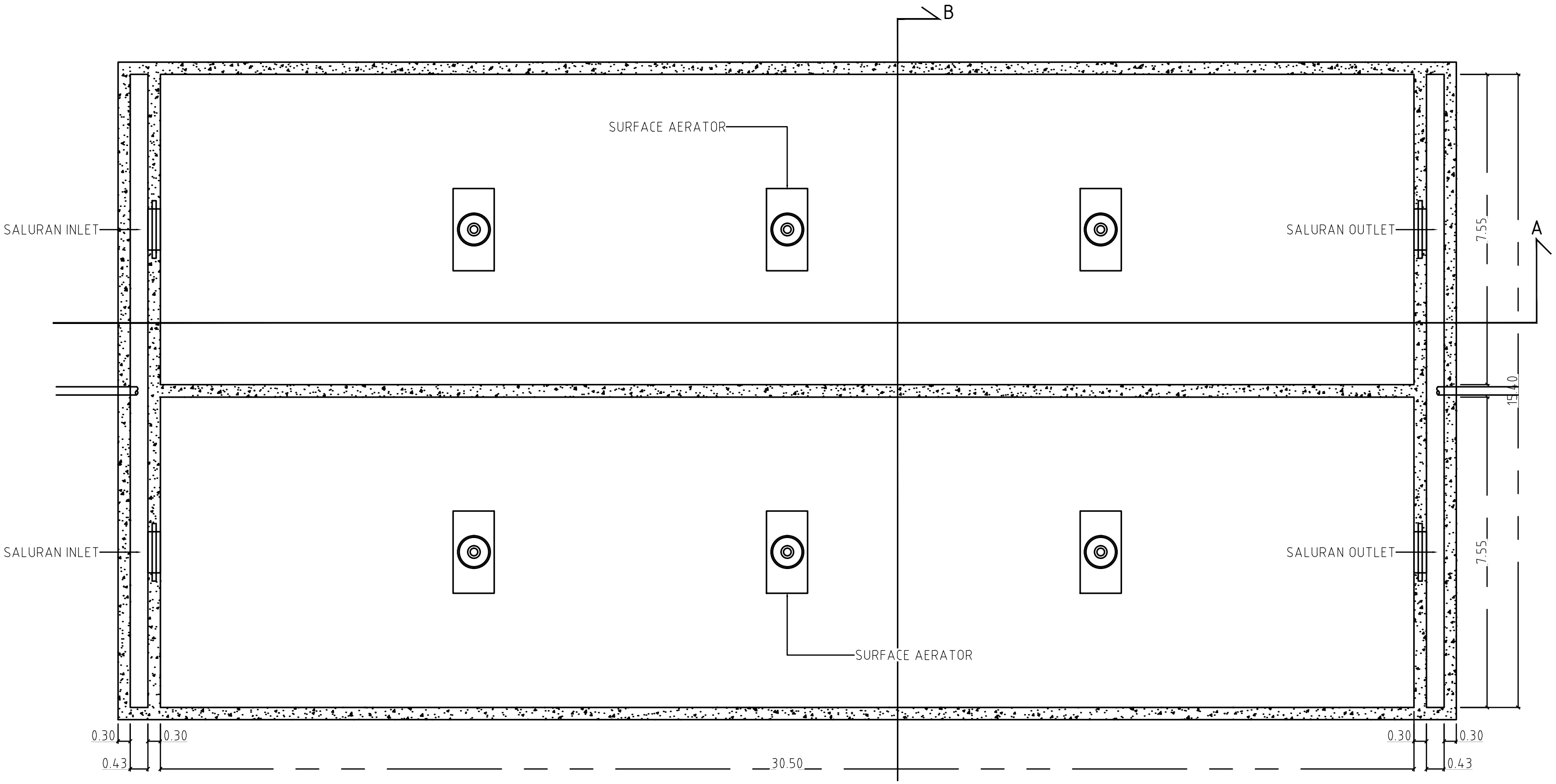
JUDUL	SKALA
BAK AERASI (POTONGAN (B-B)	1 : 100

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
137		



BAK AERASI

1 : 175

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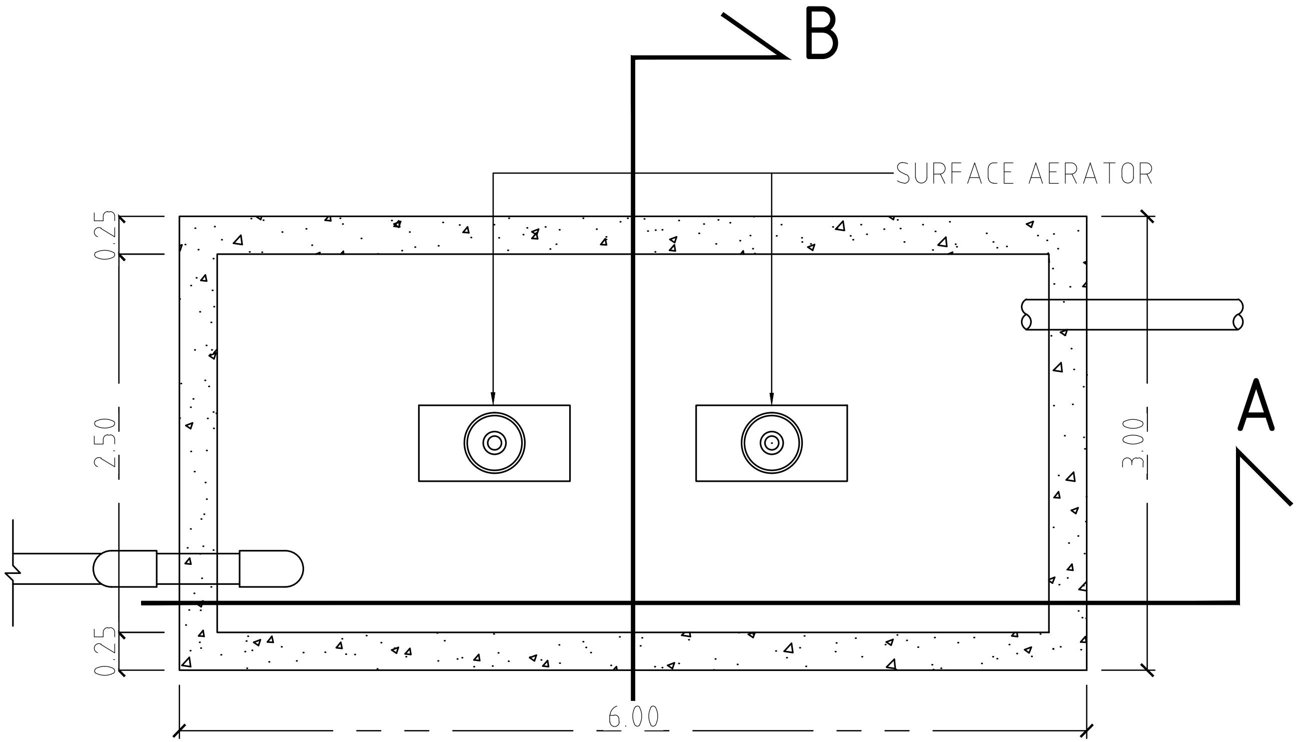
JUDUL	SKALA
BAK AERASI	1 : 175

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
135		



BAK EQUALISASI

1 : 50

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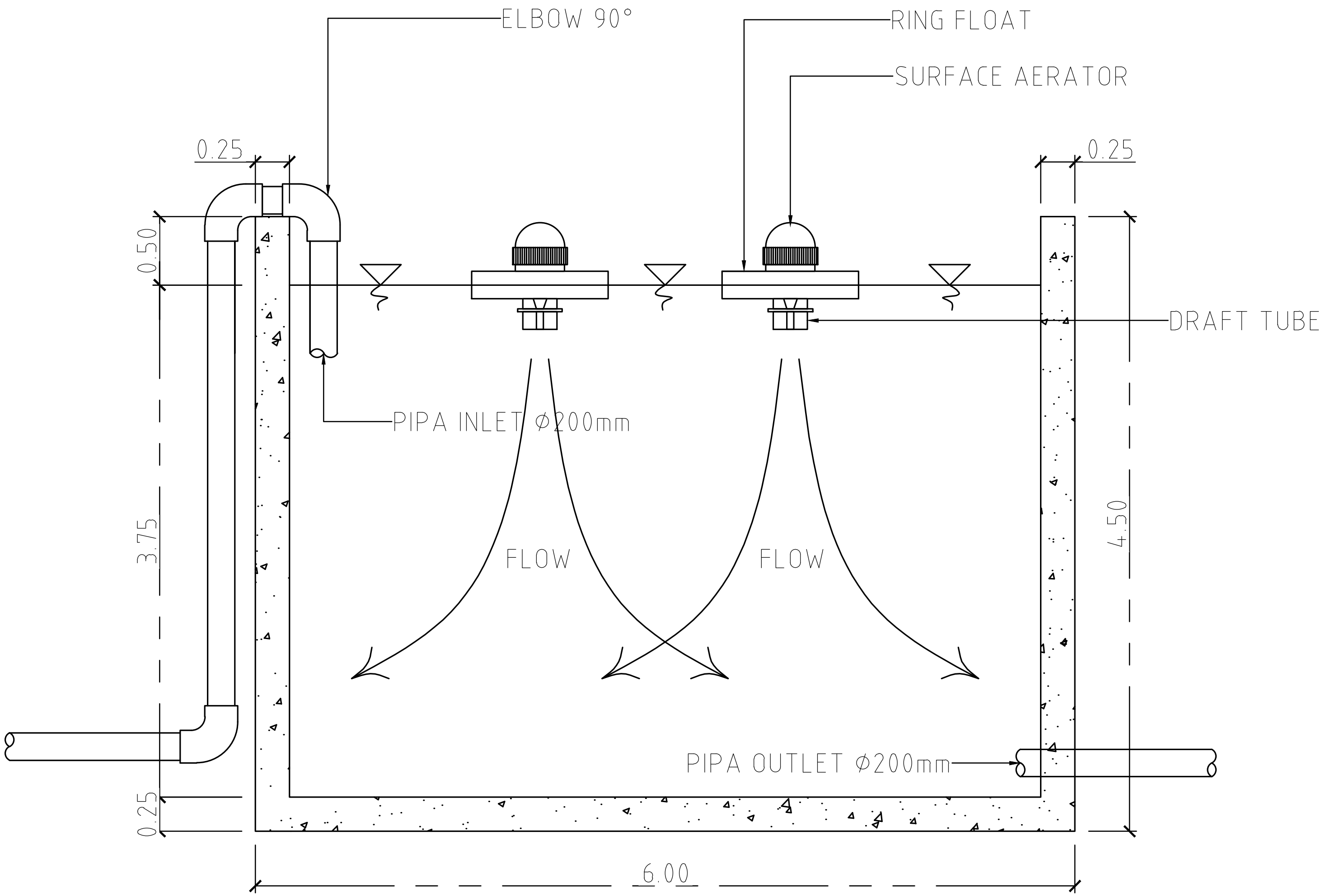
JUDUL	SKALA
BAK EQUALISASI	1 : 50

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
125		



POTONGAN A-A
1 : 50

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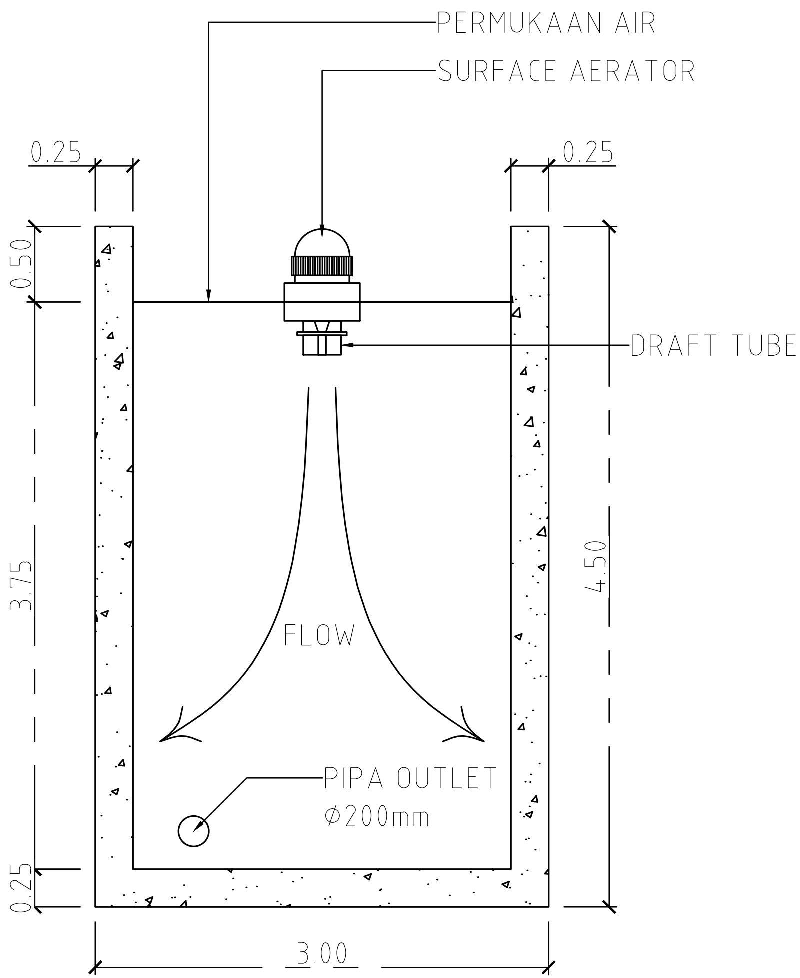
JUDUL	SKALA
BAK EQUALISASI (POTONGAN A-A)	1 : 50

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
126		



POTONGAN B-B

1 : 50

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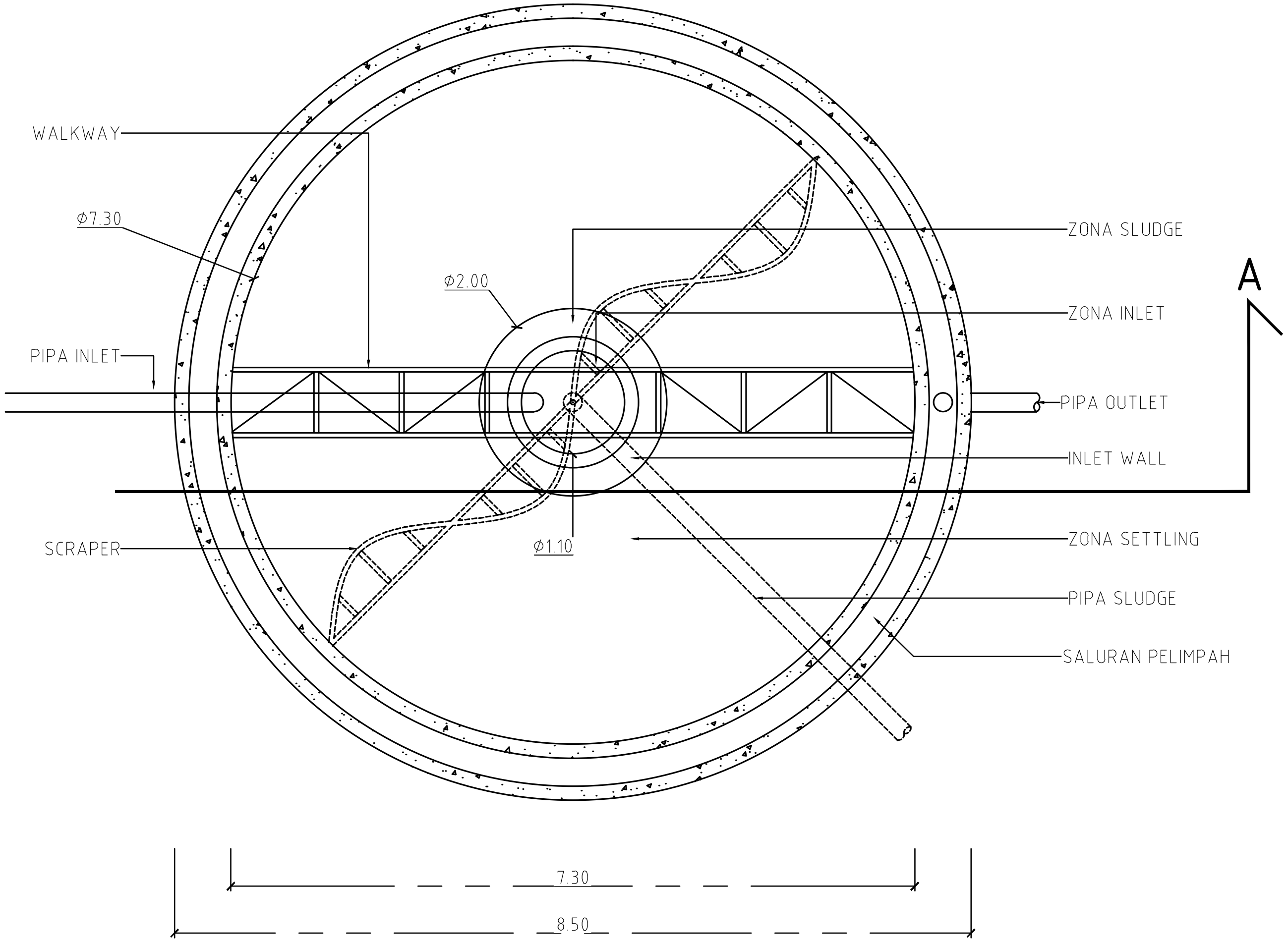
SISSAR EKA B.	1452010025
JUDUL	SKALA
BAK EQUALISASI (POTONGAN B-B)	1 : 50

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
127		



BAK PENGENDAP I (CLARIFIER)

1 : 80

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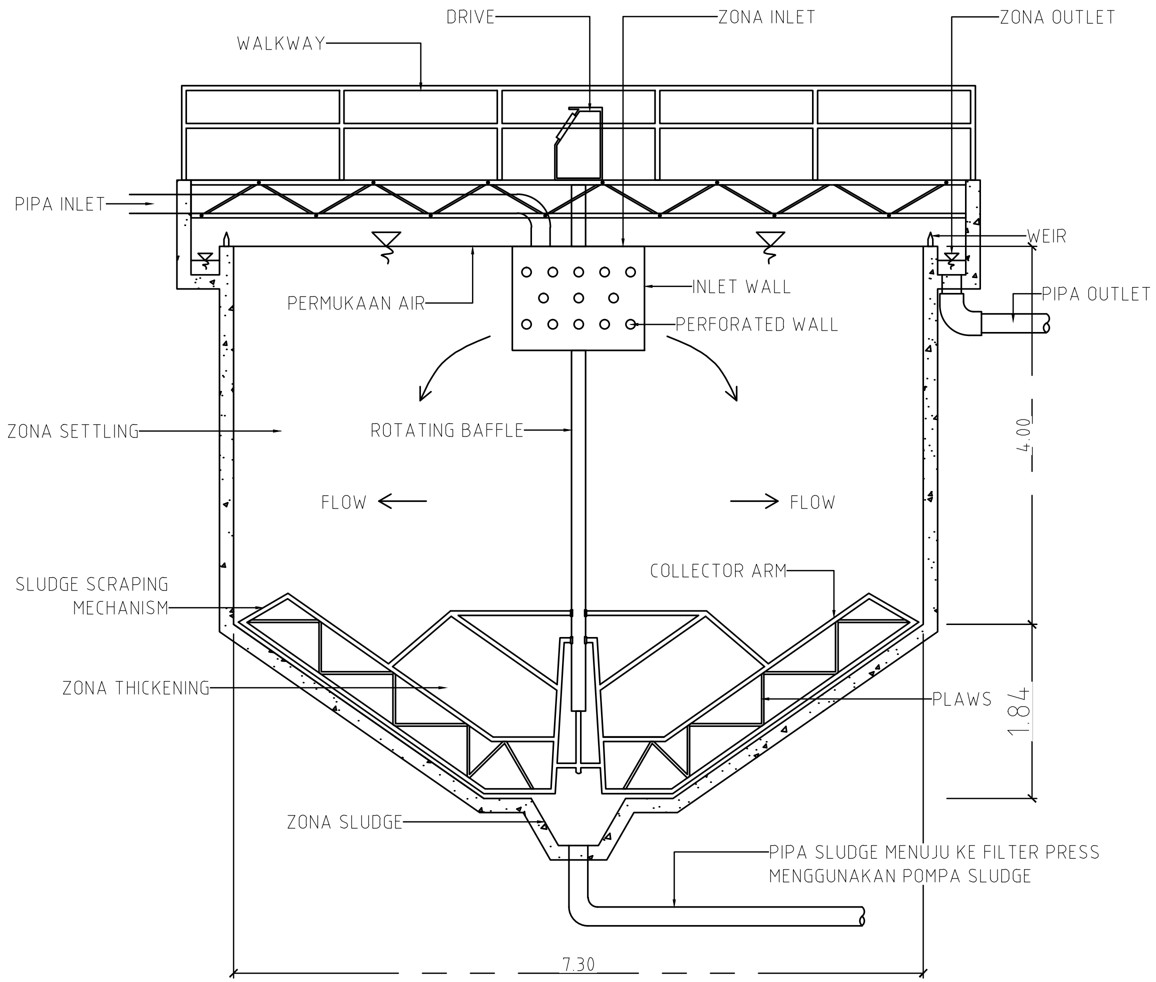
IR. YAYOK SURYO P., MS FIRRA R., ST, MT		
DOSEN PEMBIMBING		
AULIA ULFAH F., ST. M.,Sc		
MAHASISWA	NPM	
SISSAR EKA B.	1452010025	
JUDUL	SKALA	
BAK PENGENDAP I (CLARIFIER)	1 : 80	
NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
133		



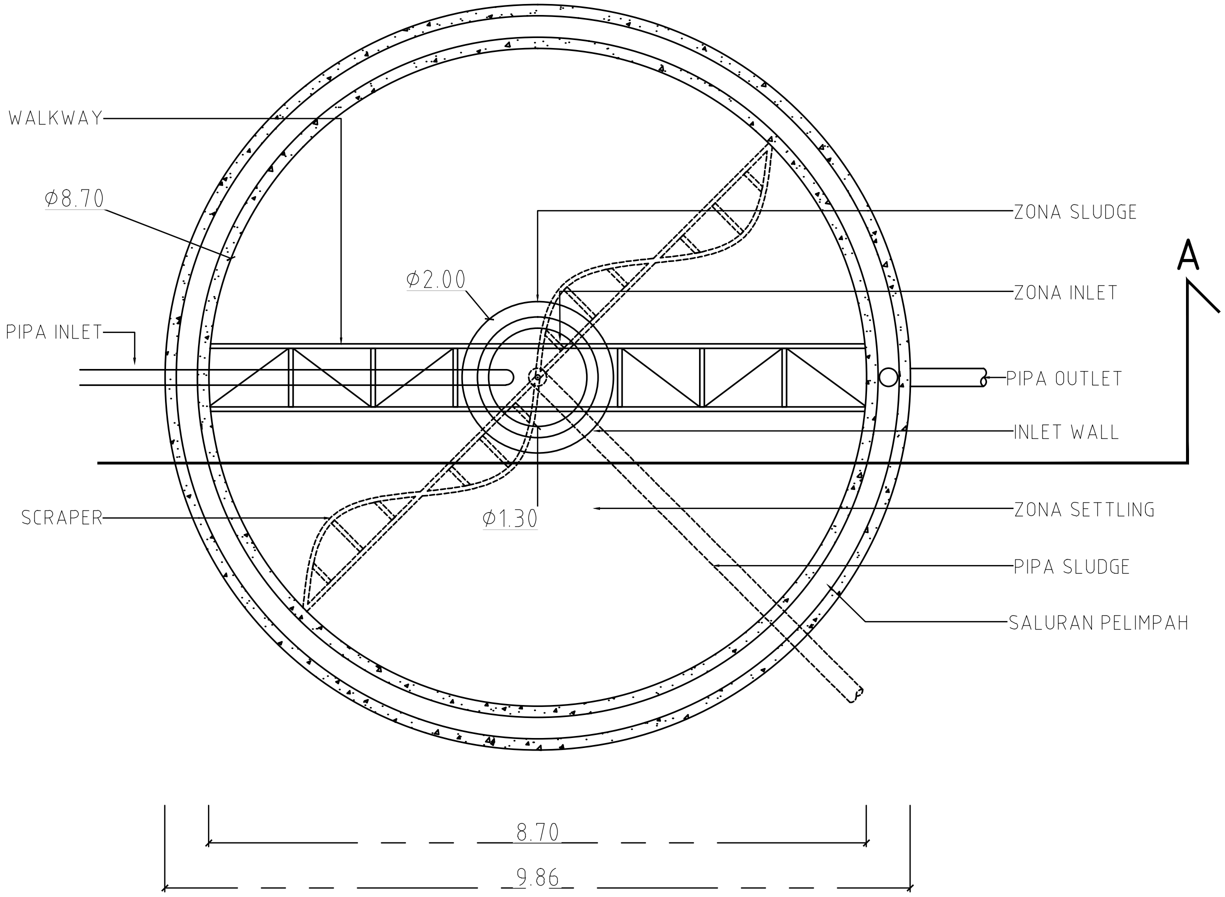
POTONGAN A-A

1 : 80

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
BAK PENGENDAP I (CLARIFIER) (POTONGAN A-A)	1 : 80

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
134		

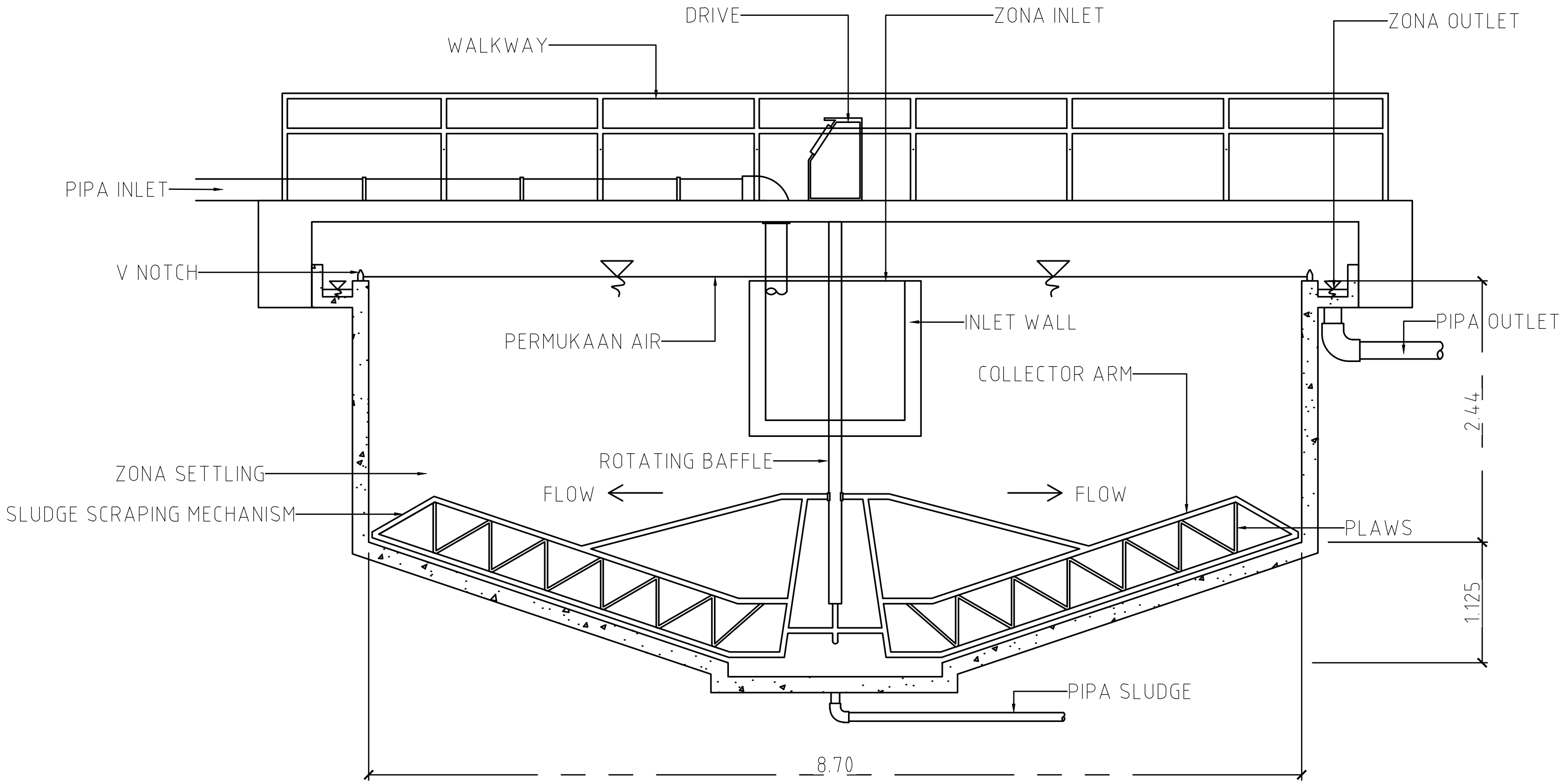


BAK PENGENDAP II (CLARIFIER)
1 : 100

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
BAK PENGENDAP II (CLARIFIER)	1 : 100

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
138		



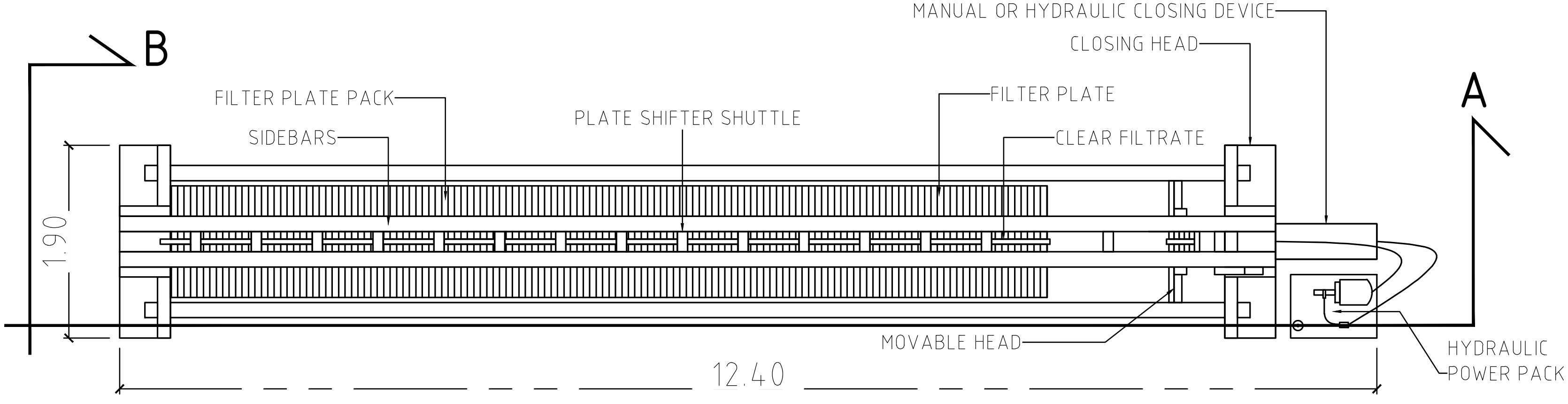
POTONGAN A-A

1 : 70

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
BAK PENGENDAP II (CLARIFIER) (POTONGAN A-A)	1 : 70

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
139		

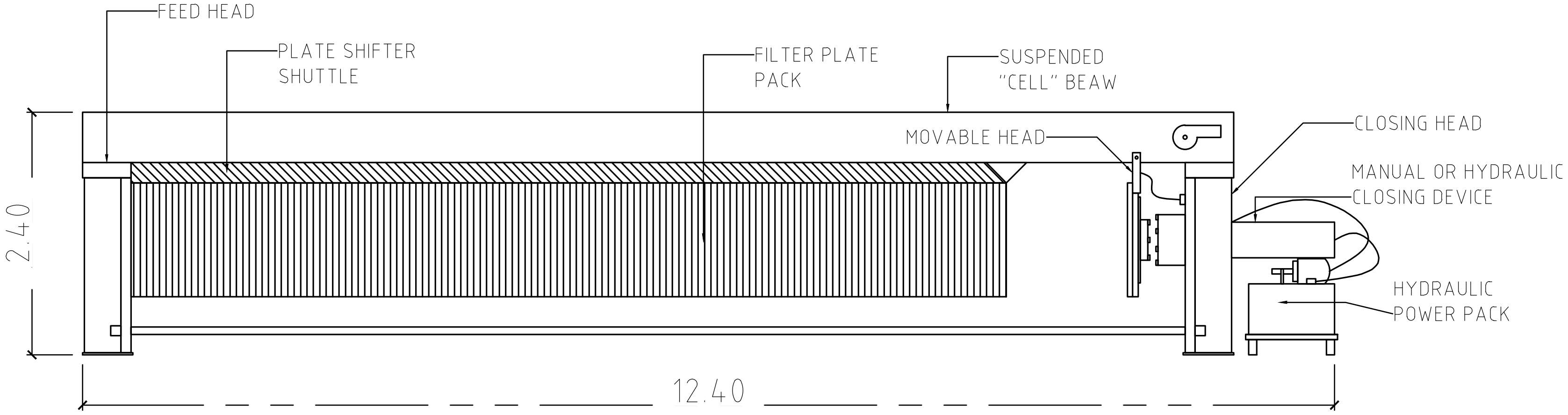


FILTER PRESS

1 : 70

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR FAKULTAS TEKNIK JURUSAN TEKNIK LINGKUNGAN	
TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
FILTER PRESS	1 : 70

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
140		



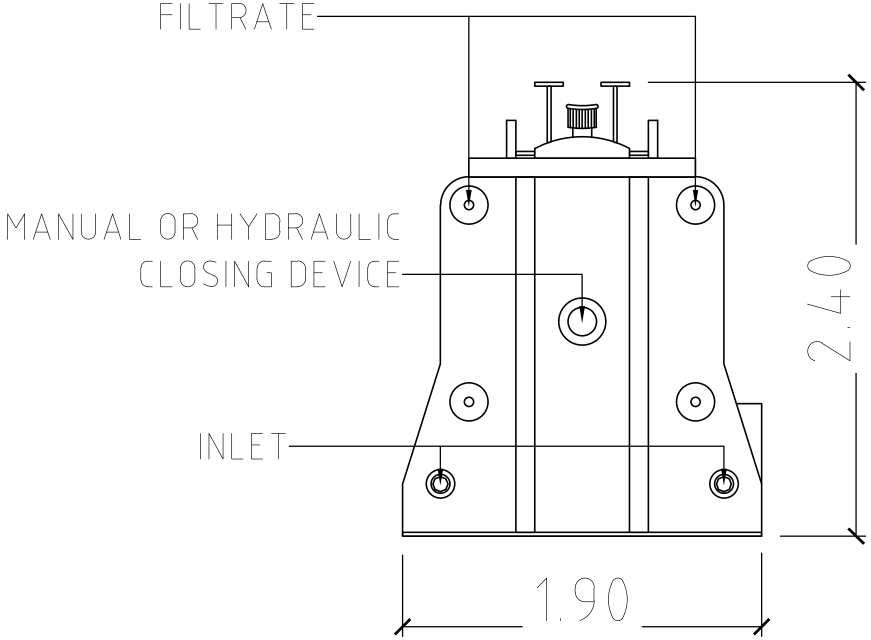
POTONGAN A-A

1 : 70

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
FILTER PRESS (POTONGAN A-A)	1 : 70

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
141		



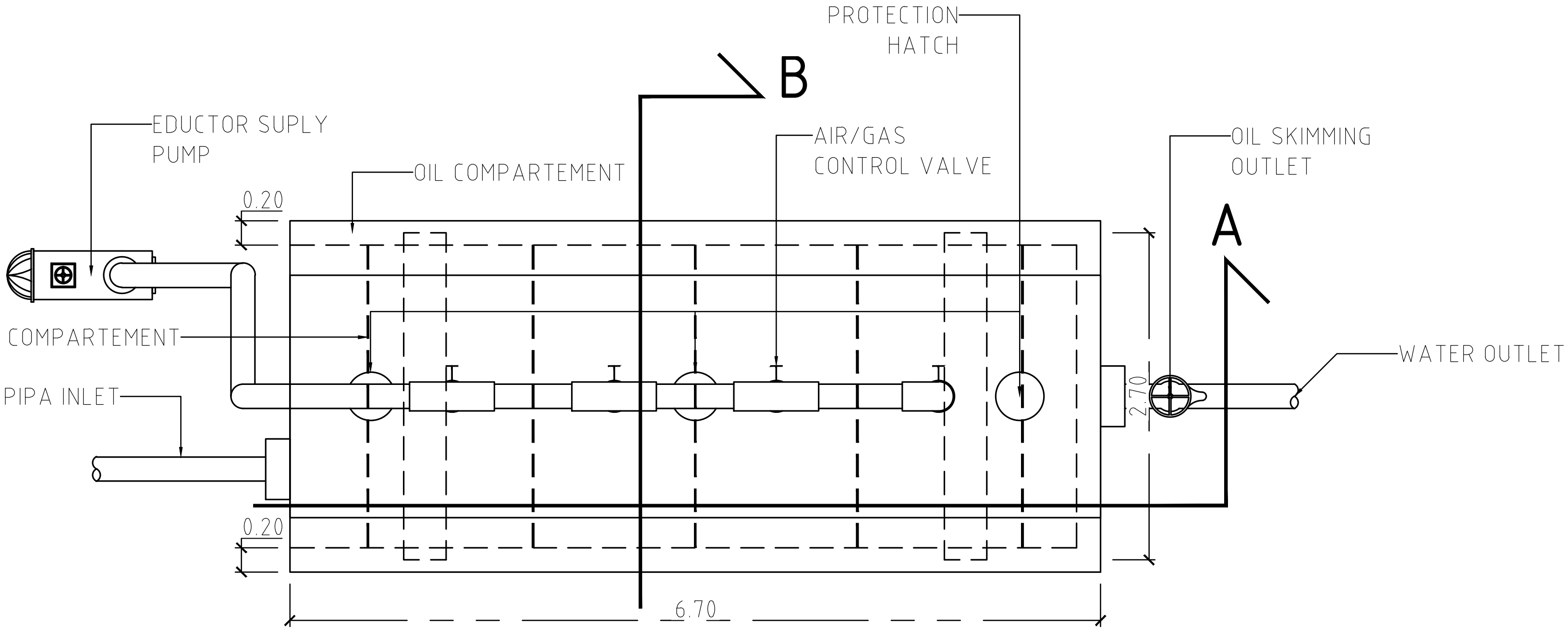
POTONGAN B-B

1 : 40

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
FILTER PRESS (POTONGAN B-B)	1 : 40

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
142		



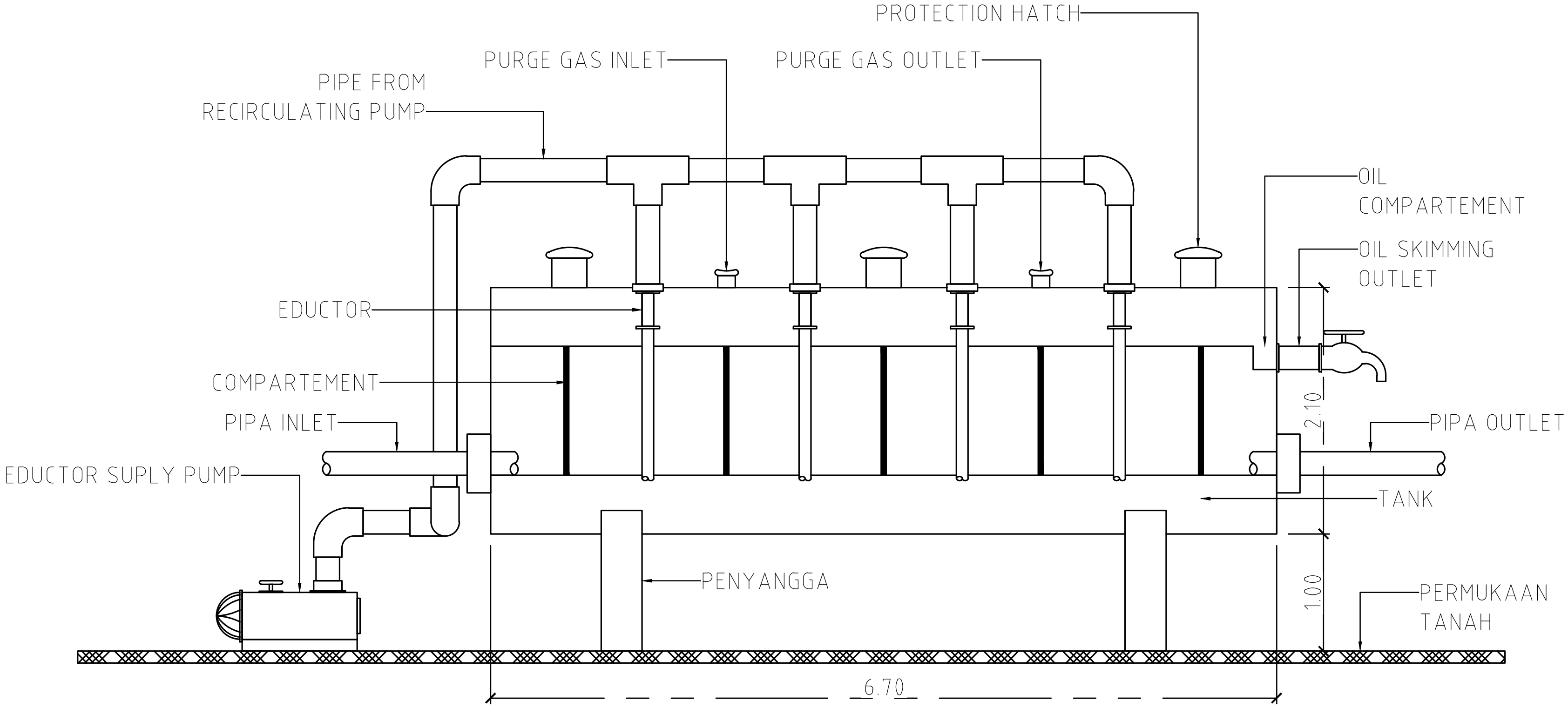
INDUCED GAS FLOTATION

1 : 60

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
INDUCED GAS FLOTATION	1 : 60

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
128		



POTONGAN A-A

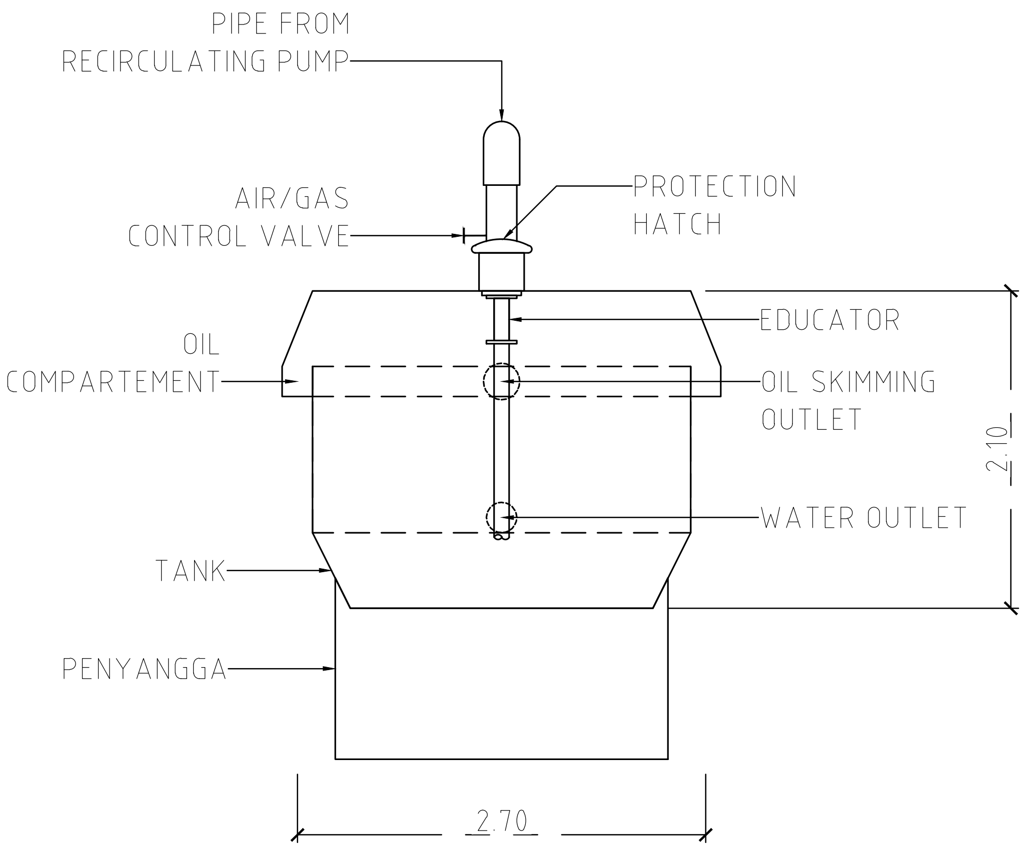
1 : 60

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN

DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
INDUCED GAS FLOTATION (POTONGAN A-A)	1 : 60

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
129		



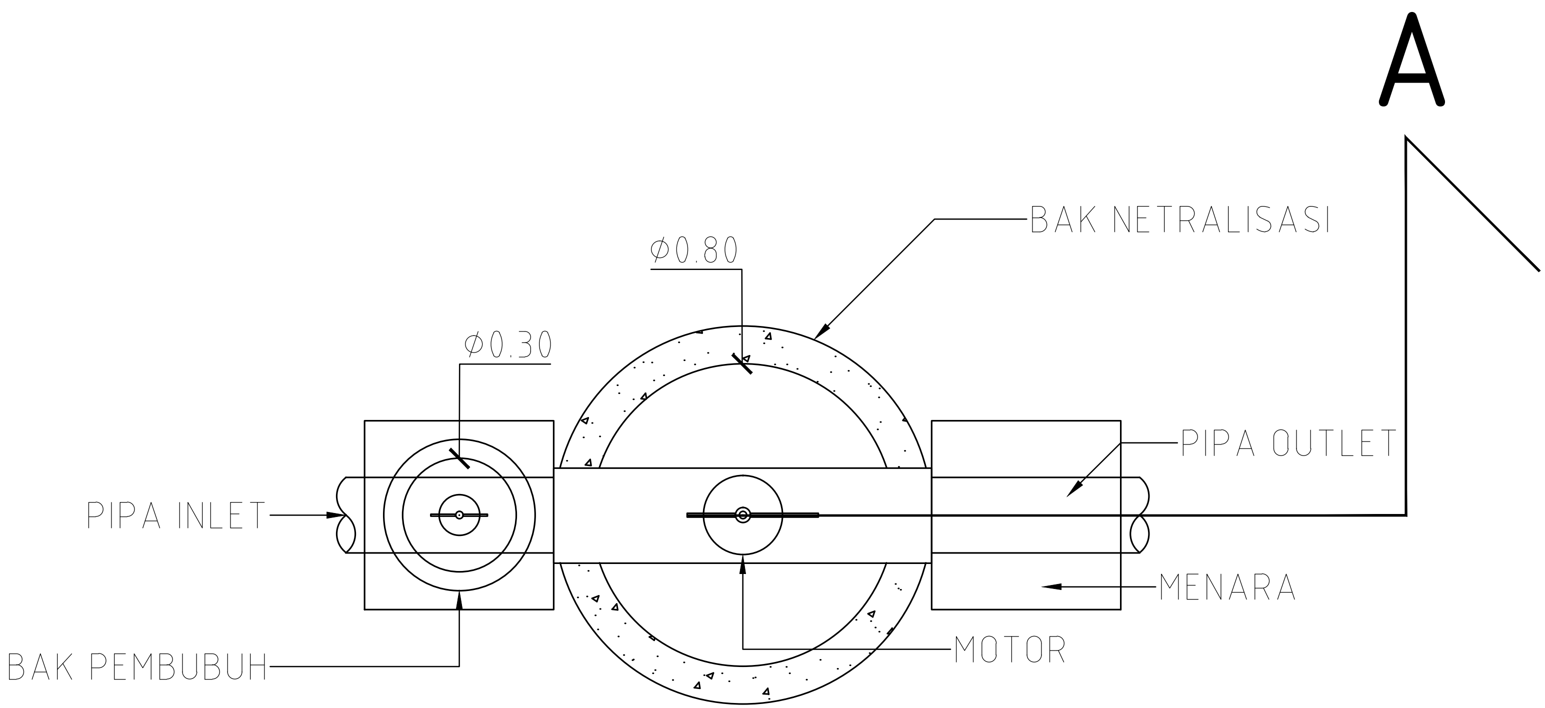
POTONGAN B-B

1 : 50

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
INDUCED GAS FLOTATION (POTONGAN B-B)	1 : 50

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
130		



BAK NETRALISASI

1 : 20

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN

DOSEN

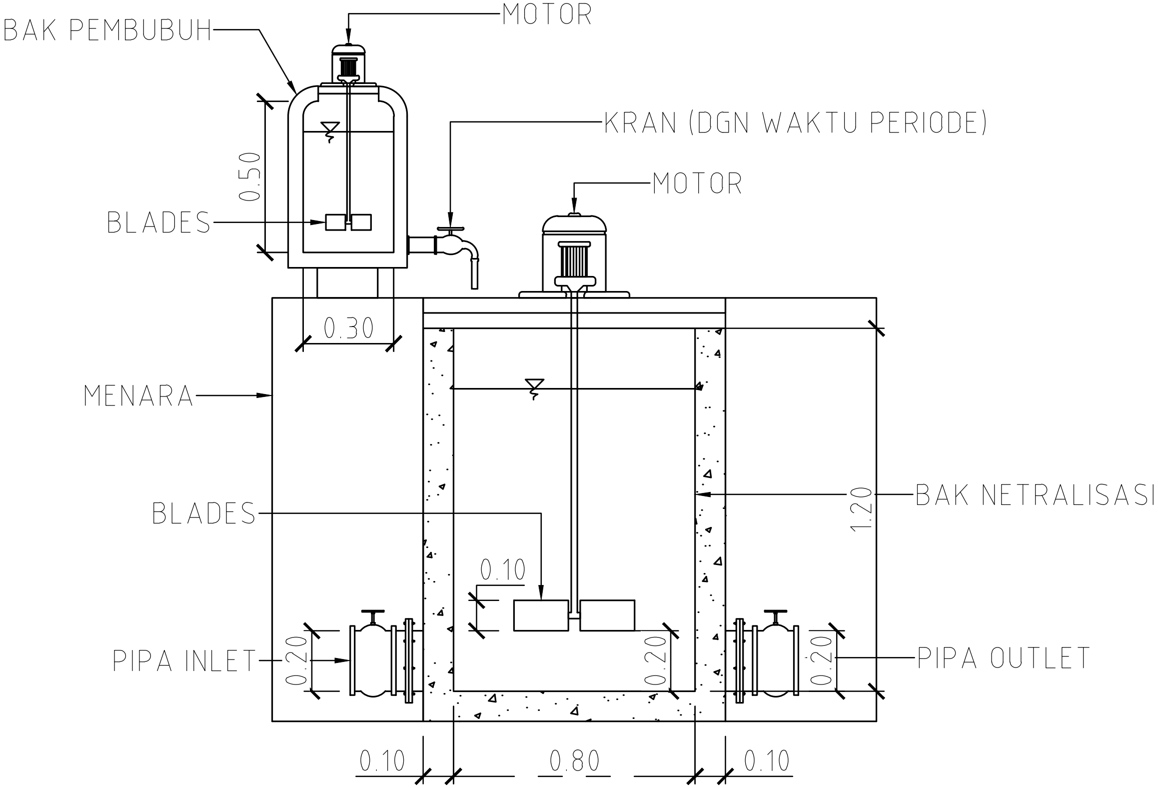
IR. YAYOK SURYO P., MS
FIRRA R., ST, MT

DOSEN PEMBIMBING

AULIA ULFAH F., ST. M.,Sc

MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
BAK NETRALISASI	1 : 20

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
131		



POTONGAN A-A

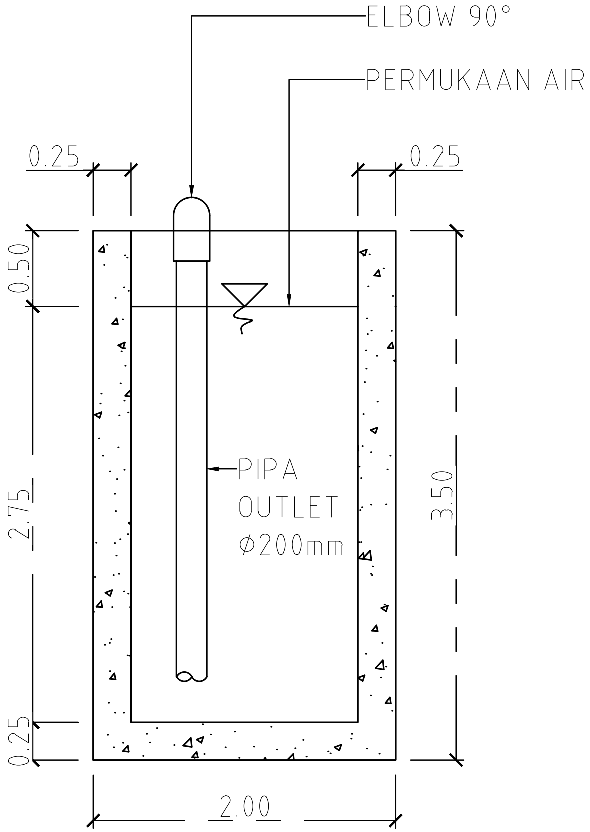
1 : 25

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN

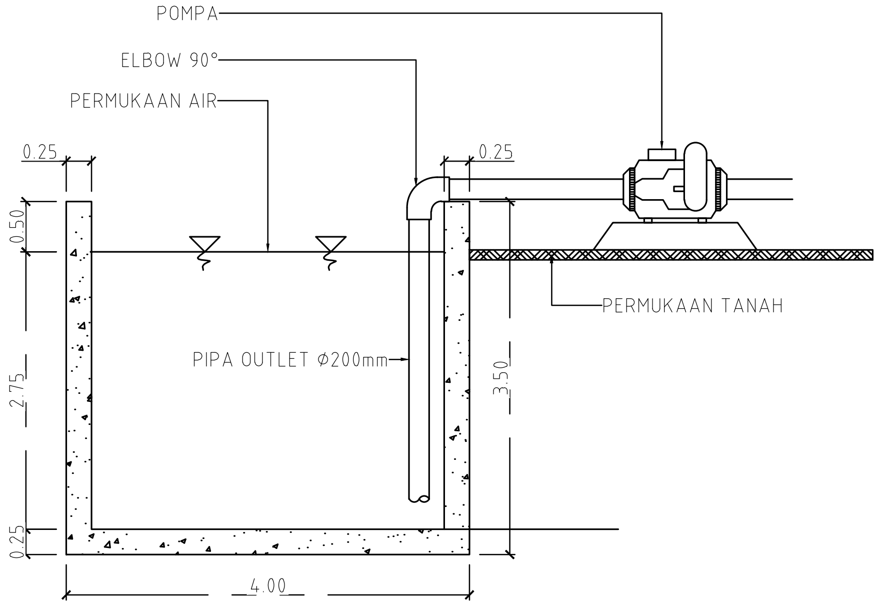
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH F., ST. M.,Sc	
MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
BAK NETRALISASI (POTONGAN A-A)	1 : 25

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
132		



POTONGAN A-A

1 : 50



POTONGAN B-B

1 : 75

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

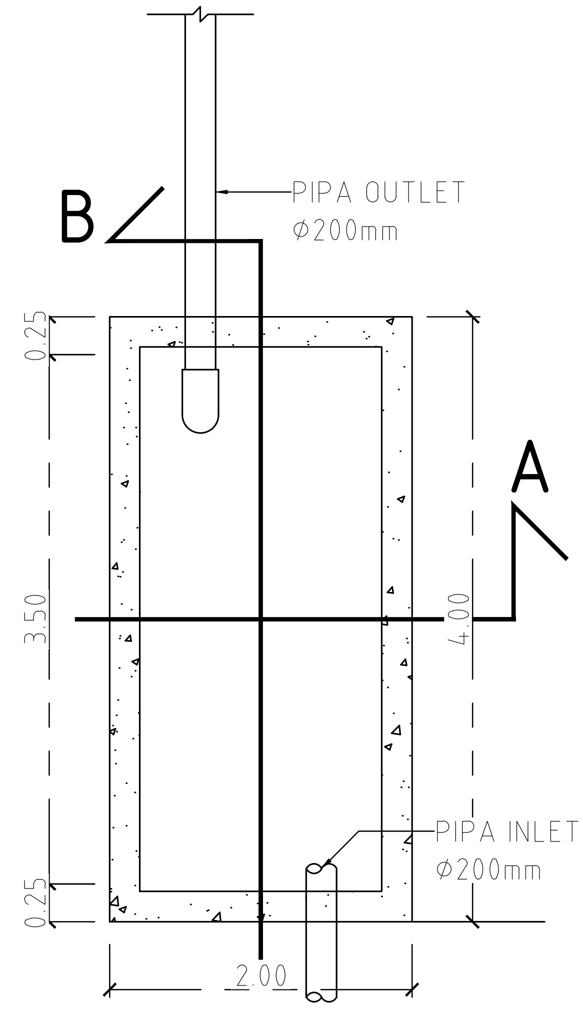
TUGAS PERENCANAAN

DOSEN
IR. YAYOK SURYO P., MS FIRRA R., ST, MT
DOSEN PEMBIMBING
AULIA ULFAH F., ST. M.,Sc

MAHASISWA	NPM
SISSAR EKA B.	1452010025

JUDUL	SKALA
SUMUR PENGUMPUL (POTONGAN A-A)	1 : 50
SUMUR PENGUMPUL (POTONGAN B-B)	1 : 75

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
124		



SUMUR PENGUMPUL

1 : 50

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN

DOSEN

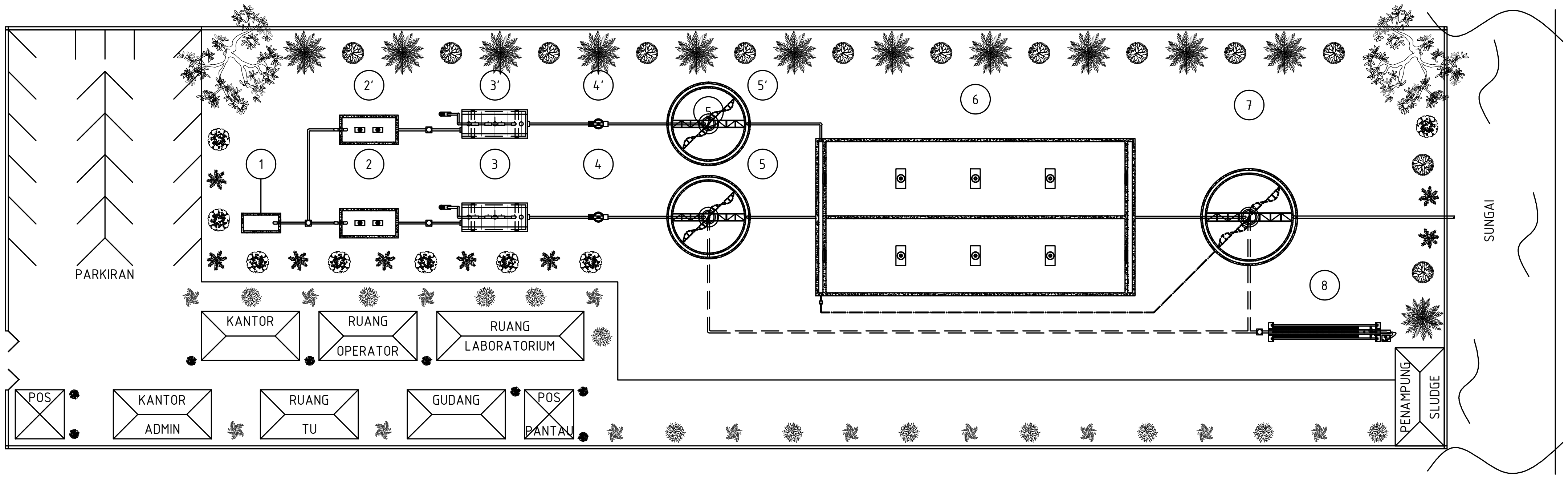
IR. YAYOK SURYO P., MS
FIRRA R., ST, MT

DOSEN PEMBIMBING

AULIA ULFAH F., ST. M.,Sc

MAHASISWA	NPM
SISSAR EKA B.	1452010025
JUDUL	SKALA
SUMUR PENGUMPUL	1 : 50

NO. LEMBAR	JUMLAH LEMBAR	DI PERIKSA
123		



LAYOUT
NTS

KETERANGAN	LEGENDA
1. SUMUR PENGUMPUL	POMPA
2. BAK EQUALISASI	SURFACE AERATOR
3. INDUCED GAS FLOTATION	PIPA LIMBAH
4. BAK NETRALISASI	PIPA SLUDGE
5. BAK PENGENDAP I (CLARIFIER)	PIPA RESIRKULASI
6. AERASI	
7. BAK PENGENDAP II (CLARIFIER)	
8. FILTER PRESS	
2'. BAK EQUALISASI SEBAGAI CADANGAN OPERASIONAL	
3'. IGF SEBAGAI CADANGAN OPERASIONAL	
4'. BAK NETRALISASI SEBAGAI CADANGAN OPERASIONAL	
5'. BAK PENGENDAP I SEBAGAI CADANGAN OPERASIONAL	

UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA TIMUR
FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN

DOSEN

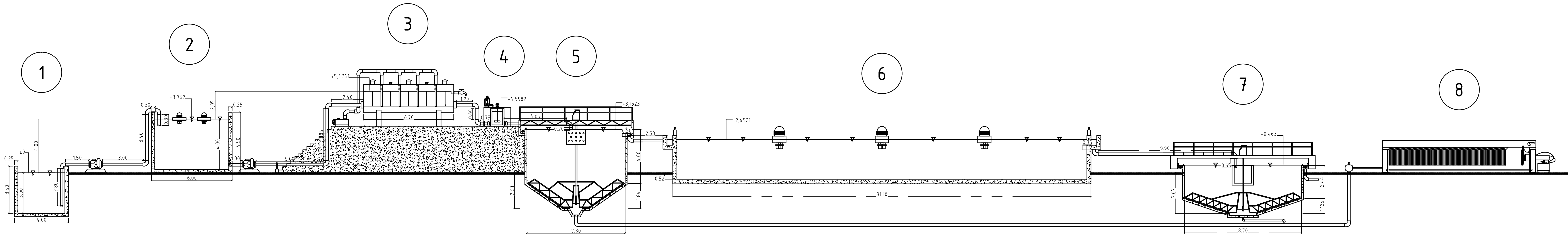
IR. YAYOK SURYO P., MS
FIRRA R., ST, MT

DOSEN PEMBIMBING

AULIA ULFAH ., ST. M.,Sc

MAHASISWA	NPM
SISSAR EKA BIMANTARA	1452010025
JUDUL	SKALA
LAYOUT	NTS

NO. LEMBAR	JUMLAH LEMBAR	DIPERIKSA
121		



PROFIL HIDROLIS

NTS

KETERANGAN	LEGENDA
1. SUMUR PENGUMPUL	POMPA
2. BAK EQUALISASI	SURFACE AERATOR
3. INDUCED GAS FLOTATION	KOMPRESOR
4. BAK NETRALISASI	POMPA SLUDGE
5. BAK PENGENDAP I (CLARIFIER)	KRAN
6. AERASI	
7. BAK PENGENDAP II (CLARIFIER)	
8. FILTER PRESS	

UNIVERSITAS PEMBANGUNAN NASIONAL
"VETERAN" JAWA TIMUR

FAKULTAS TEKNIK
JURUSAN TEKNIK LINGKUNGAN

TUGAS PERENCANAAN	
DOSEN	
IR. YAYOK SURYO P., MS FIRRA R., ST, MT	
DOSEN PEMBIMBING	
AULIA ULFAH., ST. M., Sc	
MAHASISWA	NPM
SISSAR EKA BIMANTARA	1452010025
JUDUL	SKALA
PROFIL HIDROLIS	1 : NTS

NO. LEMBAR	JUMLAH LEMBAR	DIPERIKSA
122		

= -2,63 + 5,84 m - 0,0577
= +3,1523 m

6. Aerasi

Kedalaman (H) = 3 m
Freeboard = 0,3 m
Elevasi Awal = -0,52 m
Lvl. Muka Air = Elevasi Awal + H – Hf total
= -0,52 + 3 - 0,0279
= +2,4521 m

7. Bak Pengendap II

Kedalaman (H) = 3,565 m
Freeboard = 0,3 m
Elevasi Awal = -3,03 m
Lvl. Muka Air = Elevasi Awal + H – Hf total
= -3,03 + 3,565 - 0,072
= +0,463 m