# BAB 5
# PERHITUNGAN BANGUNAN PENGOLAHAN AIR MINUM

## 5.1. UNIT INTAKE

### a) Perhitungan Pipa Inlet

Pada pengambilan air baku dari sungai, diperlukan pipa inlet untuk mengalirkan air ke sumur pengumpul. Berikut data-data yang direncanakan untuk pipa inlet air baku.

**Kriteria Perencanaan :**

| No. | Kriteria | Kriteria Desain |
|---|---|---|
| 1. | Kecepatan air masuk pipa inlet | 0,6 – 1,5 m/detik |

*Sumber : Kawamura, 1991.*

**Data Perencanaan :**

1. Direncanakan terdapat 3 pipa inlet untuk kondiri HWL (high water level), AWL (average water level), dan LWL (low water level)
2. Debit yang dibutuhkan : 170396,35 $m^3$/hari = 1,97 $m^3$/detik
3. Kedalaman sungai : 15 m
4. Panjang pipa (L)
   - L pipa HWL : 2 m
   - L pipa AWL :1,5 m
   - L pipa LWL :1 m
5. Kecepatan (v)
   - Pipa HWL : 0,6 m/s
   - Pipa AWL : 0,6 m/s
   - Pipa LWL : 0,6 m/s
6. Ketinggian (H)
   - Pipa HWL : 10 m
   - Pipa AWL : 7 m
   - Pipa LWL : 5 m

7. Menggunakan Pipa Cast Iron dengan nilai C = 130 *(Sumber : Evett & Liu, 1987)*
8. Nilai K *Gate Valve* = 0,19 *(Sumber : Qasim,2000)*

**Perhitungan**

- Debit tiap pipa

  Q $= \frac{Q_{Kapasitas\ Produksi}}{\Sigma jumlah\ pipa} = \frac{1{,}97\ m^3/dtk}{3}$ = 0,66 $m^3$/dtk

- Luas penampang pipa inlet A

  $A_{HWL} = \frac{Q_{tiappipa}}{V_{HWL}} = \frac{0{,}66\ m^3/dtk}{0{,}6\ m/dtk}$ = 1,1 $m^2$

  $A_{AWL} = \frac{Q_{tiappipa}}{V_{AWL}} = \frac{0{,}66\ m^3/dtk}{0{,}6\ m/dtk}$ = 1,1 $m^2$

  $A_{LWL} = \frac{Q_{tiap\ pipa}}{V_{LWL}} = \frac{0{,}66\ m^3/dtk}{0{,}6\ m/dtk}$ = 1,1 $m^2$

- Diameter pipa inlet

  $D_{HWL} = \left(\frac{4\times A_{HWL}}{\pi}\right)^{0,5} = \left(\frac{4\times 1{,}1}{3{,}14}\right)^{0,5}$ = 1,18 ≈ 1,2 m

  $D_{AWL} = \left(\frac{4\times A_{HWL}}{\pi}\right)^{0,5} = \left(\frac{4\times 1{,}1}{3{,}14}\right)^{0,5}$ = 1,18 m ≈ 1,2 m

  $D_{LWL} = \left(\frac{4\times A_{HWL}}{\pi}\right)^{0,5} = \left(\frac{4\times 1{,}1}{3{,}14}\right)^{0,5}$ = 1,18 m ≈ 1,2 m

  Memakai pipa dengan diameter 1,2 m sesuai dengan pipa yang tersedia di vendor https://indoprecast.com/jual/harga-pipa-beton/ .

- Check Kecepatan

  $V_{HWL} = \frac{Q}{¼\times\pi\times D^2} = \frac{0{,}66\ m^3/dtk}{¼\times 3{,}14\times(1{,}2)^2}$ = 0,58 m/dtk ≈ 0,6 m/dtk

  $V_{AWL} = \frac{Q}{¼\times\pi\times D^2} = \frac{0{,}66\ m^3/dtk}{¼\times 3{,}14\times(1{,}2)^2}$ = 0,58 m/dtk ≈ 0,6 m/dtk

  $V_{LWL} = \frac{Q}{¼\times\pi\times D^2} = \frac{0{,}66\ m^3/dtk}{¼\times 3{,}14\times(1{,}2)^2}$ = 0,58 m/dtk ≈ 0,6 m/dtk

- Headloss sepanjang pipa

  $Hf_{HWL} = \left(\frac{10{,}67\times Q^{1,85}}{C^{1,85}\times D^{4,87}}\right)\times L = \left(\frac{10{,}67\times 0{,}66^{1,85}}{130^{1,85}\times 1{,}2^{4,87}}\right)\times 2$ = 0,0005

  $Hf_{AWL} = \left(\frac{10{,}67\times Q^{1,85}}{C^{1,85}\times D^{4,87}}\right)\times L = \left(\frac{10{,}67\times 0{,}66^{1,85}}{130^{1,85}\times 1{,}2^{4,87}}\right)\times 1{,}5$ = 0,0004

Hf $_{LWL}$ $= \left(\frac{10,67 \times Q^{1,85}}{C^{1,85} \times D^{4,87}}\right) \times L = \left(\frac{10,67 \times 0,66^{1,85}}{130^{1,85} \times 1,2^{4,87}}\right) \times 1 = 0,00025$

- Slope Pipa Inlet (S)

  $S_{HWL} = \frac{Hf}{L} = \frac{0,0005}{2} = 0,00025$ m

  $S_{AWL} = \frac{Hf}{L} = \frac{0,0004}{1,5} = 0,00026$ m

  $S_{LWL} = \frac{Hf}{L} = \frac{0,00025}{1} = 0,00025$ m

- Head loss pada saat keluar dari pintu air

  $Hf_{HWL} = K \times \left(\frac{v^2}{2 \times g}\right) = 0,19 \times \left(\frac{0,6^2}{2 \times 9,81}\right) = 0,0035$

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  $Hf_{LWL} = K \times \left(\frac{v^2}{2 \times g}\right) = 0,19 \times \left(\frac{0,6^2}{2 \times 9,81}\right) = 0,0035$

**Resume Pipa Intake**

- Debit tiap pipa intake : 0,66 $m^3$/dtk
- Luas penampang pipa inlet

  A $_{HWL}$ = 1,1 $m^2$

  $A_{AWL}$ = 1,1 $m^2$

  $A_{LWL}$ = 1,1 $m^2$
- Diameter pipa inlet

  D $_{HWL}$ = 1,2 m

  D $_{AWL}$ = 1,2 m

  D $_{LWL}$ = 1,2 m
- Check kecepatan (v)

  V $_{HWL}$ = 0,6 m/s

  V $_{AWL}$ = 0,6 m/s

  V $_{LWL}$ = 0,6 m/s
- Slope

  S $_{HWL}$ = 0,00025 m

  S $_{AWL}$ = 0,00026 m

  S $_{LWL}$ = 0,00025 m

- Headloss pintu air

  $Hf_{HWL}$ = 0,0035 m

  $Hf_{AWL}$ = 0,0035 m

  $Hf_{LWL}$ = 0,0035 m

**b) Barscreen**

Sebelum air sungai masuk ke dalam pipa sadap air baku terlebih dahulu, air yang berasal dari sungai melewati *bar screen* yang berfungsi agar sampah dan kotoran-kotoran lain tidah ikut masuk dalam pipa sadap air baku. Data-data yang digunakan dan direncanakan dalam merencanakan *bar screen* adalah sebagai berikut :

**Kriteria Desain Perencanaan :**

| No. | Kriteria | Kriteria Desain |
|---|---|---|
| 1. | Jarak antar kisi (r) (medium)<br>(Droste, 1997; 287) | 20 - 50 mm = 0,02 – 0,05 m |
| 2. | Slope dengan horizontal (derajat) | 45° - 60° |
| 3. | Lebar kisi (r) | 4 - 8 mm = 0,004 – 0,008 m |
| 4. | Tebal kisi | 25 – 50 mm = 0,025 – 0,05 m |
| 5. | Kecepatan aliran melalui kisi (v)<br>(Nusa Idaman Said, hal 13) | 0,3 - 0,6 m/detik |
| 6. | Faktor bentuk kisi berbentuk bulat (β) | 1,79 |
| 7. | Head loss ($H_f$)<br>(Nusa Idaman Said, ) | 150-800 mm |

**Data Perencanaan :**

1. Screen yang dipakai Coarse Screen
2. Debit = 1972,18 L/dtk = 1,97 m3/dtk
3. Jumlah bar screen 3 buah di setiap pipa inlet
4. Debit tiap bar screen = $\frac{1,97}{3}$ = 0,66 m3/dtk

5. Lebar Screen (D) = diameter terbesar = 1,2 m (Disesuai diameter pipa inlet)
6. Lebar saluran (Ws) = 1,2 m (Disesuaikan dengan diameter pipa inlet)
7. Lebar kisi (d) = 4 mm = 0,004 m
8. Kemiringan kisi (β ) = 45º
9. Jarak antar kisi (r) = 0,03 m
10. Faktor bentuk kisi berbentuk bulat (β) = 1,79 (Circular)

**Perhitungan :**

- Dimensi Screen

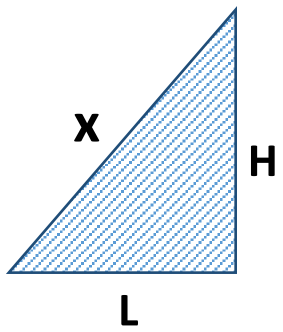
Tinggi bangunan screen (H) $= \sqrt{\frac{4\times(\frac{Q}{v})}{\pi}}$

$= \sqrt{\frac{4\times(\frac{0,66}{0,6})}{3,14}}$

$= 1,18 \approx 1,2$ m

Lebar bangunan screen (L) $= \frac{H}{Tg\ \alpha} = \frac{1,2}{Tg\ 45} = 1,2$ m

Kemiringan screen (X) $= \frac{H}{sin\ \alpha} = \frac{1,2}{sin\ 45} = 1,69 \approx 1,7$ m




- Jumlah kisi (n)

| | |
|---|---|
| Ws | = n × d + (n+1) × r |
| 1,2 | = n × 0,004 + (n + 1) × 0,03 |
| 1,2 | = 0,004n + 0,03n + 0,03 |
| 1,2 – 0,03 | = 0,034n |
| 1,17 | = 0,034 n |

n $= \frac{1,17}{0,034}$

n = 34,4 ≈ 35 kisi

- Check r

Ws = n × d + (n+1) × r

1,2 = 35 × 0,004 + (35 + 1) × r

1,2 = 0,14 + 36r

r $= \frac{1,2-0,14}{36}$

= 0,029 ≈ 0,03 Memenuhi (Range 0,02-0,05)

- Kecepatan melalui *Barscreen*

Vc $= \frac{Q}{A} = \frac{4 \times 0,66\ m^3/dtk}{3,14 \times (1,2)^2}$ = 0,58 ≈ 0,6 m/dtk (memenuhi 0,3-0,6 m/dtk)

- Menghitung area terbuka dari *screen*

Total lebar area terbuka (w) = n × r

= 35 buah × 0,03

= 1,05 m

Total penampang area terbuka (b) = (n-1) × r

= (29-1) × 0,03

= 1,02 m

- Mencari *velocity head*

Hv $= \frac{Vc}{2g} = \frac{0,6\ m/dtk}{2 \times 9,81}$ = 0,03 m/dtk

- Head Loss

Hf $= \beta \left(\frac{W}{b}\right)^{4/3} \times 0,043 \times sin\alpha$

$= 1,79 \times \left(\frac{1,05}{1,02}\right)^{4/3} \times 0,043 \times \sin 45$

= 0,57 m = 570 mm Headloss memenuhi (150-800 mm)

**Resume Barscreen**

- Panjang screen (x) = 1,7 m
- Lebar screen (L) = 1,2 m
- Tinggi screen (h) = 1,2 m

- Kecepatan pada bar screen (v) = 0,6 m/s
- Jarak antar kisi (r) = 0,03 m
- Diameter kisi (d) = 0,004 m
- Jumlah kisi (n) = 35 buah
- Kemiringan kisi = 45°
- Headloss = 0,57 m

**c) Sumur Pengumpul**

Sumur pengumpul berfungsi untuk mengumpulkan air baku dari sungai untuk mengantisipasi terjadinya fluktuasi air sungai. Level air sungai yang fluktuatif dapat mempengaruhi kinerja dari Instalasi Pengolahan Air Minum, sehingga dikhawatirkan proses pengolahan tidak berjalan dengan maksimal.

**Kriteria Perencanaan:**

| No. | Kriteria | Kriteria Desain |
|---|---|---|
| 1. | Waktu detensi | (1-5) menit |
| 2. | Tinggi *foot valve* dari dasar sumur | > 0,6 m |
| 3. | Konstruksi kedap air dan tebal dinding | ≥ 20 cm |
| 4. | Kemiringan dasar sumur | 1 – 2 % |

*Sumber: PERMEN PU, 2007.*

**Data perencanaan pada sumur pengumpul :**

1. Jumlah sumur : 1 sumur pengumpul
2. Waktu detensi (td) = 4 menit = 240 detik
3. Free board = 1 m
4. Kedalaman lumpur = 1 m
5. Kedalaman sungai = 15 m
6. Ketinggian air sungai : 15 m
7. H pipa

   $H_{HWL}$ = 10 meter

$H_{AWL}$ = 7 meter

$H_{LWL}$ = 5 meter

**Perhitungan :**

- Debit Sumur

  Q = $\frac{Q\ kapasitas\ produksi}{jumlah\ sumur}$ = = $\frac{1{,}97\ m^3/detik}{1}$ = 1,97 $m^3$/detik

- Volume Bak Sumur

  V = Q × td

  = 1,97 m3/detik × 240 detik

  = 472,8 $m^3$

- Tinggi Efektif Sumur Pengumpul ($H_{ef}$)

  $H_{ef}$ = $H_{HWL}$ + Freeboard + H lumpur

  = 10 m + 1 m + 1,5 m

  = 12,5 m

- Luas Bak (A)

  A = $\frac{volume}{H_{total}}$ = $\frac{472{,}8}{12{,}5}$ = 37,8 $m^2$

- Dimensi Sumur Pengumpul (panjang : lebar = 0,8 : 1)

  A = l × p

  37,8 m2 = l × 0,8 l

  37,8 m2 = 0,8 l2

  l = $\sqrt{47{,}25}$ = 6,87 m = 7 m

  maka :

  p = 0,8 × l

  = 2 × 7

  = 5,6 m

- Check Volume

  V = p × l × H

  = 5,6 m × 7 m × 12,5 m

  = 490 $m^3$

- Cek td

  Td $= \frac{v}{Q} = \frac{490\ m^3}{1{,}97 m^3/dtk \times 60\ dtk}$ = 4,15 mnt

**Resume bangunan Sumur Pengumpul :**

- Debit sumur = 1,97 $m^3$/dtk
- Volume bak = 490 m3
- Luas bak (A) = 37,8 m2
- Panjang bak = 5,6 m
- Lebar bak = 7 m
- Tinggi bak = 12,5 m
- Waktu detensi = 4,15 mnt

**d) Pipa Penguras**

Pipa penguras berfungsi untuk menguras lumpur endapan dari sumur pengumpul, hal ini bertujuan untuk mengantisipasi tidak terjadinya peningkatan kekeruhan air baku dan pendangkalan akibat endapan lumpur.

**Data perencanaan :**

1. Kecepatan aliran = 1 m/dtk
2. Waktu detensi (td) = 10 mnt = 600 dtk

**Perhitungan :**

- Debit lumpur

  $Q_{lumpur} = \frac{1}{3} \times Q_{sumur\ pengumpul} = \frac{1{,}97\ m^3/dtk}{3}$ = 0,66 $m^3$/dtk

- Debit tiap pipa

  Q $= \frac{Q_{lumpur}}{2} = \frac{0{,}66}{2}$ = 0,33$m^3$/dtk

- Luas permukaan (A)

  A $= \frac{Q}{v} = \frac{0{,}33\ m^3/dtk}{1\ m/dtk}$ = 0,33 $m^2$

- Diameter pipa

D $= \sqrt{\frac{4 \times Q}{\pi}} = \sqrt{\frac{4 \times 0,33}{3,14}} = 0,65$ m

Memakai pipa 630 mm sesuai vendor https://www.rucika.co.id/wp-content/uploads/2019/08/Brosur-Rucika-Black-2018.pdf.

- Cek kecepatan (v)

V $= \frac{Q}{\frac{1}{4} \times \pi \times D^2} = \frac{0,33}{\frac{1}{4} \times 3,14 \times 0,63^2} = 1,1$ m/dtk

**Resume pipa penguras :**

- Debit lumpur = 0,33 $m^3$/detik
- Jumlah pipa = 2
- Diameter pipa = 630 mm = 24" inch
- Luas permukaan = 0,33 m2
- Cek kecepatan = 1,1 m/dtk

**e) Perhitungan Pompa**

Pompa mempunyai fungsi yang sangat penting dalam kelancaran proses pengolahan antara lain dapat menaikkan level muka air ke daerah yang lebih tinggi. **Pompa = (Suction = Discharge)**

**Kriteria Perencanaan:**

1. Kecepatan (V) = 0,3 – 2,5 m/s

**Data perencanaan :**

1. Debit = 1,97 $m^3$/dtk
2. Jumlah pompa = 4
3. Debit tiap pompa =1,97 $m^3$/dtk : 4 = 0,5 $m^3$/dtk

**Perhitungan**

- Luas permukaan pipa :

A $= \frac{Q}{V} = \frac{0,5\ m^3/dtk}{2\ m/dtk}$ = 0,25 $m^2$

- Diameter pipa suction

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

$= \sqrt{\frac{4 \times 0,25}{3,14}}$

= 0,56 m

Menggunakan pipa berdiameter 560 mm sesuai dengan pipa yang tersedia di vendor https://www.rucika.co.id/wp-content/uploads/2019/08/Brosur-Rucika-Black-2018.pdf.

- Cek kecepatan

V $= \frac{Q}{\frac{1}{4} \times \pi \times D^2} = \frac{0,5\ m^3/dtk}{\frac{1}{4} \times 3,14 \times 0,56^2}$ = 2m/dtk (memenuhi range = 0,3- 2,5 m/s)

- Headloss pompa
  - Head Statis = 11 m
  - L pipa Discharge = 10 m
  - H suction = 18 m

- Headloss mayor

Hf Discharge $= \left(\frac{Q}{0,2785 \times c \times D^{2,63}}\right)^{1,85} \times L$

$= \left(\frac{0,5}{0,2785 \times 130 \times 0,56^{2,63}}\right)^{1,85} \times 10$

= 0,061 m

Hf Suction $= \left(\frac{Q}{0,2785 \times c \times D^{2,63}}\right)^{1,85} \times L$

$= \left(\frac{0,5}{0,2785 \times 130 \times 0,56^{2,63}}\right)^{1,85} \times 18$

= 0,12 m

Hf Statis $= \left(\frac{Q}{0,2785 \times c \times D^{2,63}}\right)^{1,85} \times L$

$= \left(\frac{0,5}{0,2785 \times 130 \times 0,56^{2,63}}\right)^{1,85} \times 11$

= 0,067 m

Hf Mayor total = Hf Discharge + H suction  Hf Statis

= 0,061 + 0,12 + 0,067

= 0,248 m

- Headloss minor
  - Head kecepatan suction dan discharge $= \frac{v}{2 \times g}$

    $= \frac{2\ m/dtk}{2 \times 9,81}$

    = 0,1 m
  - Hf foot valve  belokan = 1 buah = k =2,3

    Hf $= n \times K \times \frac{v}{2 \times g}$

    = 1 × 2,3 × 0,1

    = 0,23
  - Hf minor belokan   n belokan = 2 buah = k = 0,9

    Hf $= n \times K \times \frac{v}{2 \times g}$

    = 2 × 0,9 × 0,1

    = 0,18 m
  - Hf minor total = H kec. Discharge + Hfm Foot Valve + Hfm belok

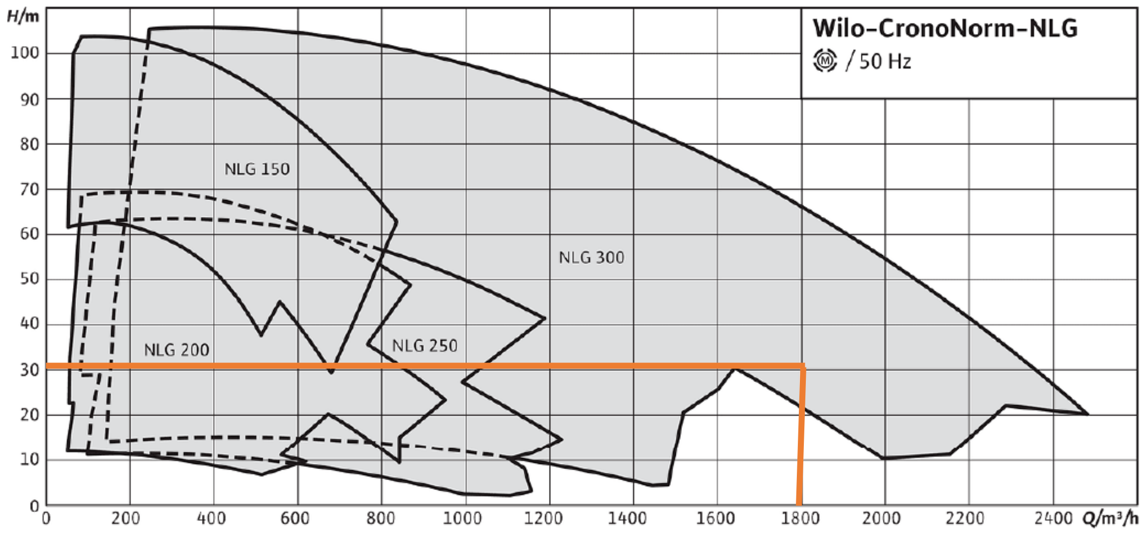
    = 0,1 m + 0,23 m + 0,18 m

    = 0,51 m
  - Hf total = Hs + Hf Mayor total + Hf minor total

    = 11 m + 0,248 m + 0,51 m

    = 11,43 m

Didapatkan Q sebesar 0,5 $m^3$/s = 1800 $m^3$/jam dengan head sebesar 13 m, diperoleh tipe pompa DCZ250-315 Pumps dengan model petrochemical prosess pump.




Wilo-CronoNorm-NLG

## Product list

| Product description | Number of poles | Motor efficiency class | Nominal flange diameter | Mechanical seal | Rated power $P_2$ | Gross weight, approx. $m$ | Article number |
|---|---|---|---|---|---|---|---|
| CronoNorm-NLG 300/400-75/4 | 4 | IE3 | DN 300 | AQ1EGG | 75 kW | 1794 kg | 4452624 |
| CronoNorm-NLG 300/400-90/4 | 4 | IE3 | DN 300 | AQ1EGG | 90 kW | 1864 kg | 4452625 |
| CronoNorm-NLG 300/400-110/4 | 4 | IE3 | DN 300 | AQ1EGG | 110 kW | 2143 kg | 4452626 |
| CronoNorm-NLG 300/400-132/4 | 4 | IE3 | DN 300 | AQ1EGG | 132 kW | 2203 kg | 4452627 |
| CronoNorm-NLG 300/400-160/4 | 4 | IE3 | DN 300 | AQ1EGG | 160 kW | 2273 kg | 4452628 |
| CronoNorm-NLG 300/400-200/4 | 4 | IE3 | DN 300 | AQ1EGG | 200 kW | 2525 kg | 4453350 |
| CronoNorm-NLG 300/315-45/4 | 4 | IE3 | DN 300 | AQ1EGG | 45 kW | 1052 kg | 4461275 |
| CronoNorm-NLG 300/315-55/4 | 4 | IE3 | DN 300 | AQ1EGG | 55 kW | 1224 kg | 4461276 |
| CronoNorm-NLG 300/315-75/4 | 4 | IE3 | DN 300 | AQ1EGG | 75 kW | 1424 kg | 4461277 |
| CronoNorm-NLG 300/550-200/4 | 4 | IE3 | DN 300 | AQ1EGG | 200 kW | 2620 kg | 4461278 |
| CronoNorm-NLG 300/550-250/4 | 4 | IE3 | DN 300 | AQ1EGG | 250 kW | 2757 kg | 4461279 |
| CronoNorm-NLG 300/550-315/4 | 4 | IE3 | DN 300 | AQ1EGG | 315 kW | 3107 kg | 4461280 |
| CronoNorm-NLG 300/550-355/4 | 4 | IE3 | DN 300 | AQ1EGG | 355 kW | 3235 kg | 4461281 |
| CronoNorm-NLG 300/550-400/4 | 4 | IE3 | DN 300 | AQ1EGG | 400 kW | - | 4461282 |
| CronoNorm-NLG 300/550-450/4 | 4 | IE3 | DN 300 | AQ1EGG | 450 kW | - | 4461283 |

f) **Perhitungan Strainer**

Strainer berbentuk kubus, yang dimana kubus memiliki 6 luas penampang, namun karena salah satu penampangnya digunakan sebagai masuknya pipa suction

**Kriteria Perencanaan :**

1. Kecepatan melalui lubang striner = 0,15 – 0,3 m/s
2. Bukaan pada lubang strainer = 6-12 mm
3. Diameter strainer (D) = 1,5-2 × Dsuction

   *Sumber : Prosser, 1980*

**Data perencanaan**

1. Direncanakan bentuk strainer kubus berlubang
2. Q = 1,97 $m^3$/dtk
3. Debit tiap unit = $\frac{1,97}{4}$ = 0,5 $m^3$/dtk
4. Diameter lubang = 30 mm = 0,03 m
5. Diameter pipa inlet
   - $D_{HWL}$ = 1,2 m
   - $D_{AWL}$ = 1,2 m
   - $D_{LWL}$ = 1,2 m
6. D suction = 0,6 m = 50,4 inch

**Perhitungan**

- Luas permukaan strainer

  A = $\frac{Q}{v} = \frac{0,5\ m^3/dtk}{0,3\ m/dtk}$ = 1,7 $m^2$
- Diameter Stainer

  1,5 × D suction = 1,5 × 0,6 = 0,9 m
- Dimensi

  A = S × S

  1,7 $m^2$ = $S^2$

  S = 1,3 $m^2$

- Luas lubang

  AL $= \frac{1}{4} \times \pi \times S^2$

  = ¼ × 3,14 × 0,032

  = 0,00071 m
- Jumlah lubang

  n $= \frac{luas\ permukaan}{Al} = \frac{1,7}{0,00071}$ = 2395 buah
- Jumlah lubang tiap sisi

  $\frac{n}{s} = \frac{2395}{1,3}$ = 1842 buah
- Jarak Stainer dari dasar sumur = ½ × D strainer

  = ½ × 0,6 m

  = 0,3 m
- Jarak ujung stainer ke permukaan air =1,5 × D stainer

  = 1,5 × 0,6 m

  = 0,9 m
- Jarak ujung stainer ke dinding sumur = ¼ × Dstainer

  = ¼ × 0,6

  = 0,15 m

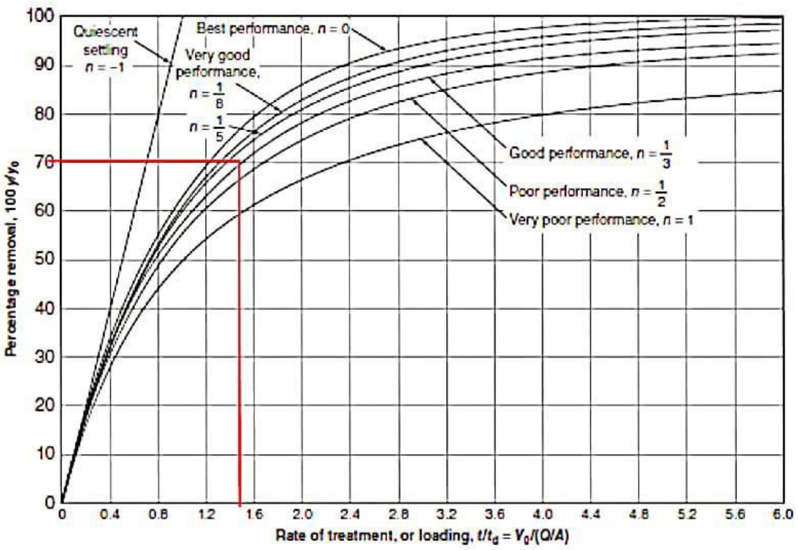
## 5.2. Prasedimentasi

Bangunan prasedimentasi adalah bangunan yang berfungsi untuk mengendapkan partikel – partikel diskrit yang terkandung dalam air baku. Pengendapan didalam bangunan prasedimentasi dilakukan dengan secara gravitasi.

**Kriteria perencanaan :**

1. Waktu detensi = 1,5 – 2,5 jam (tipikal 2 jam)
   (Metcalf & eddy, 2003 : 398)
2. Q = 1972,18 L/s = 1,97 m3/s
3. Jumlah unit = 4 unit
4. Q tiap unit = $\frac{1{,}97\ m^3/s}{4}$ = 0,5 m3/s
5. % Removal yang diinginkan = 70%

Maka diplotkan pada grafik performa dibawah ini




Berdasarkan grafik diatas untuk persen removal 70% untuk *Good Performance* maka

$\frac{t}{td} = \frac{V_0}{Q/A} = 1{,}5$

Tes kolom dilakukan dengan ketinggian kolom 3 m selama 1 jam

$V_0 = \frac{H}{t} = \frac{3}{1 \times 3600} = 0{,}000833$ m/s

$\frac{t}{td} = \frac{Q}{A} = \frac{V_0}{1{,}5}$

$\frac{t}{td} = \frac{Q}{A} = 0.0005556$ m/s

**a) Zona Inlet**

Zona inlet berfungsi untuk mengalirkan air baku ke bangunan prasedimentasi. Zona inlet harus didesain sedemikian rupa agar proses pengaliran ke bak prasedimentasi dapat berjalan dengan baik.

**Kriteria perencanaan :**

1. Direncanakan saluran berbentuk persegi empat
2. Debit air baku (Q) = 1,97 $m^3/s$
3. Kecepatan aliran (v) = 0,6 m/s
4. Panjang Saluran (L) = 17,3 m
5. Freeboard = 10 – 30%
6. Koefisien manning (n) = 0,013 (Tata Cara Perencanaan Sistem Drainase Perkotaan, Nomor 12/PRT/M/2014)

**Perhitungan**

- Luas penampang (A) = Q/V

  $= \frac{0{,}5\ m^3/s}{0{,}6\ m/s}$

  = 0,83 $m^2$

- Diasumsikan Lebar (B) : Kedalaman (H) = 2 : 1

  A = B × H

  0,83 = 2H × H

  $H^2$ = 0,42

  H = 0,65

Maka :

B $= 2H$

$= 2 \times 0{,}65 = 1{,}3$ m

H total $= H +$ Freeboard (30%)

$= 0{,}65 + 0{,}3$

$= 0{,}95$ m

- Jari – jari hidrolis

R $= \frac{LuasKelilingBasah}{KelilingPenampangBasah}$

$= \frac{B \times H}{B + 2H}$

$= \frac{1{,}3 \times 0{,}95}{1{,}3 + (2 \times 0{,}95)}$

$= 0{,}38$ m

- Slope Saluran

S $= \left(\frac{V \times n}{R^{2/3}}\right)^2$

$= \left(\frac{0{,}6 \times 0{,}013}{0{,}38^{2/3}}\right)^2$

$= 0{,}00023$ m/m

- Cek kecepatan

V $= \frac{Q}{A} = \frac{0{,}5}{0{,}83} = 0{,}6$ m/s (memenuhi)

- Headloss inlet

Hf $= s \times L$

$= 0{,}00023$ m/m $\times$ 5 m

$= 0{,}00115$ m

- Headloss saat keluar (K gate valve = 0,2)

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

$= 0{,}2 \times \frac{o{,}6^2}{2 \times 9{,}81}$

$= 0{,}004$

**Resume :**

- Luas permukaan (A) = 0,83 $m^2$
- Lebar (B) = 1,3 m
- Kedalaman (H) = 0,95 m
- Panjang = 17,3 m
- Slope saluran = 0,00023
- Jari – jari hidrolis = 0,37 m
- Kecepatan = 0,6 m/s

**b) Zona Pengendapan**

Zona pengendapan merupakan area yang berfungsi sebagai area pengendapan dari bangunan pra-sedimentasi. Zona pengendapan ini untuk mengendapkan partikel – partikel kasar pada air baku yang dapat mengendapkan dengan sendirinya tanpa penambahan zat kimia.

- **Dimensi zona pengendapan**

**Kriteria perencanaan :**

1. Debit air baku (Q) = 1,97 m3/dtk
2. Jumlah bak = 4 unit
3. Debit tiap bak (Qbak) = 0,5 m3/detik
4. Waktu detensi (td) = 1 jam = 3600detik
5. Kedalaman (h) = 3 m
6. Freeboard = 30%
7. Kecepatan (v) = 1 m/detik
8. Suhu air = 30°C; $\upsilon$ = 0,8039×10-6 m2/dtk; $\rho$ = 995,68 kg/m3; $\mu$ = 0,008004 kg/m.s (*Sumber : Reynold & Richards, 1996; 762.*)
9. K = 0,05
10. Factor friksi Darcy-weisback (f) = 0,025
11. Specific gravity (Sg) = 2,65 (*Masduqi & Assomadi, 2012*)

**Perhitungan**

- Kecepatan aliran ($V_0$) $= \frac{h}{td} = \frac{3}{3600}$ = 0,000833 m/detik
- Luas bak (A) $= \frac{Q_{bak}}{v_0} = \frac{0,5}{0,000833}$ = 600,24 $m^2$
- Diasumsikan Panjang (L) : Lebar (B) = 2 : 1

  Asumsi L = B, maka :

  A = L × B

  600,24 = 2B × B

  600,24 = 2B2

  $B^2$ = 300,12

  B = 17,3 m

  Panjang (L) = 2B

  = 2 × 17,3

  = 34,6 m
- Kecepatan horizontal (Vh) $= \frac{L}{td} = \frac{34,6}{3600}$ = 0,00961 m/detik
- Diameter partikel (d) $= \left(\frac{18 \times v_0 \times \mu}{(Sg-1)g}\right)^{1/2}$

  $= \left(\frac{18 \times 0,000833 \times 0,008004}{(2,65-1)9,81}\right)^{1/2}$

  = 0,002723 m
- Kecepatan scoring ($V_{sc}$) $= \left(\frac{8.k(Sg-1)d.g}{f}\right)^{1/2}$

  $= \left(\frac{8 \times 0,05(2,65-1)0,002723 \times 9,81}{0,025}\right)^{1/2}$

  = 0,8398 m/detik
- Jika nilai vh< vsc maka tidak terjadi penggerusan
- Kontrol Froud Number (Nfr) $= \frac{{v_h}^2}{g \times R}$

  $= \frac{0,00961^2}{9,81 \times 0,37}$

  $= 2,54 \times 10^{-5}$

- Kontrol Reynold Number (Nre) $= \frac{v_h \times R}{v}$

$= \frac{0{,}00961 \times 0{,}37}{0{,}8039 \times 10^{-6}} = 4423{,}1$

Nilai $N_{re} < 2000$ dan $N_{fr} < 10^{-5}$, jika tidak sesuai maka aliran dapat dikatakan turbulen. Pada perhitungan di atas nilai $N_{re} > 2000$ dan $N_{fr} > 10^{-5}$, perlu direncanakan perforated baffle pada bak sedimentasi agar aliran menjadi laminar.

➢ **Perforated Baffle**

**Kriteria Perencanaan :**

1. *Perforated baffle* dipasangkan di zona inlet
2. Diameter lubang (Dlubang) = 0,18 m
3. Panjang baffle = panjang zona inlet = 17,3 m
4. Tinggi baffle = tinggi zona inlet = 0,95 m
5. Asumsi kecepatan aliran melalui lubang (v) = 0,6 m/detik

**Perhitungan**

- Luas tiap lubang (A) $= \frac{1}{4} \times \pi \times D_{lubang}^2$

$= \frac{1}{4} \times 3{,}14 \times 0{,}15^2$

$= 0{,}018\ m^2$

- Luas total lubang $= \frac{Q_{tiap\ bak}}{0{,}6 \times v}$

$= \frac{0{,}5\ m^3/detik}{0{,}6 \times 0{,}6\ m/detik}$

$= 1{,}38\ m^2$

- Jumlah lubang (n) $= \frac{Luas\ total\ lubang}{Luas\ tiap\ lubang}$

$= \frac{1{,}38}{0{,}015}$

$= 76{,}6$ lubang $\approx 78$

Sehingga jumlah lubang horizontal = 26, jumlah lubang vertical = 3

- Jarak horizontal antar lubang (sh) $= \frac{panjang\ buffle - (\sum lubang \times d)}{(\sum lubang + 1)}$

  $= \frac{17,3 - (26 \times 0,15)}{(26 + 1)}$

  = 0,5 m

- Jarak vertikal antar lubang (sv) $= \frac{tinggi\ buffle - (\sum lubang \times d)}{(\sum lubang + 1)}$

  $= \frac{0,95 - (3 \times 0,15)}{(3 + 1)}$

  = 0,13 m

- Jari – jari hidrolis (R) = ¼ × D

  = ¼ × 0,15 m

  = 0,0375 m

- Kontrol bilangan froud (Nfr) $= \frac{{v_h}^2}{g \times R}$

  $= \frac{0,00961^2}{9,81 \times 0,0375}$

  $=2,5 \times 10^{-4} > 10^{-5}$ (memenuhi)

- Kontrol bilangan Reynold ($N_{re}$) $= \frac{v_h \times R}{v}$

  $= \frac{0,00961 \times 0,0375}{0,8039 \times 10^{-6}}$

  = 448,3 < 2000 (memenuhi)

- Headloss *perforated baffle* (hv) $= \frac{v^2}{2.g}$

  $= \frac{0,00961^2}{2 \times 9,81} = 0,422 \times 10^{-5}$ m

**Resume :**

- Luas bak pengendap (A) = 600,24
- Panjang bak pengendap (L) = 34,6 m
- Lebar bak pengendap (B) = 17,3 m
- Kedalaman pengendap = 3 m
- Panjang perforated baffle = 17,3 m
- Tinggi perforated baffle = 0,95 m
- Diameter tiap lubang = 0,15 m

- Jumlah lubang = 78 lubang
- Jarak lubang horizontal = 0,5 m
- Jarak lubang vertical = 0,13 m

c) **Zona Lumpur**

➢ Bak Penampung Lumpur

Zona lumpur merupakan area yan digunakan untuk menyimpan lumpur hasil pengendapan. Desain dari zona lumpur didasarkan dari besaran lumpur yang akan dihasilkan dan periode pengurasannya.

**Kriteria perencanaan :**

1. Ruang lumpur berbentuk limas terpancung dengan periode pengurasan 1 hari sekali ( ½ hari = 43.200 detik)
2. Kadar TSS = 12.000 mg/L
3. Debit = 0,5 m/s
4. Efisiensi pengendapan = 70%
5. Berat jenis lumpur = 2650 km/m$^3$
6. (*sumber : Water Treatment PlantDesign, Mc Graw Hill, 2nd Edition*)
7. Panjang permukaan lumpur = lebar bak pengendap = 17,3 m
8. Lebar permukaan = 17,3 m
9. Panjang dasar = 15 m
10. Lebar dasar = 15 m

**Perhitungan :**

- Sludge

Konsentrasi effluent (Cef) = (100%-70% × Konsentrasi TSS
= 30% × 12.000 mg/L
= 3600 mg/l

Konsentrasi lumpur (Cs) = 70% × konsentrasi TSS
= 70% × 12.000 mg/L
= 8400 mg/l

Berat lumpur tiap hari (Ws) = Q × Cs × 86400

= 0,5 $m^3/s$ × 8.400.000 $mg/m^3$ × 86400

= 362.880 kg/hari

Berat lumpur kering (Qds) = $\frac{Ws}{\rho s}$

= $\frac{362.880\ kg/hari}{2650\ kg/m^3}$

= 136,94 $m^3$/hari

Debit lumpur (Qs) = $\frac{Qds}{\%lumpur}$

= $\frac{136,94}{0,05}$ = 2738,8 $m^3$/hari

- Ruang lumpur

Volume ruang lumpur = Qs × td

= 2738,8 $m^3$/hari × ½ hari

= 1369,4 $m^3$

Dimensi ruang lumpur :

Panjang permukaan zona lumpur (*P1*) = 17,3 m

Lebar permukaan zona lumpur (L1) = 17,3 m

Panjang dasar zona lumpur (P2) = 15 m

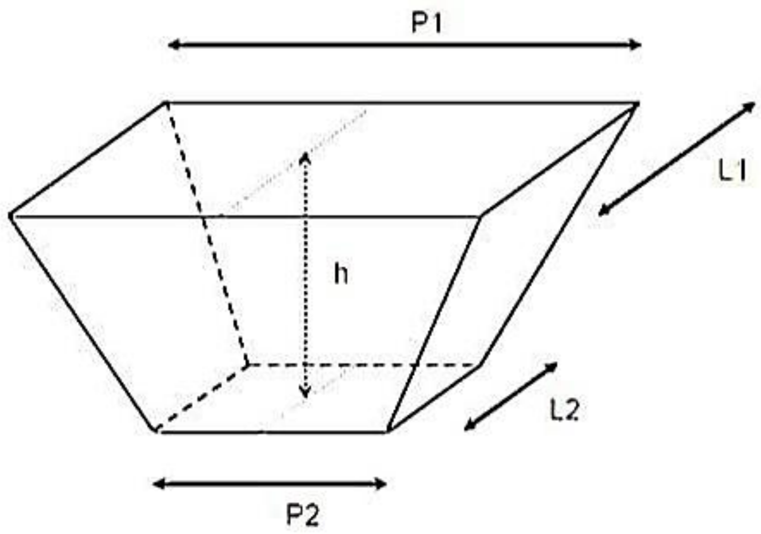
Lebar dasar zona lumpur (L1) = 15 m

$A_1$ = $P_1 \times L_1$

= 17,3 m × 17,3 m = 299,3 m2

A2 = P2 × L2

= 15 m × 15 m = 225 $m^2$




Volume grit storage $= \frac{1}{3} \times h \; ( A_1 + A_2 + \sqrt{A_1 \times A_2} \; )$

h $= \frac{volume}{\frac{1}{3} \times ( A1 + A2 + \sqrt{A_1 \times A_2} )}$

h $= \frac{1369,4 \text{ m3}}{\frac{1}{3} \times ( 299,3 + 225 + \sqrt{299,3 \times 225} )}$

h = 5,24 m

- Dimensi pipa penguras

**Data perencanaan :**

1. Jumlah pipa = 1 buah
2. Volume sludge = 1369,4 m3
3. Kecepatan aliran pipa = 0,6 m/s
4. Waktu pengurasan = 3600 s = 60 mnt

**Perhitungan :**

- Debit tiap pengurasan

Qp $= \frac{volume\ sludge}{waktu\ pengurasan} = \frac{1369,4\ m^3}{3600\ detik} = 0,38\ m^3/dtk$

- Luas permukaan pipa penguras

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

$= \frac{0,38\ m^3/dtk}{0,6\ m/detik} = 0,63\ m^2$

- Diameter pipa penguras

Dp $= \left(\frac{4 \times A}{3,14}\right)^{0,5}$

$= \left(\frac{4 \times 1,3}{3,14}\right)^{0,5}$

$= 0,89$ m ≈ 0,9 m

Memakai pipa berdiameter 900 mm sesuai dengan pipa yang tersedia di vendor https://depopipa.co.id/wp-content/uploads/2018/10/Katalog-HDPE-Vinilon.pdf.

- Cek kecepatan

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

$= \frac{0,38\ m^3/dtk}{0,63\ m^2} = 0,6$ m/s

**Resume :**

- Panjang permukaan zona lumpur (*P1*) = 17,3 m
- Lebar permukaan zona lumpur (L1) = 17,3 m
- Panjang dasar zona lumpur (P2) = 15 m
- Lebar dasar zona lumpur (L1) = 15 m
- Tinggi = 5,24 m
- Diameter pipa penguras = 0,9 m

## d) Zona Outlet

Outlet zone merupakan tempat yang digunakan untuk mengalirkan air bau hasil dari proses pengendapan di settling zone. Berikut ini merupakan perhitungan dari outlet zone.

**Kriteria perencanaan :**

1. Zona outlet bak prasedimentasi ini berupa weir bergerigi (v-notch)
2. Bentuk gutter persegi panjang
3. Jumlah gutter 3, 1 gutter dilengkapi dengan 2 buah weir.
4. Lebar v-notch = 0,1 m
5. Jarak v-notch = 0,3 m

6. Sudut v-notch = 45°
7. Koefisien drag (Cd) = 0,584
8. Weir loading = 350 $m^3/m^2$.hari
   = $4{,}1 \times 10^{-3}$ $m^3/m^2$.detik
9. Debit tiap unit = 0,5 $m^3$/detik

**Perhitungan**

➢ Gutter dan Weir

- Debit tiap gutter $= \frac{debit}{jumlah\ gutter} = \frac{0{,}5\ m^3/detik}{3}$ = 0,167 $m^3$/detik

- Panjang weir dibutuhkan $= \frac{debit}{WLR}$

  $= \frac{0{,}167\ m^3/detik}{4{,}1 \times 10{-}3\ \text{m3/m2.detik}}$

  = 40,7 $m^2$
- Panjang tiap weir $= \frac{panjang\ weir\ dibutuhkan}{jumlah\ weir}$

  $= \frac{40{,}7\ m^2}{6}$

  = 6,8 m
- Debit tiap pelimpah $= \frac{0{,}5\ m^3/detik}{6}$ = 0,0833 $m^3$/dtk
- Luas saluran pelimpah (A) $= \frac{Q/jumlah\ weir}{v}$

  $= \frac{0{,}5\frac{m^3}{dtk}/8}{0{,}6\ m/dtk}$

  = 0,104 $m^2$
- Tinggi (h) dan lebar (w) pelimpah

  Direncanakan h : w = 1 : 2, maka :

  A = h × w

  0,104 = h × 2h

  0,104 = $2h^2$

  h = 0,23 m

lebar (w) = 2h

= 2 × 0,23 m

= 0,46 m

- Tinggi air pada gutter

H air = $\left(\frac{Q\ gutter}{1{,}38 \times lebar\ gutter}\right)^{2/3}$

= $\left(\frac{0{,}167}{1{,}38 \times 0{,}46}\right)^{2/3}$

= 0,4 m

- Tinggi gutter = H air + (Hair × 30%)

= 0,4 + (0,4 × 30%)

= 0,52 m

- Lebar saluran gutter

Direncanakan lebar gutter = 2 × tinggi gutter

Maka = 2 × 0,52 m = 1,04 m

- Jari – jari hidrolis

R gutter = $\frac{H\ air \times lebar\ gutter}{(2 \times Hair) + lebar\ gutter}$

= $\frac{0{,}4 \times 1{,}04}{(2 \times 0{,}4) + 1{,}04}$

= 0,21 m

- Luas basah gutter = lebar gutter × Hair

= 1,04 m × 0,4 m

= 0,42 m

- Slope gutter = $\left(\frac{Q\ gutter \times n}{A\ gutter \times (R\ guter)^{\frac{2}{3}}}\right)^2$

= $\left(\frac{0{,}167 \times 0{,}013}{0{,}42 \times (0{,}21)^{\frac{2}{3}}}\right)^2$

= 0,00021

- Headloss pada gutter = panjang gutter × Slope gutter

= 6,8 m × 0,00021

= 0,0014

- V notch
  - Jumlah v notch

    Dimana : panjang weir 6,8 m,

    jumlah v notch $= \frac{panjang\ weir}{jarak\ antar\ v\ notch + lebar\ v\ notch}$

    $= \frac{6{,}8\ m}{0{,}3\ m + 0{,}1\ m}$

    = 17

  - Debit tiap v notch $= \frac{Q\ tiap\ weir}{jumlah\ v\ notch}$

    $= \frac{0{,}0625}{17}$

    = 0,0037 $m^3$/dtk

  - Tinggi peluapan melalui v-notch

    Q $= \frac{8}{15} \times (cd) \sqrt{2 \times g} \times \tan\frac{\theta}{2} \times H^{5/2}$

    0,0625 $m^3$/dtk $= \frac{8}{15} \times (0{,}584) \sqrt{2 \times 9{,}81} \times \tan\frac{45}{2} \times H^{5/2}$

    H = 0,41 m

- Saluran Pengumpul

  **Kriteria Perencanaan**

  1. Q saluran : 0,5 m3/dtk
  2. Kecepatan : 0,6 m/s
  3. Lebar saluran = lebar settling : 17,3 m
  4. Kedalaman = kedalaman settling : 3 m
  5. Waktu detensi : 600 dtk = 10 mnt

  **Perhitungan**

  - Volume saluran = Q × td

    = 0,5 $m^3$/dtk × 600 dtk

    = 300 $m^3$

  - Luas penampang $= \frac{Q}{v} = \frac{0{,}5\ m^3/dtk}{0{,}6\ m/dtk}$ = 0,833 $m^2$

- Dimensi saluran pengumpul

  Volume = L × W × H

  L $= \frac{V}{W \times H}$

  $= \frac{300}{17,3 \times 3}$

  = 5,8 m

- Jari – jari hodrolis

  R $= \frac{luaskelilingbasah}{luaspenampangbasah}$

  $= \frac{W \times H}{W + 2H}$

  $= \frac{17,3 \times 3\ m}{17,3 + (2 \times 3\ m)}$

  = 0,5 m

- Slope saluran $= \left(\frac{v \times n}{R^{2/3}}\right)^2$

  $= \left(\frac{0,6 \times 0,013}{0,5^{2/3}}\right)^2$ = 0,00015 m/m

- Headloss saluran pengumpul (Hf)

  Hf = S × L

  = 0,00015 × 3 m

  = 0,00045

➢ Saluran pipa outlet

**Kriteria Perencanaan**

1. Kecepatan : 0,6 – 1,5 m/s

**Data perencanaan**

1. Debit : 0,5 $m^3$/s
2. Kecepatan : 0,6 m/s

**Perhitungan**

- Luas Penampang pipa

  A $= \frac{Q}{v} = \frac{0,5\ m^3/s}{1,3\ m/s}$ = 0,38 $m^2$

- Diameter pipa

  A = ¼ × π × D2

  0,38 $m^2$ = ¼ × 3,14 × D2

  D = 0,7 m

  Menggunakan pipa berdiameter 710 mm sesuai dengan yang ada di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf .

- Cek kecepatan

  V $= \frac{Q}{A} = \frac{0,5\ m^3/s}{0,38\ m^2}$ = 1,32 m/s

**Resume zona outlet**

- Jumlah gutter : 3 gutter
- Tinggi gutter :0,52 m
- Lebar gutter : 1,04 m
- Slope gutter : 0,00021 m
- Panjang tiap weir : 6,8 m
- Tinggi weir : 0,23 m
- Lebar weir : 0,46 m
- Jumlah v-notch : 17
- Lebar v-notch : 0,1 m
- Jarak antar v-notch : 0,3 m
- Tinggi peluapan : 0,41 m
- Panjang saluran pengumpul : 5,8 m
- Lebar saluran pengumpul : 17,3 m
- Tinggi saluran pengumpul : 3 m
- Diameter pipa outlet : 0,71 m

## 5.3. Netralisasi

**Kriteria Perencanaan**

1. Waktu tinggal : 20 – 60 dtk
2. Gradient kecepatan : 1000 – 700 /dtk

   (*Sumber : Reynold, 2003. Wastewater Engineering Treatment and Reuse 4th edition, hal. 182*)
3. Kecepatan putaran impeller paddle : 10 – 150 rpm

   (*Sumber : Reynold, 2003. Wastewater Engineering Treatment and Reuse 4th edition, hal. 185*)
4. Reynold Number : >10.000

   (*Sumber : Reynold, 2003. Wastewater Engineering Treatment and Reuse 4th edition, hal. 187*)
5. Diameter paddle : 30 – 50% lebar bak
6. Lebar paddle : 1/6 – 1/10 lebar bak

   (*Sumber :Ali Masduqi, Operasi & Proses Pengolahan Air, Hal. 113*)
7. Jarak paddle dengan dasar bak : 30 – 50% diameter paddle

   (*Sumber: Reynolds. 2003. Wastewater Engineering Treatment and Reuse 4th edition, hal 184*)

**Data Perencanaan**

1. Direncanakan bak berbentuk circular
2. Debit : 1,97 $m^3$/dtk
3. Jumlah bak : 4 bak
4. Q tiap bak : 0,5 $m^3$/dtk = 43.200.000 L/hari
5. Gradient kecepatan : 700/s
6. Waktu detensi : 60 dtk
7. Koefisien impeller (kt) : 1,7
8. Kecepatan putaran impeller (n) :120 rpm = 2 rps
9. Konsentrasi NaOH : 20% (dipasaran)
10. Tinggi bak : 3 m
11. Densitas air suhu 25° (ρ) : 977 kg/$m^3$

12. Viskositas air suhu 25° (μ) : 0,89×10-3 Ns/m3
13. Berat jenis NaOH : 39,997 g/mol
14. Massa jenis NaOH : 2,13 kg/L

**Perhitungan**

➢ **Bak Pembubuh**

- Dosis pembubuhan :

  Proses pembubuhan menggunakan NaOH yang dilarutkan, agar dapat diaplikasikan kedalam bak pebubuh dalam fase cair.

  pH air baku = 5

  p [OH⁻] = 8,5 – 5 = 3

  Dosis untuk menetralkan air baku yang bersifat asam

  Dosis NaOH $= \frac{Y\ (mg)}{Vol.air\ (L)} \times \frac{1}{Berat\ Molekul\ \ (g/mol)} \times \frac{1}{10^3\ (mg/mol)}$

  $= \frac{Y\ (mg)}{1\ L} \times \frac{1}{39{,}997\ \ (g/mol)} \times \frac{1}{10^3\ (mg/mol)}$

  $= \frac{Y\ (mg)}{39997\ L}$

  Dosis Y adalah nilai dosis NaOH, maka persamaan reaksi :

  NaOH → Na + $OH^-$

  $[OH^-] = \frac{Y\ (mg)}{39997\ L} \times 1$

  $[OH^-] = \frac{Y\ (mg)}{39997\ L}$

  pOH $= -\log [OH^-]$

  3,5 $= -\log \left[\frac{Dosis\ (mg)}{39997\ L}\right]$

  10-3,5 $= \frac{Dosis\ (mg)}{39997\ L}$

  Dosis = 12.65 mg/L = 39,9 mg/L ≈ 40 mg/L

  Artinya, proses pembubuhan membutuhkan 40 mg NaOH tiap 1 L air baku

- Kebutuhan NaOH = dosis NaOH × Q

  = 12,65 mg/L × 43.200.000 L/hari

  = 546.480.000 mg/L= 546,5 kg/hari

- Volume NaOH $= \frac{kebutuhan\ NaOH}{\rho\ NaOH} \times$ periode pelarutan

  $= \frac{546{,}5\ kg/hari}{2{,}13\ kg/L} \times$ 1 hari

  = 256,57 L = 0,257 $m^3$

- Kebutuhan air pelarut

  Konsentrasi larutan NaOH diinginkan = 20%

  Vol. air pelarut $= \frac{\left(\frac{100\%-20\%}{20\%}\right) \times kebutuhan\ NaOH}{\rho\ air} \times$ 1 hari

  $= \frac{\left(\frac{100\%-20\%}{20\%}\right) \times 546{,}5\ kg/hari}{997\ kg/m^3} \times$ 1 hari

  = 2,19 $m^3$

- Volume total tangki pembubuh

  V total = V NaOH + V air pelarut

  = 0,257 $m^3$ + 2,19 $m^3$

  = 2,45 $m^3$

- Dimensi tangki pelarut

  V = ¼ × π × $D^2$ × h

  2,45 $m^3$ = ¼ × 3,14 × $D^2$ × 1,25D

  2,45 $m^3$ = 0,98 × $D^3$

  D = 1,36 m

  Maka :

  H = 1,25 D

  = 1,25 × 1,36

  = 1,7 m

  H total = H + Freeboard

  = 1,7 + 0,3 = 2 m

- Cek volume

  V = ¼ × π × $D^2$ × h

  = ¼ × 3,14 × $1{,}36^2$ × 2 = 2,9 $m^3$

- Power (P) yang dibutuhkan

  P = $G^2 \times \mu \times V$

  = $(700/s)^2 \times 0.8004 \times 10^{-3}$ N.s/m$^2 \times 2,9$ m$^3$

  = 1.137 N.m/s

  = 1.137 Watt

  = 1,14 kW

- Diameter impeller

  Di = $\left(\frac{P}{KT\ x\ n^3\ x\ \rho}\right)^{\frac{1}{5}}$

  = $\left(\frac{1.137\ N.m/s}{1,7 \times (2\ rps)^3 \times 997\ kg/m^3}\right)^{\frac{1}{5}}$

  = 0,61 m

  Perbandingan diameter impeller dengan diameter bak

  $\frac{Di}{D} \times 100\% = \frac{0,61}{1,36} \times 100\% = 45\%$ (memenuhi, 30 – 50% lebar bak)

- Lebar paddle = 1/6 × Di

  = 1/6 × 0.61 m= 0,1 m

- Jarak paddle dari dasar bak

  Jarak = 50% × D

  = 50% × 0.61 m = 0,3 m

- Cek Bilangan Reynold

  Nre = $\frac{Di^2 \times n \times \rho}{\mu}$

  = $\frac{(0,61)^2 \times 2\ rps \times 997\ kg/m^3}{0,89 \times 10^{-3} N.S/m^2}$

  = 833.671,24 (memenuhi Nre > 10000)

➢ Pompa injek mengunakan dosing

**Data Perencanaan :**

1. Kecepatan : 1 m/s
2. Lama injeksi : 20 mnt
3. Q : 0,5 m$^3$/dtk
4. L suction : 3,2 m
5. L discharge : 5 m

6. H statis : 2,2 m
7. Koefisien Kekasaran : 120

**Perhitungan :**

- Q injek $= \frac{volume\ bak\ pembubuh}{waktu\ injeksi}$

  $= \frac{2{,}45\ m^3}{20\ menit}$

  = 0,123 $m^3$/mnt

  = 7,4 $m^3$/jam

- A pipa $= \frac{Q\ injek}{v} = \frac{0{,}02\ m^3/dtk}{1\ m/dtk}$ = 0,002 $m^2$

- Diameter pipa $= \left(\frac{4 \times A}{3{,}14}\right)^{0{,}5} = \left(\frac{4 \times 0{,}002}{3{,}14}\right)^{0{,}5}$ = 0,16 m

  Menggunakan pipa berdiameter 160 mm sesuai dengan pipa yang tersedia di vendor https://www.rucika.co.id/wp-content/uploads/2019/08/Brosur-Rucika-Black-2018.pdf.

- Cek kecepatan

  V $= \left(\frac{Q}{\frac{1}{4} \times \pi \times D^2}\right) = \left(\frac{0{,}002\ m^3/dtk}{\frac{1}{4} \times 3{,}14 \times 0{,}16^2}\right)$ = 0,31 m/dtk

- Hf Mayor pipa suction $= \left(\frac{Q}{0{,}2785 \times c \times D^{2{,}65}}\right)^{1{,}85} \times$ L

  $= \left(\frac{0{,}002\ m^3/dtk}{0{,}2785 \times 120 \times 0{,}165^{2{,}65}}\right)^{1{,}85} \times 3{,}2$

  = 0,0003 m

- Hf Mayor pipa discharge $= \left(\frac{Q}{0{,}2785 \times c \times D^{2{,}65}}\right)^{1{,}85} \times$ L

  $= \left(\frac{0{,}002\ m^3/dtk}{0{,}2785 \times 120 \times 0{,}165^{2{,}65}}\right)^{1{,}85} \times 5$

  = 0,0005 m

- Total Hf Mayor = Hf suction + Hf Discharge

  = 0,0003 m + 0,005 m

  = 0,0008 m

- Hf minor

3 elbow 90° (K = 0,3)

$$= 3 \times \left(0,3 \times \frac{1^2}{2 \times 9,81}\right) = 0,046 \text{ m}$$

1 gate valve (K = 0,19)

$$= 0,19 \times \frac{1^2}{2 \times 9,81} = 0,018 \text{ m}$$

Total Hf Minor = 0,046 m + 0,018 m = 0,064 m

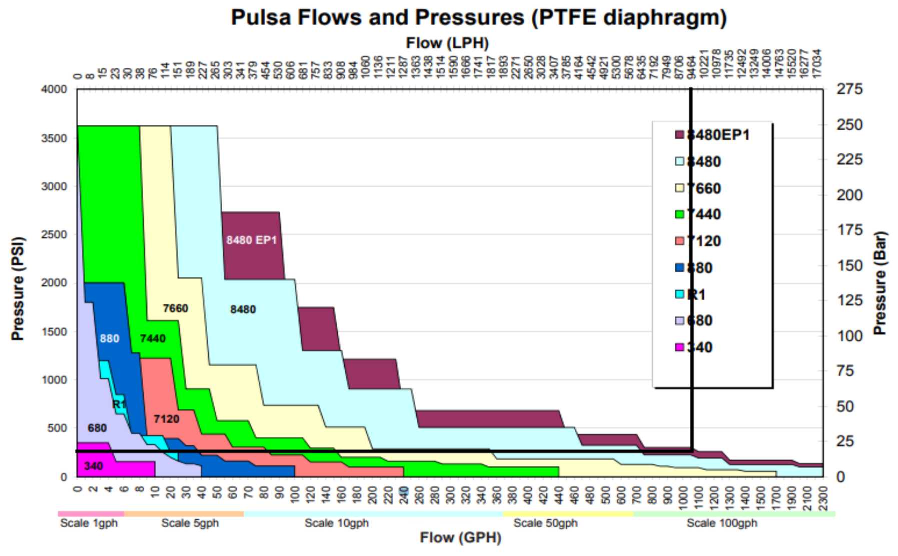
Hf Statis = 0,5 m

Total head = Hf Mayor + Hf minor +Hf Statis

= 0,0008 m + 0,064 m + 0,5m

= 0,565 m

Pompa yang digunakan adalah pompa Pulsa Series 8481EP1 dengan laju aliran 9464 L/jam dan tekanan pompa mencapai 300 PSI (Pounds per Square Inch)




- Bak Netralisasi
  - Pipa inlet

    A $= \frac{Q}{v} = \frac{0{,}5\ m^3/s}{1{,}3\ m/s}$ = 0,38 m$^2$

    Diameter pipa

    A = ¼ × π × D2

    0,38 m$^2$ = ¼ × 3,14 × D2

    D = 0,7 m

    Menggunakan pipa berdiameter 710 mm sesuai dengan yang ada di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf .

    Cek kecepatan

    V $= \frac{Q}{A} = \frac{0{,}5\ m^3/s}{0{,}38\ m^2}$ = 1,32 m/s

  - Volume air baku = Q air baku × td

    = 0,5 m$^3$/dtk × 60 dtk = 30 m$^3$

    Volume total = Volume air baku + Volume pembubuh

    = 30 m$^3$ + 2,9 m$^3$

    = 32.9 m$^3$ ≈ 33 m$^3$

  - Luas permukaan bak

    A $= \frac{v}{h} = \frac{33\ m^3}{3\ m}$ = 11 m$^2$

- Diameter bak

D $= \left(\frac{4 \times A}{\pi}\right)^{1/2}$

$= \left(\frac{4 \times 11}{3,14}\right)^{1/2}$ = 3,7 m

- Cek kedalaman

A = ¼ × π × $D^2$

= ¼ × 3,14 × $3,7^2$

= 10,75 $m^2$

H $= \frac{v}{A} = \frac{33\ m^3}{10,75\ m^2}$ = 3,06 m ≈ 3,1 m

Total kedalaman = kedalaman + Freeboard

= 3,1 m + 0,3 m

= 3,4 m

- Daya pengadukan bek netralisasi (P)

P = $G^2$ × μ × Volume

= 700/$s^2$ × 0,89×$10^{-3}$ Ns/$m^3$ × 33 $m^3$

= 14.391Nm/s

= 14.391 Watt

= 13,391 kW

Dari perhitungan tenaga/power yang didapat, maka spesifikasi motor pengaduk yang digunakan adalah type C1T-15 vertical agitator type, output 15 kW.

- Diameter impeller (Di)

Di $= \left(\frac{P \times g}{kt \times n^3 \times \rho}\right)^{1/5}$

$= \left(\frac{14.391 \times 9,81}{2,75 \times 2^3 \times 997}\right)^{1/5}$ = 1,4 m

- Tinggi paddle dari dasar bak (T)

T = ½ D = ½ × 1,4 m = 0,7 m

- Cek Bilangan Reynold

Nre $= \frac{Di^2 \times n \times \rho}{\mu}$

$= \frac{1,4^2 \times 2 \times 997}{0,00089}$ = 4.391.280,9

Nilai Nre mlebihi 10.000 sehingga aliran air memenuhi kategori turbulen.

- Pipa outlet

D $= \left(\frac{Q}{v \times \frac{1}{4} \times \pi}\right)^{1/2} = \left(\frac{0,5\ m^3/dtk}{0,6 \times \frac{1}{4} \times 3,14}\right)^{1/2}$ = 1,03 m ≈ 1 m

Memakai pipa berdiameter 1000 mm sesuai dengan pipa yang tersedia di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf.

v cek $= \left(\frac{Q}{\frac{1}{4} \times \pi \times D^2}\right)$

$= \left(\frac{0,5\ m^3/dtk}{\frac{1}{4} \times 3,14 \times 1^2}\right)$ = 0,64 m/s

**Resume :**

- Diameter bak pembubuh : 1,36 m
- Kedalaman bak pembubuh : 2 m
- H air bak pembubuh : 1,7 m
- Diameter impeller : 0,61 m
- Lebar paddle : 0,1 m
- Jarak paddle dari dasar bak : 0,3 m
- Diameter pipa injek : 0,165 m
- Diameter bak netralisasi : 3,6 m
- Kedalaman bak netralisasi : 3,4 m
- H air bak netralisasi : 3,1 m
- Diameter impeller : 1,4 m
- Jarak paddle dari dasar : 0,7 m
- Diameter pipa outlet : 1m
- Diameter pipa inlet : 0,71 m

# Vertical type

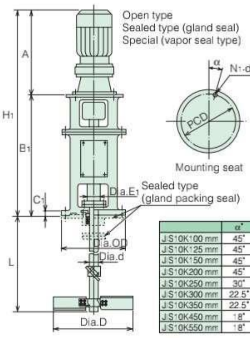
## C1T

**For medium/low speeds (cycloid reducer type)**
**(for processes)**

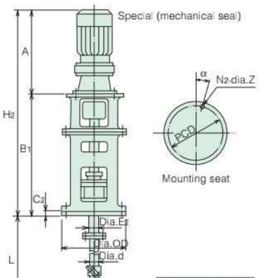
This model has been designed to be rigid for use in processes. Select the model to suit your particular requirements. A high-precision cyclo, Bayel-Cyclo, ring cone, and other adjustable speed reducers can also be mounted. A mechanical seal type is also available.

C1T

## External Dimensions




| | α° |
|---|---|
| JIS10K100 mm | 45° |
| JIS10K125 mm | 45° |
| JIS10K150 mm | 45° |
| JIS10K200 mm | 45° |
| JIS10K250 mm | 30° |
| JIS10K300 mm | 22.5° |
| JIS10K350 mm | 22.5° |
| JIS10K450 mm | 18° |
| JIS10K550 mm | 18° |




| | α° |
|---|---|
| JIS10K250 mm | 0° |
| JIS10K300 mm | 11.25° |
| JIS10K350 mm | 11.25° |
| JIS10K450 mm | 0° |

* The agitation shaft can also be made to custom lengths. Contact your dealer.
* Agitation shafts of diameter 45 or less are sleeve insertion types.
* Gear ratios other those indicated can also be made.

## Body Dimensions

| Mounting Flange | Gear Reducer Frame No. | Motor kW | A | $B_1$ | $B_2$ | $C_1$ | $C_2$ | Dia. $E_1$ | Dia. $E_2$ | $H_1$ | $H_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10K100 mm | 4075 | 0.1 | 192 | 285 | — | 13 | — | 16 | — | 477 | — |
| | | 0.2 | 234 | | | | | | | 519 | — |
| 10K125 mm | 4085 | 0.1 | 190 | | | | | | | 569 | — |
| | | 0.2 | 232 | 379 | — | 16 | — | 22 | — | 611 | — |
| | | 0.4 | 252 | | | | | | | 631 | — |
| 10K150 mm | 4095 | 0.1 | 228 | | | | | | | 707 | — |
| | | 0.2 | 270 | | | | | | | 749 | — |
| | | 0.4 | 290 | | | | | | | 769 | — |
| | | 0.75 | 331 | 479 | — | 18 | — | 32 | — | 810 | — |
| | 4105 | 0.4 | 304 | | | | | | | 783 | — |
| | | 0.75 | 345 | | | | | | | 824 | — |
| | | 1.5 | 378 | | | | | | | 857 | — |
| 10K200 mm (10K250 mm mechanical seal type) | 4105 | 0.4 | 304 | 592 | 682 | | | | | 896 | 986 |
| | | 2.2 | 398 | | | | | | | 990 | 1080 |
| | 4115 | 0.75 | 354 | | | 22 | 45 | 45 | 40·45 | 950 | 1040 |
| | | 1.5 | 387 | 596 | 686 | | | | | 983 | 1073 |
| | | 2.2 | 407 | | | | | | | 1003 | 1093 |
| | | 3.7 | 430 | | | | | | | 1026 | 1116 |
| 10K250 mm | 4115 | 0.75 | 354 | 678 | 763 | | | | | 1032 | 1117 |
| | | 2.2 | 407 | | | | | | | 1085 | 1170 |
| | 413□ | 1.5 | 434 | | | | | | | 1120 | 1205 |
| | | 2.2 | 454 | | | | | | | 1140 | 1225 |
| | | 3.7 | 477 | 686 | 771 | | | | | 1163 | 1248 |
| | | 5.5 | 521 | | | 25 | 45 | 65 | 50 to 65 | 1207 | 1292 |
| | | 7.5 | 544 | | | | | | | 1230 | 1315 |
| | 414□ | 1.5 | 434 | | | | | | | 1135 | 1220 |
| | | 2.2 | 454 | | | | | | | 1155 | 1240 |
| | | 7.5 | 544 | 701 | 786 | | | | | 1245 | 1330 |
| | 415□ | 3.7 | 477 | | | | | | | 1178 | 1263 |

| Mounting Flange | Gear Reducer Frame No. | Motor kW | A | $B_1$ | $B_2$ | $C_1$ | $C_2$ | Dia. $E_1$ | Dia. $E_2$ | $H_1$ | $H_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10K250 mm | 415□ | 5.5 | 521 | | | | | | | 1222 | 1307 |
| | | 11 | 604 | | | | | | | 1305 | 1390 |
| | 416□ | 2.2 | 509 | | | | | | | 1210 | 1295 |
| | | 3.7 | 532 | | | | | | | 1233 | 1318 |
| | | 5.5 | 576 | 701 | 786 | 25 | 45 | 65 | 50 to 65 | 1277 | 1362 |
| | | 7.5 | 604 | | | | | | | 1305 | 1390 |
| | | 11 | 664 | | | | | | | 1365 | 1450 |
| 10K300 mm | 416□ | 5.5 | 576 | | | | | | | 1403 | 1498 |
| | | 7.5 | 604 | 827 | 922 | | | | | 1431 | 1526 |
| | | 15 | 749 | | | | | | | 1576 | 1671 |
| | 417□ | 3.7 | 586 | | | | | | | 1417 | 1512 |
| | | 5.5 | 630 | | | | | | | 1461 | 1556 |
| | | 7.5 | 648 | 831 | 926 | | | | | 1479 | 1574 |
| | | 11 | 708 | | | 30 | 55 | 85 | 70 to 80 | 1539 | 1634 |
| | | 22 | 883 | | | | | | | 1714 | 1809 |
| | 418□ | 5.5 | 651 | | | | | | | 1486 | 1581 |
| | | 7.5 | 669 | | | | | | | 1504 | 1599 |
| | | 11 | 729 | 835 | 930 | | | | | 1564 | 1659 |
| | | 15 | 809 | | | | | | | 1644 | 1739 |
| | | 22 | 904 | | | | | | | 1739 | 1834 |
| 10K350 mm | 418□ | 15 | 809 | 945 | 1030 | | | | | 1754 | 1839 |
| | 419□ | 7.5 | 725 | | | | | | | 1680 | 1765 |
| | | 11 | 785 | 955 | 1040 | 35 | 65 | 95·105 | 95 to 105 | 1740 | 1825 |
| | | 22 | 945 | | | | | | | 1900 | 1985 |
| 10K450 mm | 419□ | 11 | 785 | | | | | | | 1925 | 2040 |
| | | 15 | 850 | 1140 | 1255 | | | | | 1990 | 2105 |
| | 420□ | 22 | 923 | 1175 | 1290 | 40 | 75 | 120·130·140·150 | 110 to 150 | 2098 | 2213 |
| | 421□ | 15 | 863 | 1180 | 1295 | | | | | 2043 | 2158 |
| 10K550 mm | — | — | — | (1500) | — | 42 | — | 170 | — | — | — |

□ in the gear reducer frame No. is 0 or 5.

## Specification Dimensions

| Model | Motor Output (kW) | Gear Reducer Frame No. (#) | Gear Reducer Gear Ratio (i) | Revolution speed (rpm) 50 Hz | Revolution speed (rpm) 60 Hz | Agitation Shaft Standard Length (L) mm | Agitation Shaft Dia. (Dia.d) mm | 2-vane Paddle 2-stage Dia. (Dia.d) mm | Mounting Flange Nominal Dia JIS 10K | Mounting Flange Outer Dia (OD) mm | Mounting Flange Pitch (PCD) mm | Hole (Z) mm | Hole (N1) pcs | Hole (N2) pcs | Max. Agitation Capacity Diluted Liquids L | Max. Agitation Capacity Medium Viscosity Liquid L | Approx. Weight W/motor kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/11 | 136 | 164 | | | 200 | | | | | | | | | 25 |
| | | | 1/17 | 88 | 106 | | | 250 | | | | | | | | | 25 |
| | | 4075 | 1/29 | 52 | 62 | 1000 | 16 | 350 | 100 mm | 210 | 175 | 19 | 4 | — | | | 26 |
| C1T□-0.1 | 0.1 | | 1/35 | 43 | 51 | | | 400 | | | | | | | 700 | 300 | 26 |
| | | | 1/43 | 35 | 42 | | | 450 | | | | | | | | | 26 |
| | | 4085 | 1/59 | 25 | 31 | 1200 | 22 | 500 | 125 mm | 250 | 210 | 23 | 4 | — | | | 41 |
| | | 4095 | 1/87 | 17 | 21 | 1500 | 32 | 700 | 150 mm | 280 | 240 | 23 | 4 | — | | | 80 |
| | | 4075 | 1/11 | 136 | 164 | 1000 | 16 | 250 | 100 mm | 210 | 175 | 19 | 4 | — | | | 26 |
| | | | 1/17 | 88 | 106 | | | 350 | | | | | | | | | 27 |
| | | | 1/29 | 52 | 62 | | | 450 | | | | | | | | | 41 |
| C1T□-0.2 | 0.2 | 4085 | 1/35 | 43 | 51 | 1200 | 22 | 500 | 125 mm | 250 | 210 | 23 | 4 | — | 1300 | 600 | 42 |
| | | | 1/43 | 35 | 42 | | | 550 | | | | | | | | | 43 |
| | | 4095 | 1/59 | 25 | 31 | 1500 | 32 | 600 | 150 mm | 280 | 240 | 23 | 4 | — | | | 79 |
| | | | 1/87 | 17 | 21 | | | 800 | | | | | | | | | 85 |
| | | 4085 | 1/11 | 136 | 164 | 1200 | 22 | 350 | 125 mm | 250 | 210 | 23 | 4 | — | | | 42 |
| | | | 1/17 | 88 | 106 | | | 400 | | | | | | | | | 42 |
| | | | 1/29 | 52 | 62 | | | 550 | | | | | | | | | 79 |
| C1T□-0.4 | 0.4 | 4095 | 1/35 | 43 | 51 | 1500 | 32 | 600 | 150 mm | 280 | 240 | 23 | 4 | — | 2500 | 1200 | 80 |
| | | | 1/43 | 35 | 42 | | | 650 | | | | | | | | | 80 |
| | | 4105 | 1/59 | 25 | 31 | | | 900 | | | | | | | | | 91 |
| | | | 1/87 | 17 | 21 | 2200 | 45 | 1150 | 200 mm | 330 | 290 | 23 | 4 | — | | | 140 |
| | | 4095 | 1/11 | 136 | 164 | | | 400 | | | | | | | | | 81 |
| | | | 1/17 | 88 | 106 | | | 550 | | | | | | | | | 83 |
| | | | 1/29 | 52 | 62 | 1500 | 32 | 700 | 150 mm | 280 | 240 | 23 | 4 | — | | | 88 |
| C1T□-0.75 | 0.75 | 4105 | 1/35 | 43 | 51 | | | 800 | | | | | | | 5000 | 2500 | 92 |
| | | | 1/43 | 35 | 42 | | | 900 | | | | | | | | | 95 |
| | | 4115 | 1/59 | 25 | 31 | 2200 | 45 | 1000 | 200 mm | 330 | 290 | 23 | 4 | — | | | 150 |
| | | | 1/87 | 17 | 21 | 2400 | 50 | 1350 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 268 |
| | | 4105 | 1/11 | 136 | 164 | 1500 | 32 | 500 | 150 mm | 280 | 240 | 23 | 4 | — | | | 89 |
| | | | 1/17 | 88 | 106 | | | 600 | | | | | | | | | 90 |
| | | | 1/29 | 52 | 62 | | | 800 | | | | | | | | | 143 |
| C1T□-1.5 | 1.5 | 4115 | 1/35 | 43 | 51 | 2200 | 45 | 900 | 200 mm | 330 | 290 | 23 | 4 | — | 10000 | 5000 | 145 |
| | | | 1/43 | 35 | 42 | | | 1000 | | | | | | | | | 153 |
| | | 4130 | 1/59 | 25 | 31 | 2400 | 50 | 1200 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 279 |
| | | 4145 | 1/87 | 17 | 21 | | | 1600 | | | | | | | | | 338 |
| | | 4105 | 1/11 | 136 | 164 | | | 550 | | | | | | | | | 130 |
| | | | 1/17 | 88 | 106 | 2200 | 45 | 700 | 200 mm | 330 | 290 | 23 | 4 | — | | | 143 |
| | | 4115 | 1/29 | 52 | 62 | | | 950 | | | | | | | | | 150 |
| C1T□-2.2 | 2.2 | | 1/35 | 43 | 51 | | | 1000 | | | | | | | 15000 | 7500 | 255 |
| | | 4130 | 1/43 | 35 | 42 | 2400 | 50 | 1100 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 279 |
| | | 4145 | 1/59 | 25 | 31 | | | 1350 | | | | | | | | | 296 |
| | | 4160 | 1/87 | 17 | 21 | 2600 | 60 | 1750 | | | | | | | | | 408 |
| | | 4115 | 1/11 | 136 | 164 | 2200 | 45 | 600 | 200 mm | 330 | 290 | 23 | 4 | — | | | 152 |
| | | | 1/17 | 88 | 106 | | | 750 | | | | | | | | | 154 |
| | | 4135 | 1/29 | 52 | 62 | 2400 | 50 | 1000 | | | | | | | | | 285 |
| C1T□-3.7 | 3.7 | | 1/35 | 43 | 51 | | | 1200 | 250 mm | 400 | 355 | 23 | 6 | 12 | 25000 | 12000 | 293 |
| | | 4155 | 1/43 | 35 | 42 | 2600 | 60 | 1300 | | | | | | | | | 326 |
| | | 4160 | 1/59 | 25 | 31 | | | 1500 | | | | | | | | | 378 |
| | | 4170 | 1/87 | 17 | 21 | 2800 | 70 | 1950 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 626 |
| | | 4130 | 1/11 | 136 | 164 | 2400 | 50 | 650 | | | | | | | | | 276 |
| | | | 1/17 | 88 | 106 | | | 800 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 281 |
| | | 4155 | 1/29 | 52 | 62 | 2600 | 60 | 1100 | | | | | | | | | 320 |
| C1T□-5.5 | 5.5 | 4160 | 1/35 | 43 | 51 | | | 1300 | | | | | | | 35000 | 18000 | 366 |
| | | | 1/43 | 35 | 42 | 2800 | 70 | 1400 | | | | | | | | | 472 |
| | | 4170 | 1/59 | 25 | 31 | | | 1700 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 588 |
| | | 4180 | 1/87 | 17 | 21 | 3000 | 80 | 2150 | | | | | | | | | 722 |
| | | 4135 | 1/11 | 136 | 164 | 2400 | 50 | 700 | | | | | | | | | 292 |
| | | 4145 | 1/17 | 88 | 106 | 2600 | 60 | 850 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 319 |
| | | 4160 | 1/29 | 52 | 62 | | | 1200 | | | | | | | | | 370 |
| C1T□-7.5 | 7.5 | 4165 | 1/35 | 43 | 51 | 2800 | 70 | 1400 | | | | | | | 50000 | 25000 | 512 |
| | | 4170 | 1/43 | 35 | 42 | | | 1500 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 568 |
| | | 4180 | 1/59 | 25 | 31 | 3000 | 80 | 1850 | | | | | | | | | 680 |
| | | 4190 | 1/87 | 17 | 21 | 3500 | 100 | 2250 | 350 mm | 490 | 445 | 25 | 8 | 16 | | | 1085 |
| | | 4155 | 1/11 | 136 | 164 | 2600 | 60 | 750 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 329 |
| | | 4160 | 1/17 | 88 | 106 | | | 900 | | | | | | | | | 368 |
| | | 4170 | 1/29 | 52 | 62 | 2800 | 70 | 1300 | | | | | | | | | 563 |
| C1T□-11 | 11 | 4175 | 1/35 | 43 | 51 | 3000 | 80 | 1500 | 300 mm | 445 | 400 | 25 | 8 | 16 | 75000 | 35000 | 617 |
| | | 4180 | 1/43 | 35 | 42 | | | 1600 | | | | | | | | | 670 |
| | | 4190 | 1/59 | 25 | 31 | 3500 | 100 | 1950 | 350 mm | 490 | 445 | 25 | 8 | 16 | | | 1038 |
| | | 4195 | 1/87 | 17 | 21 | 3800 | 110 | 2450 | 450 mm | 620 | 565 | 27 | 10 | 20 | | | 1461 |
| | | 4160 | 1/11 | 136 | 164 | 2800 | 70 | 800 | | | | | | | | | 549 |
| | | 4165 | 1/17 | 88 | 106 | | | 1100 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 562 |
| | | 4180 | 1/29 | 52 | 62 | 3000 | 80 | 1400 | | | | | | | | | 693 |
| C1T□-15 | 15 | | 1/35 | 43 | 51 | | | 1600 | | | | | | | 100000 | 50000 | 732 |
| | | 4185 | 1/43 | 35 | 42 | 3500 | 100 | 1700 | 350 mm | 490 | 445 | 25 | 8 | 16 | | | 987 |
| | | 4195 | 1/59 | 25 | 31 | 3800 | 110 | 2050 | 450 mm | 620 | 565 | 27 | 10 | 20 | | | 1427 |
| | | 4215 | 1/87 | 17 | 21 | | | 2600 | | | | | | | | | 1687 |
| | | 4170 | 1/11 | 136 | 164 | 3000 | 80 | 850 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 701 |
| C1T□-30 | 22 | 4180 | 1/17 | 88 | 106 | | | 1100 | | | | | | | | | 740 |
| | | 4190 | 1/29 | 52 | 62 | 3500 | 100 | 1500 | 350 mm | 490 | 445 | 25 | 8 | 16 | 150000 | 75000 | 1092 |
| | | 4205 | 1/43 | 43 | 51 | 3800 | 110 | 1900 | 450 mm | 620 | 565 | 27 | 10 | 20 | | | 1518 |

- Contact your dealer when racing may occur.
- The standard paint color is Munsell 7.5GY-5/5.5.
- The standard liquid contact materials are SUS304 and SUS316. Linings can also be made in various materials.
- The standard motor is a totally enclosed fan-cooled outdoor type.

## 5.4. AERASI

**Kriteria Perencanaan**

1. Tinggi : 1,2 – 9 m
2. Luas bak : 105 – 320 $m^2$

   (*Sumber : Qasim et. Al., 2000*)

3. Kecepatan pipa inlet: 0,6 – 1,5 m/s
4. Kecepatan pipa outlet : 0,3 – 2,5 m/s

   (*Sumber : Bangunan Pengolahan Air Minum, M. Razif, jilid 2*)

5. Jarak nozzle : 0,6 – 3,6 m
6. Tekanan semprot : 10 – 60 psi

**Data Perencanaan**

1. Desain menggunakan aerator spray
2. Debit : 1,97 $m^3$/s = 118,2 $m^3$/min = 170.208 $m^3$/hari
3. Jumlah bak = 4 bak
4. Debit tiap bak = 0,5 $m^3$/s
5. Kedalaman bak : 3 m dengan Freeboard 30%
6. Panjang bak : 2 × lebar
7. Panjang inlet : 5 m

**Perhitungan**

- Pipa inlet

$$D = \left(\frac{Q}{v \times \frac{1}{4} \times \pi}\right)^{1/2} = \left(\frac{0,5\ m^3/dtk}{0,6 \times \frac{1}{4} \times 3,14}\right)^{1/2} = 1,03\ \text{m} \approx 1\ \text{m}$$

Memakai pipa berdiameter 1000 mm sesuai dengan pipa yang tersedia di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf.

$$v\ cek = \left(\frac{Q}{\frac{1}{4} \times \pi \times D^2}\right)$$

$$= \left(\frac{0,5\ m^3/dtk}{\frac{1}{4} \times 3,14 \times 1^2}\right) = 0,64\ \text{m/s}$$

- Luas bak

  Volume bak = debit × Td = 0,5 $m^3$/dtk × 1800 = 900 $m^3$

  Luas bak = $\frac{Volume}{H}$ = $\frac{900\ m^3}{3\ m}$ = 300 $m^2$
- Dimensi bak aerasi

  Asumsi Panjang : Lebar = 1,5 : 1

  V = P × L × H

  900 $m^3$ = 1,5L × L × 3 m

  900 $m^3$ = $L^2$

  L = 14,15 m

  P = 1,5 × L

  = 1,5 × 14,15 = 21,23 m

  H total = kedalaman + (20%×kedalaman)

  = 3 m + (20% × 3 m)

  = 3,6 m

  Cek volume

  V = P × L × H

  = 21,23 m × 14,15 m × 3,6 m = 1081,46 $m^3$
- Waktu detensi

  Td = $\frac{v}{Q}$ = $\frac{900\ m^3}{0,5\ m^3/dtk}$ = 1800 dtk = 30 menit

**<u>Nozzle</u>**

Menggunakan nozzle merk Everloy type Square Spray Nozzle nomor 600090

Qmaks = 1,5 $m^3$/mnt = 0,025 $m^3$/s

Diameter = 200 mm = 0,32 m

Panjang = 215 mm = 0,44 m

Tekanan = 0,3 MPa = 43,5 psi (memenuhi 10 – 60 psi)

## Square Spray Nozzle Flange type

### ▶ Feature

● Spray pattern of square.

### ▶ Applications

● Wastewater treatment, dust prevention.
● Seawater desalination, deaerators in plants.

### ▶ Materials

● 304 Stainless steel

● Standard type model number list (model: KS····SQF, flange size: 3B to 8B) ●: Model availability

| Flange size | | | | | Model number | Minimum orifice diameter [mm] | Flow rate [L/min] at following pressure [MPa] | | | | | | | Spray angle at 0.07 MPa |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3B | 4B | 5B | 6B | 8B | | | 0.03 | 0.05 | 0.07 | 0.1 | 0.15 | 0.2 | 0.3 | |
| ● | | | | | 90065 | 17 | 335 | 417 | 482 | 562 | 669 | 757 | 900 | 65° |
| ● | | | | | 90090 | 17 | 335 | 417 | 482 | 562 | 669 | 757 | 900 | 90° |
| ● | | | | | 100065 | 18 | 372 | 463 | 535 | 624 | 743 | 841 | 1000 | 65° |
| ● | | | | | 100090 | 18 | 372 | 463 | 535 | 624 | 743 | 841 | 1000 | 90° |
| | ● | | | | 125065 | 20 | 465 | 579 | 669 | 780 | 929 | 1051 | 1250 | 65° |
| | ● | | | | 125090 | 20 | 465 | 579 | 669 | 780 | 929 | 1051 | 1250 | 90° |
| | ● | | | | 150065 | 22 | 558 | 695 | 803 | 936 | 1114 | 1261 | 1500 | 65° |
| | ● | | | | 150090 | 22 | 558 | 695 | 803 | 936 | 1114 | 1261 | 1500 | 90° |
| | | ● | | | 175065 | 24 | 651 | 811 | 937 | 1092 | 1300 | 1471 | 1750 | 65° |
| | | ● | | | 175090 | 24 | 651 | 811 | 937 | 1092 | 1300 | 1471 | 1750 | 90° |
| | | ● | | | 200065 | 26 | 744 | 926 | 1071 | 1248 | 1486 | 1681 | 2000 | 65° |
| | | ● | | | 200090 | 26 | 744 | 926 | 1071 | 1248 | 1486 | 1681 | 2000 | 90° |
| | | ● | | | 250065 | 29 | 930 | 1158 | 1338 | 1560 | 1857 | 2102 | 2500 | 65° |
| | | ● | | | 250090 | 29 | 930 | 1158 | 1338 | 1560 | 1857 | 2102 | 2500 | 90° |
| | | | ● | | 300065 | 32 | 1115 | 1390 | 1606 | 1872 | 2229 | 2522 | 3000 | 65° |
| | | | ● | | 300090 | 32 | 1115 | 1390 | 1606 | 1872 | 2229 | 2522 | 3000 | 90° |
| | | | ● | | 350065 | 34 | 1301 | 1621 | 1873 | 2184 | 2600 | 2942 | 3500 | 65° |
| | | | ● | | 350090 | 34 | 1301 | 1621 | 1873 | 2184 | 2600 | 2942 | 3500 | 90° |
| | | | ● | | 400065 | 37 | 1487 | 1853 | 2141 | 2496 | 2971 | 3363 | 4000 | 65° |
| | | | ● | | 400090 | 37 | 1487 | 1853 | 2141 | 2496 | 2971 | 3363 | 4000 | 90° |
| | | | | ● | 500065 | 41 | 1859 | 2316 | 2676 | 3120 | 3714 | 4203 | 5000 | 65° |
| | | | | ● | 500090 | 41 | 1859 | 2316 | 2676 | 3120 | 3714 | 4203 | 5000 | 90° |
| | | | | ● | 600065 | 45 | 2231 | 2779 | 3212 | 3744 | 4457 | 5044 | 6000 | 65° |
| | | | | ● | 600090 | 45 | 2231 | 2779 | 3212 | 3744 | 4457 | 5044 | 6000 | 90° |

* Method to calculate spray angles
• The spray angle is calculated from the spray opposite side distance at a distance of 1000 mm when spraying downward.

**Perhitungan:**

- Jumlah nozzle $= \dfrac{Q\ tiap\ bak}{Q\ tiap\ nozzle} = \dfrac{0{,}5\ m^3/s}{0{,}025\ m^3/s} = 20$ buah
- Diameter pipa untuk nozzle

  Direncanakan pipa untuk nozzle = 4 buah

  Maka debit tiap pipa $= \dfrac{jumlah\ nozzle}{jumlah\ pipa} \times$ Q nozzle

  $= \dfrac{20}{4} \times 0{,}025\ m^3/s$

  $= 0{,}125\ m^3/s$

  Diameter pipa $= \left(\dfrac{0{,}125\ m^3/s}{0{,}6 m/s \times \frac{1}{4} \times 3{,}14}\right)^{1/2}$

  $= 0{,}52$ m

Menggunakan pipa berdiameter 500 mm sesuai dengan yang tersedia pada vendor https://www.rucika.co.id/wp-content/uploads/2019/08/Brosur-Rucika-Black-2018.pdf.

Cek kecepatan

V $= \frac{Q}{A} = \frac{0,125\ m^3/s}{\frac{1}{4} \times 3,14 \times 0,5^2}$ = 0,64 m/s

- Jarak antar nozzle

  Panjang pipa = panjang bak = 21,23

  Jumlah nozzle tiap pipa $= \frac{jumlah\ nozzle}{jumlah\ pipa} = \frac{20}{4}$ = 5 buah

  Jarak antar nozzle $= \frac{panjang\ pipa}{jumlah\ nozzle + 1} = \frac{21,23}{5+1}$ = 3,54 m

**Resume :**

- Panjang saluran inlet : 5 m
- Lebar saluran inlet : 1,3 m
- Kedalaman saluran inlet : 0,95 m
- H air inlet : 0,65 m
- Kedalaman bak aerasi : 3,3 m
- H air bak aerasi : 3 m
- Lebar bak aerasi : 14,15 m
- Panjang bak aerasi : 21,23 m
- Diameter pipa nozzle : 0,5 m
- Diameter nozzle : 0,2 m
- Panjang nozzle : 0,215 m
- Jumlah nozzle : 20 buah
- Jarak antar nozzle : 3,54 m

**Kebutuhan Oksigen**

**Baku mutu**

1. DO = 6 mg/L

2. Fe = 0,3 mg/L
3. Mn = 0,4 mg/L

**Data Perencanaan**

1. DO = 3 mg/L
2. Fe = 12 mg/L
3. Mn = 10 mg/L

**Perhitungan**

- Kebutuhan oksigen untuk peningkatan DO

  Konsentrasi DO = Kons. DO akhir – Kons. DO awal
  = 6 mg/L – 3 mg/L
  = 3 mg/L

- Kons. Oksigen unuk meremoval Fe dan Mn

  Untuk mengoksidasi 1 mg/L Fe dan Mn diperlukan 0,14 mg/L oksigen secara teoritis. Reaks :

  $4Fe^{+2} + O_2 + 10H_2O \rightarrow 4Fe(OH)^{3-} + 8H^+$

  $2Mn^{+2} + O_2 + 2H_2O \rightarrow 2MnO_2 + 4H^+$

  - Oksidasi 12 mg/L Fe, perlu :

    Kons. Oksigen Fe = 0,14 mg/L × 12 mg/L= 1,68 mg/L
  - Oksidasi 10 mg/L Mn, perlu :

    Kons. Oksigen Mn = 0,14 mg/L × 10 mg/L= 1,4 mg/L
  - Total Kon. Oksigen = Kon.Oksigen Fe + Kon.Oksigen Mn + Kon. DO

    = 1,68 mg/L + 1,4 mg/L + 3 mg/L

    = 6,08 mg/L
  - Kebutuhan oksigen untuk mengolah air baku dengan Q = 500 L/s

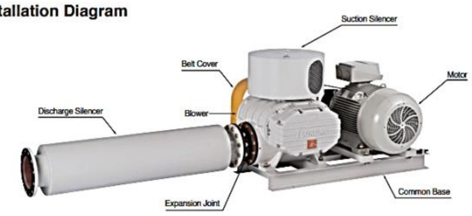
    Kebutuhan $O_2$ $= \frac{(Q \times Kons.Oksigen \times Faktor\ Desain)}{Konversi\ ke\ menit}$

    $= \frac{(500L/s \times 6{,}08mg/L \times 2)}{60}$

    = 101,33 L/mnt

Menggunakan Blowe merk Tsurumi type Tsurumi RSR-KS, nama produk RSR2-50KS (50) https://www.tsurumi-global.com/products/water_treatment_equipment/pdf/RSR-KS_IA103-E.pdf

**Installation Diagram**




| Model (Discharge Bore in mm) | Speed (rpm) | Suction air volume at standard condition (Qs in m³/min) and required power (La in kW) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.1kg/cm² (9.8kPa) | | 0.2kg/cm² (19.6kPa) | | 0.3kg/cm² (29.4kPa) | | 0.4kg/cm² (39.2kPa) | | 0.5kg/cm² (49.0kPa) | | 0.6kg/cm² (58.8kPa) | |
| | | Qs | La | Qs | La | Qs | La | Qs | La | Qs | La | Qs | La |
| RSR2 -50KS (50) | 1240 | 1.46 | 0.74 | 1.26 | 1.07 | 1.12 | 1.37 | 0.99 | 1.68 | 0.86 | 2.02 | 0.72 | 2.32 |
| | 1450 | 1.79 | 0.87 | 1.58 | 1.23 | 1.42 | 1.58 | 1.27 | 1.94 | 1.12 | 2.31 | 1.00 | 2.68 |
| | 1750 | 2.25 | 1.02 | 2.03 | 1.48 | 1.87 | 1.95 | 1.72 | 2.41 | 1.57 | 2.88 | 1.45 | 3.34 |
| | 2100 | 2.84 | 1.24 | 2.58 | 1.82 | 2.40 | 2.39 | 2.23 | 2.98 | 2.05 | 3.57 | 1.91 | 4.16 |
| RSR2 -65KS (65) | 1240 | 1.90 | 0.97 | 1.66 | 1.36 | 1.46 | 1.70 | 1.27 | 2.06 | 1.12 | 2.39 | 0.96 | 2.63 |
| | 1450 | 2.35 | 1.10 | 2.08 | 1.57 | 1.84 | 1.98 | 1.63 | 2.44 | 1.46 | 2.86 | 1.34 | 3.36 |
| | 1750 | 3.04 | 1.35 | 2.70 | 1.93 | 2.46 | 2.51 | 2.25 | 3.19 | 2.07 | 3.85 | 1.92 | 4.60 |
| | 2100 | 3.81 | 1.62 | 3.40 | 2.32 | 3.11 | 3.03 | 2.86 | 3.87 | 2.64 | 4.68 | 2.48 | 5.65 |
| RSR2 -80KS (80) | 1150 | 3.72 | 1.45 | 3.31 | 2.16 | 2.96 | 2.74 | 2.67 | 3.31 | 2.37 | 3.76 | 2.14 | 4.19 |
| | 1450 | 5.09 | 1.79 | 4.68 | 2.75 | 4.33 | 3.60 | 4.04 | 4.50 | 3.75 | 5.36 | 3.52 | 6.20 |
| | 1750 | 6.46 | 2.09 | 6.05 | 3.27 | 5.70 | 4.36 | 5.41 | 5.55 | 5.12 | 6.73 | 4.88 | 7.91 |
| | 2100 | 8.14 | 2.51 | 7.64 | 3.94 | 7.22 | 5.27 | 6.88 | 6.71 | 6.53 | 8.17 | 6.24 | 9.63 |
| RSR2 -100KS (100) | 1150 | 5.01 | 1.82 | 4.60 | 2.82 | 4.25 | 3.73 | 3.94 | 4.73 | 3.67 | 5.73 | 3.43 | 6.73 |
| | 1450 | 6.71 | 2.18 | 6.31 | 3.45 | 5.96 | 4.64 | 5.65 | 5.82 | 5.37 | 7.09 | 5.13 | 8.36 |
| | 1750 | 8.41 | 2.55 | 8.01 | 4.09 | 7.66 | 5.64 | 7.35 | 7.18 | 7.07 | 8.64 | 6.83 | 10.18 |
| | 2100 | 10.57 | 3.05 | 10.09 | 4.91 | 9.67 | 6.78 | 9.30 | 8.69 | 8.96 | 10.43 | 8.67 | 12.31 |

## 5.5. Koagulasi

Pada perencanaan ini dipilih koagulasi dengan pengadukan cepat (*mixing*) yang bertujuan untuk menyatukan partikel koloid hingga menjadi flok-flok yang akan diendapkan melalui unit selanjutnya.Berikut kriteria, data-data, dan perhitungan yang akan direncanakan:

**a) Bak pembubuh koagulan**

**Kriteria Perencanaan :**

1. Gradien kecepatan (G) = 700-1000/s
   (*Sumber: Reynolds & Richards. 1996. Unit Operations and Processes in Environmental Engineering 2nd edition, hal 184.*)
2. Tinggi bak (H) = 1 – 1,25 lebar bak/diameter bak
   (*Sumber: Reynolds&Richards. 1996. Unit Operations and Processes in Environmental Engineering 2nd edition, hal 185*)
3. Lebar paddle = 1/6 – 1/10 m
   (*Sumber :Ali Masduqi, Operasi & Proses Pengolahan Air, Hal. 113*)
4. Diameter paddle = 50 – 80%
   (*Sumber: Reynolds&Richards. 1996. Unit Operations and Processes in Environmental Engineering 2nd edition, hal 185*)
5. Nre >10000 Turbulen
   (*Sumber: Reynolds&Richards. 1996. Unit Operations and Processes in Environmental Engineering 2nd edition, hal 187*)
6. Kecepatan putaran*paddle* = 20-150 rpm
   (*Sumber: Reynolds&Richards. 1996. Unit Operations and Processes in Environmental Engineering 2nd edition, hal 185*)
7. Massa jenis air (ρ), T (28°C) = 0,9963 g/cm3→ 996,3 kg/m3
8. Viskositas Absolut (μ) T (28°C) = 0,8363 x $10^{-3}$ N.s/m2
   (*Sumber: Reynolds & Richards. 1996. Unit Operations and Processes in Environmental Engineering 2nd edition, hal 762.*)

**Data Perencanaan :**

1. Menggunakan bahan kimia PAC (4 bak koagulan)
2. Debit (Q) = 1,97 $m^3/s$
3. Debit tiap bak = 0,5 $m^3/s$
4. Massa Jenis PAC = 1,23 gr/ml = 1,23 kg/L
5. Konsentrasi PAC liquid = 10% dipasaran
6. Dosis optimum PAC = 30 mg/L (asumsi)
7. Gradien Kecepatan (G) = 700/s
8. Jenis pengaduk = *flat paddle 2 blades*
9. Konstanta pengaduk $K_T$ = 1,7

   (*Sumber :Reynolds & Richards. 1996. Unit Operations and Processes in Environmental Engineering 2nd edition, hal 188*)
10. Kecepatan putaran paddle (n) = 150 rpm → 2,5 rps

**Perhitungan :**

- Kebutuhan PAC harian

  Keb. PAC = Dosis optimum PAC× Q

  = 30 mg/L × 500L/detik

  = 15.000 mg/dtk

  = 1296 kg/hari

  Kadar Kebutuhan Koagulan $= \frac{100\%}{konsentrasi\ PAC} \times$ Kebutuhan PAC

  $= \frac{100\%}{10\%} \times$ 1296 kg/hari

  = 12.960 kg/hari

- Debit koagulan

  $Q_{koagulan} = \frac{KebutuhanPAC}{\rho PAC}$

  $= \frac{12.960\ kg/hari}{1,23\ kg/L}$

  =10.536,6 L/hari

  = 10,54 $m^3$/hari

- Volume bak pembubuh (pembubuhan dilakukan 1 hari)

  V = $Q_{koagulan}$ × td

  = 10,54 $m^3$/hari × 1 hari

  = 10,54 $m^3$

- Dimensi bak (bak bentuk tabung)

  V = ¼ × $\pi$ × $d^2$ × H

  10,54 $m^3$ = ¼ × 3,14 × $d^2$ × 1,25d

  10,54 $m^3$ = 0,98 $d^3$

  D = 2,2 m

  Kedalaman

  H = 1,25 D

  H = 1,25 × 2,2 m

  H = 2,8 m

  Htot = H + Fb

  = 2,8 m + 0,3 m

  = 3,1 m

- Daya Pengadukan

  P = $G^2$ × u × V

  = $(700/s)^2$ × 0,8363 × 10-3 N.s/$m^2$ × 10,54 $m^3$

  = 4319,15 N.m/detik → **4,**32 kw

- Diameter paddle

  Di $= \left(\frac{p}{KT \times n^3 \times \rho}\right)^{1/5} = \left(\frac{4319{,}15\ n.m/dtk}{1{,}7 \times 2{,}5^3 \times 996{,}3\ kg/m^3}\right)^{1/5}$ = 0,7 m

  Lebar paddle

  Wi = ¼ × Di

  = ¼ × 0,7 = 0,175 m

- Jarak paddle dari dasar bak = ½ × Di

  = ½ × 0,7 m = 0,35 m

- Cek bilangan Reynold ($N_{RE}$)

$$N_{RE} = \frac{Di^2 \times n \times \rho}{\mu}$$

$$= \frac{0{,}7^2\ m \times 2{,}5\ rps \times 996{,}3 kg/m^3}{0{,}8363 \times 10^{-3} N.s/m^2}$$

= 1.459.365,66 (memenuhi > 10.000)

- Cek bilangan Froud ($N_{FR}$)

$$N_{FR} = \frac{Di \times n^2}{g} = \frac{0{,}7 \times 2{,}5^2}{9{,}81} = 0{,}45 \text{ (memenuhi} > 10^{-5})$$

- Diameter Pipa Outlet

$$Q \text{ injek} = \frac{volume\ bak\ pembubuh}{waktu\ injeksi}$$

$$= \frac{10{,}54\ m^3}{60\ menit}$$

= 0,175$m^3$/mnt

= 0,003 $m^3$/dtk

$$A \text{ pipa} = \frac{Q\ injek}{v} = \frac{0{,}009\ m^3/dtk}{1\ m/dtk} = 0{,}009\ m^2$$

$$\text{Diameter pipa} = \left(\frac{4 \times A}{3{,}14}\right)^{0{,}5}$$

$$= \left(\frac{4 \times 0{,}009}{3{,}14}\right)^{0{,}5} = 0{,}11\ m$$

Menggunakan pipa berdiameter 100 mm/4 inch sesuai dengan yang tersedia pada vendor https://ksglobaltrading.co.id/produk/detail/104/pipa-besi .

- Cek kecepatan $= \left(\frac{Q}{\frac{1}{4} \times \pi \times D^2}\right) = \left(\frac{0{,}009\ m^3/dtk}{\frac{1}{4} \times 3{,}14 \times 0{,}1^2}\right) = 1{,}1$ m/dtk

- Hf Mayor pipa suction $= \left(\frac{Q}{0{,}2785 \times c \times D^{2{,}65}}\right)^{1{,}85} \times L$

$$= \left(\frac{0{,}003\ m^3/dtk}{0{,}2785 \times 120 \times 0{,}1^{2{,}65}}\right)^{1{,}85} \times 3{,}2$$

= 0,0083 m

- Hf Mayor pipa discharge $= \left(\frac{Q}{0{,}2785 \times c \times D^{2,65}}\right)^{1,85} \times$ L

  $= \left(\frac{0{,}003\ m^3/dtk}{0{,}2785 \times 120 \times 0{,}1^{2,65}}\right)^{1,85} \times 5$

  = 0,013 m
- Hf Statis $= \left(\frac{Q}{0{,}2785 \times c \times D^{2,65}}\right)^{1,85} \times$ L

  $= \left(\frac{0{,}003\ m^3/dtk}{0{,}2785 \times 120 \times 0{,}1^{2,65}}\right)^{1,85} \times 2{,}3$

  = 0,006
- Total Hf Mayor = Hf suction + Hf Discharge + HF Statis

  = 0,0083 m + 0,013 m+ 0,006

  = 0,0273 m
- Hf minor

  3 elbow 90° (K = 0,3)

  $= 3 \times \left(K \times \frac{v^2}{2 \times g}\right)$

  $= 3 \times \left(0{,}3 \times \frac{1{,}1^2}{2 \times 9{,}81}\right) = 0{,}056$ m

  1 gate valve (K = 0,19)

  $= K \times \frac{v^2}{2 \times g}$

  $= 0{,}19 \times \frac{1{,}1^2}{2 \times 9{,}81} = 0{,}012$ m

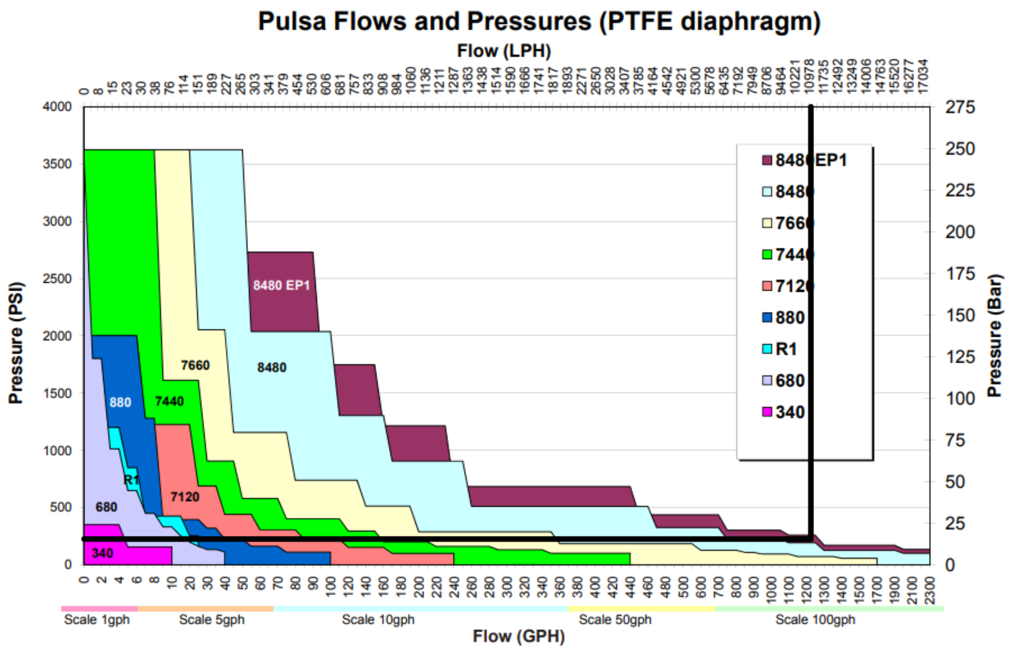
  Total Hf Minor = 0,056 m + 0,012 m = 0,068 m

  Total head = Hf Mayor + Hf minor

  = 0,0273 m + 0,068 m

  = 0,0953 m

  Berdasarkan data, Pompa yang digunakan adalah pompa Pulsa Series 8481EP1 dengan laju aliran maksimum 10978 L/jam dan tekanan pompa mencapai 300 PSI (Pounds per Square Inch)




## b) Bak Koagulasi

**Data Perencanaan :**

1. Jumlah bak = 2 bak
2. Debit air baku = 1,97 $m^3$/dtk
3. Debit tiap bak = 1 $m^3$/dtk
4. Tinggi bak = 2 m dengan Freeboad 30%
5. Volume bak pembubuh = 10,54 $m^3$
6. Gradient kecepatan = 700/s
7. Bilangan Reynold = >10.000
8. Massa jenis air (ρ), T (28°C) = 0,9963 g/cm3 → 996,3 kg/m3
9. Viskositas Absolut (μ) T (28°C) = 0,8363 x $10^{-3}$ N.s/m2

   (*Sumber: Reynolds & Richards. 1996. Unit Operations and Processes in Environmental Engineering 2nd edition, hal 762.*)

**Perhitungan :**

- Volume bak

  Volume air baku = $Q_{air\ baku} \times Td$

  = $0{,}5\ m^3/dtk \times 60\ dtk$

  = $30\ m^3$

  Total volume = Vol. Air baku + Vol. Bak pembubuh

  = $30\ m^3 + 10{,}54\ m^3$

  = $40{,}54\ m^3$

- Dimensi bak koagulasi

  Luas bak $= \frac{volume}{H} = \frac{40{,}54\ m^3}{2\ m} = 20{,}27\ m^2$

  Dimensi bak (panjang : lebar = 1 : 1)

  A = $S^2$

  $20{,}27\ m^2 = S^2$

  S = 4,5 m

- Daya pengadukan bak koagulasi (P)

  P = $G^2 \times \mu \times$ Volume

  = $700/s^2 \times 0{,}8363\times10^{-3}\ Ns/m^3 \times 40{,}54\ m^3$

  = 16613 Nm/s

  = 16613 Watt

  = 16,613 kW

  Dari perhitungan tenaga/power yang didapat, maka spesifikasi motor pengaduk yang digunakan adalah type C1T-30 vertical agitator type, output 22 kW.

- Diameter impeller (Di)

  $$Di = \left(\frac{P}{kt \times n^3 \times \rho}\right)^{1/5}$$

  $$= \left(\frac{16.613}{2{,}75 \times 2{,}5^3 \times 996{,}3}\right)^{1/5} = 0{,}83\ m$$

- Tinggi paddle dari dasar bak (T)

  T = ½ Di = ½ × 0,83 m = 0,42 m

- Cek Bilangan Reynold

  Nre $= \frac{Di^2 \times n \times \rho}{\mu}$

  $= \frac{0,83^2 \times 2,5 \times 996,3}{0,0008363} = 2.039.530,14$

  Nilai Nre melebihi 10.000 sehingga aliran air memenuhi kategori turbulen.

- Pipainlet dan outlet

  D $= \left(\frac{Q}{v \times \frac{1}{4} \times \pi}\right)^{1/2} = \left(\frac{0,5\ m^3/dtk}{0,6 \times \frac{1}{4} \times 3,14}\right)^{1/2}$ = 1,03 m ≈ 1 m

  Memakai pipa berdiameter 1000 mm sesuai dengan pipa yang tersedia di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf.

  v cek $= \left(\frac{Q}{\frac{1}{4} \times \pi \times D^2}\right)$

  $= \left(\frac{0,5\ m^3/dtk}{\frac{1}{4} \times 3,14 \times 1^2}\right)$ = 0,64 m/s

  Headloss $= \left(\frac{10,67 \times Q^{1,85}}{130^{1,85} \times D^{4,87}}\right)$ × L m

  $= \left(\frac{10,67 \times 0,5^{1,85}}{130^{1,85} \times 1^{4,87}}\right)$ × 5 m

  = 0,00182 m

  Slope $= \frac{Hf}{L} = \frac{0,00182}{5}$ = 0,000364

**Resume :**

- Diameter bak pembubuh = 2,2 m
- Kedalam bak pembubuh = 3,1 m
- Diameter paddle bak pembubuh = 0,7 m

- Lebar paddle bak pembubuh = 0,175 m
- Jarak paddle dari dasar bak pembubuh = 0,35 m
- Diameter pipa menuju bak koagulasi = 0,1 m
- Kedalaman bak koagulasi = 2 m
- Panjang bak koagulasi = 4,5 m
- Lebar bak koagulasi = 4,5 m
- Diameter paddle bak koagulasi = 3,8 m
- Jarak paddle dari dasar bak koagulasi = 1 m
- Diameter pipa inlet outlet = 1 m

# Vertical type

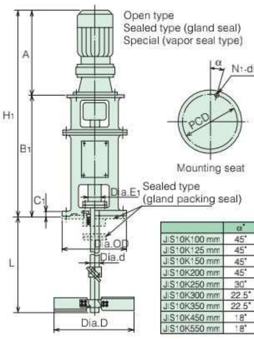
## C1T

**For medium/low speeds (cycloid reducer type)**
**(for processes)**

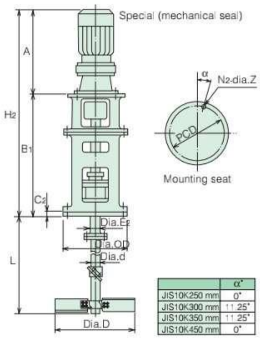
This model has been designed to be rigid for use in processes. Select the model to suit your particular requirements. A high-precision cyclo, Bayel-Cyclo, ring cone, and other adjustable speed reducers can also be mounted. A mechanical seal type is also available.

C1T

## External Dimensions




| | α° |
|---|---|
| JIS10K100 mm | 45° |
| JIS10K125 mm | 45° |
| JIS10K150 mm | 45° |
| JIS10K200 mm | 45° |
| JIS10K250 mm | 30° |
| JIS10K300 mm | 22.5° |
| JIS10K350 mm | 22.5° |
| JIS10K450 mm | 18° |
| JIS10K550 mm | 18° |




| | α° |
|---|---|
| JIS10K250 mm | 0° |
| JIS10K300 mm | 11.25° |
| JIS10K350 mm | 11.25° |
| JIS10K450 mm | 0° |

* The agitation shaft can also be made to custom lengths. Contact your dealer.
* Agitation shafts of diameter 45 or less are sleeve insertion types.
* Gear ratios other those indicated can also be made.

## Body Dimensions

| Mounting Flange | Gear Reducer Frame No. | Motor | Body Related Dimensions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kW | A | $B_1$ | $B_2$ | $C_1$ | $C_2$ | Dia. $E_1$ | Dia. $E_2$ | $H_1$ | $H_2$ |
| 10K100 mm | 4075 | 0.1 | 192 | 285 | — | 13 | — | 16 | — | 477 | — |
| | | 0.2 | 234 | | | | | | | 519 | — |
| 10K125 mm | 4085 | 0.1 | 190 | 379 | — | 16 | — | 22 | — | 569 | — |
| | | 0.2 | 232 | | | | | | | 611 | — |
| | | 0.4 | 252 | | | | | | | 631 | — |
| 10K150 mm | 4095 | 0.1 | 228 | 479 | — | 18 | — | 32 | — | 707 | — |
| | | 0.2 | 270 | | | | | | | 749 | — |
| | | 0.4 | 290 | | | | | | | 769 | — |
| | | 0.75 | 331 | | | | | | | 810 | — |
| | 4105 | 0.4 | 304 | | | | | | | 783 | — |
| | | 0.75 | 345 | | | | | | | 824 | — |
| | | 1.5 | 378 | | | | | | | 857 | — |
| 10K200 mm (10K250 mm mechanical seal type) | 4105 | 0.4 | 304 | 592 | 682 | 22 | 45 | 45 | 40·45 | 896 | 986 |
| | | 2.2 | 398 | | | | | | | 990 | 1080 |
| | 4115 | 0.75 | 354 | 596 | 686 | | | | | 950 | 1040 |
| | | 1.5 | 387 | | | | | | | 983 | 1073 |
| | | 2.2 | 407 | | | | | | | 1003 | 1093 |
| | | 3.7 | 430 | | | | | | | 1026 | 1116 |
| 10K250 mm | 4115 | 0.75 | 354 | 678 | 763 | 25 | 45 | 65 | 50 to 65 | 1032 | 1117 |
| | | 2.2 | 407 | | | | | | | 1085 | 1170 |
| | 413□ | 1.5 | 434 | 686 | 771 | | | | | 1120 | 1205 |
| | | 2.2 | 454 | | | | | | | 1140 | 1225 |
| | | 3.7 | 477 | | | | | | | 1163 | 1248 |
| | | 5.5 | 521 | | | | | | | 1207 | 1292 |
| | | 7.5 | 544 | | | | | | | 1230 | 1315 |
| | 414□ | 1.5 | 434 | 701 | 786 | | | | | 1135 | 1220 |
| | | 2.2 | 454 | | | | | | | 1155 | 1240 |
| | | 7.5 | 544 | | | | | | | 1245 | 1330 |
| | 415□ | 3.7 | 477 | | | | | | | 1178 | 1263 |
| 10K250 mm | 415□ | 5.5 | 521 | 701 | 786 | 25 | 45 | 65 | 50 to 65 | 1222 | 1307 |
| | | 11 | 604 | | | | | | | 1305 | 1390 |
| | 416□ | 2.2 | 509 | | | | | | | 1210 | 1295 |
| | | 3.7 | 532 | | | | | | | 1233 | 1318 |
| | | 5.5 | 576 | | | | | | | 1277 | 1362 |
| | | 7.5 | 604 | | | | | | | 1305 | 1390 |
| | | 11 | 664 | | | | | | | 1365 | 1450 |
| 10K300 mm | 416□ | 5.5 | 576 | 827 | 922 | 30 | 55 | 85 | 70 to 80 | 1403 | 1498 |
| | | 7.5 | 604 | | | | | | | 1431 | 1526 |
| | | 15 | 749 | | | | | | | 1576 | 1671 |
| | 417□ | 3.7 | 586 | 831 | 926 | | | | | 1417 | 1512 |
| | | 5.5 | 630 | | | | | | | 1461 | 1556 |
| | | 7.5 | 648 | | | | | | | 1479 | 1574 |
| | | 11 | 708 | | | | | | | 1539 | 1634 |
| | | 22 | 883 | | | | | | | 1714 | 1809 |
| | 418□ | 5.5 | 651 | 835 | 930 | | | | | 1486 | 1581 |
| | | 7.5 | 669 | | | | | | | 1504 | 1599 |
| | | 11 | 729 | | | | | | | 1564 | 1659 |
| | | 15 | 809 | | | | | | | 1644 | 1739 |
| | | 22 | 904 | | | | | | | 1739 | 1834 |
| 10K350 mm | 418□ | 15 | 809 | 945 | 1030 | 35 | 65 | 95·105 | 95 to 105 | 1754 | 1839 |
| | 419□ | 7.5 | 725 | 955 | 1040 | | | | | 1680 | 1765 |
| | | 11 | 785 | | | | | | | 1740 | 1825 |
| | | 22 | 945 | | | | | | | 1900 | 1985 |
| 10K450 mm | 419□ | 11 | 785 | 1140 | 1255 | 40 | 75 | 120·130·140·150 | 110 to 150 | 1925 | 2040 |
| | | 15 | 850 | | | | | | | 1990 | 2105 |
| | 420□ | 22 | 923 | 1175 | 1290 | | | | | 2098 | 2213 |
| | 421□ | 15 | 863 | 1180 | 1295 | | | | | 2043 | 2158 |
| 10K550 mm | — | — | — | (1500) | — | 42 | — | 170 | — | — | — |

□ in the gear reducer frame No. is 0 or 5.

## Specification Dimensions

| Model | Motor Output | Gear Reducer Frame No. | Gear Reducer Gear Ratio | Revolution speed (rpm) 50 Hz | Revolution speed (rpm) 60 Hz | Agitation Shaft Standard Length (L) | Agitation Shaft Dia. (Dia.d) | 2-vane Paddle 2-stage Dia. (Dia.d) | Mounting Flange Nominal Dia JIS-10K | Mounting Flange Outer Dia. (OD) | Mounting Flange Pitch (PCD) | Hole (Z) | Hole (N1) | Hole (N2) | Max. Agitation Capacity Diluted Liquids | Max. Agitation Capacity Medium Viscosity Liquid | Approx. Weight W/ motor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kW | # | i | 50 Hz | 60 Hz | mm | mm | mm | | mm | mm | mm | pcs | pcs | L | L | kg |
| | | | 1/11 | 136 | 164 | | | 200 | | | | | | | | | 25 |
| | | | 1/17 | 88 | 106 | | | 250 | | | | | | | | | 25 |
| | | 4075 | 1/29 | 52 | 62 | 1000 | 16 | 350 | 100 mm | 210 | 175 | 19 | 4 | — | | | 26 |
| C1T□-0.1 | 0.1 | | 1/35 | 43 | 51 | | | 400 | | | | | | | 700 | 300 | 26 |
| | | | 1/43 | 35 | 42 | | | 450 | | | | | | | | | 26 |
| | | 4085 | 1/59 | 25 | 31 | 1200 | 22 | 500 | 125 mm | 250 | 210 | 23 | 4 | — | | | 41 |
| | | 4095 | 1/87 | 17 | 21 | 1500 | 32 | 700 | 150 mm | 280 | 240 | 23 | 4 | — | | | 80 |
| | | 4075 | 1/11 | 136 | 164 | 1000 | 16 | 250 | 100 mm | 210 | 175 | 19 | 4 | — | | | 26 |
| | | | 1/17 | 88 | 106 | | | 350 | | | | | | | | | 27 |
| | | | 1/29 | 52 | 62 | | | 450 | | | | | | | | | 41 |
| C1T□-0.2 | 0.2 | 4085 | 1/35 | 43 | 51 | 1200 | 22 | 500 | 125 mm | 250 | 210 | 23 | 4 | — | 1300 | 600 | 42 |
| | | | 1/43 | 35 | 42 | | | 550 | | | | | | | | | 43 |
| | | 4095 | 1/59 | 25 | 31 | 1500 | 32 | 600 | 150 mm | 280 | 240 | 23 | 4 | — | | | 79 |
| | | | 1/87 | 17 | 21 | | | 800 | | | | | | | | | 85 |
| | | 4085 | 1/11 | 136 | 164 | 1200 | 22 | 350 | 125 mm | 250 | 210 | 23 | 4 | — | | | 42 |
| | | | 1/17 | 88 | 106 | | | 400 | | | | | | | | | 42 |
| | | | 1/29 | 52 | 62 | | | 550 | | | | | | | | | 79 |
| C1T□-0.4 | 0.4 | 4095 | 1/35 | 43 | 51 | 1500 | 32 | 600 | 150 mm | 280 | 240 | 23 | 4 | — | 2500 | 1200 | 80 |
| | | | 1/43 | 35 | 42 | | | 650 | | | | | | | | | 80 |
| | | 4105 | 1/59 | 25 | 31 | | | 900 | | | | | | | | | 91 |
| | | | 1/87 | 17 | 21 | 2200 | 45 | 1150 | 200 mm | 330 | 290 | 23 | 4 | — | | | 140 |
| | | 4095 | 1/11 | 136 | 164 | | | 400 | | | | | | | | | 81 |
| | | | 1/17 | 88 | 106 | | | 550 | | | | | | | | | 83 |
| | | | 1/29 | 52 | 62 | 1500 | 32 | 700 | 150 mm | 280 | 240 | 23 | 4 | — | | | 88 |
| C1T□-0.75 | 0.75 | 4105 | 1/35 | 43 | 51 | | | 800 | | | | | | | 5000 | 2500 | 92 |
| | | | 1/43 | 35 | 42 | | | 900 | | | | | | | | | 95 |
| | | 4115 | 1/59 | 25 | 31 | 2200 | 45 | 1000 | 200 mm | 330 | 290 | 23 | 4 | — | | | 150 |
| | | | 1/87 | 17 | 21 | 2400 | 50 | 1350 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 268 |
| | | 4105 | 1/11 | 136 | 164 | 1500 | 32 | 500 | 150 mm | 280 | 240 | 23 | 4 | — | | | 89 |
| | | | 1/17 | 88 | 106 | | | 600 | | | | | | | | | 90 |
| | | | 1/29 | 52 | 62 | | | 800 | | | | | | | | | 143 |
| C1T□-1.5 | 1.5 | 4115 | 1/35 | 43 | 51 | 2200 | 45 | 900 | 200 mm | 330 | 290 | 23 | 4 | — | 10000 | 5000 | 145 |
| | | | 1/43 | 35 | 42 | | | 1000 | | | | | | | | | 153 |
| | | 4130 | 1/59 | 25 | 31 | 2400 | 50 | 1200 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 279 |
| | | 4145 | 1/87 | 17 | 21 | | | 1600 | | | | | | | | | 338 |
| | | 4105 | 1/11 | 136 | 164 | | | 550 | | | | | | | | | 130 |
| | | | 1/17 | 88 | 106 | 2200 | 45 | 700 | 200 mm | 330 | 290 | 23 | 4 | — | | | 143 |
| | | 4115 | 1/29 | 52 | 62 | | | 950 | | | | | | | | | 150 |
| C1T□-2.2 | 2.2 | | 1/35 | 43 | 51 | | | 1000 | | | | | | | 15000 | 7500 | 255 |
| | | 4130 | 1/43 | 35 | 42 | 2400 | 50 | 1100 | | | | | | | | | 279 |
| | | 4145 | 1/59 | 25 | 31 | | | 1350 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 296 |
| | | 4160 | 1/87 | 17 | 21 | 2600 | 60 | 1750 | | | | | | | | | 408 |
| | | 4115 | 1/11 | 136 | 164 | 2200 | 45 | 600 | 200 mm | 330 | 290 | 23 | 4 | — | | | 152 |
| | | | 1/17 | 88 | 106 | | | 750 | | | | | | | | | 154 |
| | | 4135 | 1/29 | 52 | 62 | 2400 | 50 | 1000 | | | | | | | | | 285 |
| C1T□-3.7 | 3.7 | | 1/35 | 43 | 51 | | | 1200 | 250 mm | 400 | 355 | 23 | 6 | 12 | 25000 | 12000 | 293 |
| | | 4155 | 1/43 | 35 | 42 | 2600 | 60 | 1300 | | | | | | | | | 326 |
| | | 4160 | 1/59 | 25 | 31 | | | 1500 | | | | | | | | | 378 |
| | | 4170 | 1/87 | 17 | 21 | 2800 | 70 | 1950 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 626 |
| | | 4130 | 1/11 | 136 | 164 | 2400 | 50 | 650 | | | | | | | | | 276 |
| | | | 1/17 | 88 | 106 | | | 800 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 281 |
| | | 4155 | 1/29 | 52 | 62 | 2600 | 60 | 1100 | | | | | | | | | 320 |
| C1T□-5.5 | 5.5 | 4160 | 1/35 | 43 | 51 | | | 1300 | | | | | | | 35000 | 18000 | 366 |
| | | | 1/43 | 35 | 42 | 2800 | 70 | 1400 | | | | | | | | | 472 |
| | | 4170 | 1/59 | 25 | 31 | | | 1700 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 588 |
| | | 4180 | 1/87 | 17 | 21 | 3000 | 80 | 2150 | | | | | | | | | 722 |
| | | 4135 | 1/11 | 136 | 164 | 2400 | 50 | 700 | | | | | | | | | 292 |
| | | 4145 | 1/17 | 88 | 106 | 2600 | 60 | 850 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 319 |
| | | 4160 | 1/29 | 52 | 62 | | | 1200 | | | | | | | | | 370 |
| C1T□-7.5 | 7.5 | 4165 | 1/35 | 43 | 51 | 2800 | 70 | 1400 | | | | | | | 50000 | 25000 | 512 |
| | | 4170 | 1/43 | 35 | 42 | | | 1500 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 568 |
| | | 4180 | 1/59 | 25 | 31 | 3000 | 80 | 1850 | | | | | | | | | 680 |
| | | 4190 | 1/87 | 17 | 21 | 3500 | 100 | 2250 | 350 mm | 490 | 445 | 25 | 8 | 16 | | | 1085 |
| | | 4155 | 1/11 | 136 | 164 | 2600 | 60 | 750 | 250 mm | 400 | 355 | 25 | 6 | 12 | | | 329 |
| | | 4160 | 1/17 | 88 | 106 | | | 900 | | | | | | | | | 368 |
| | | 4170 | 1/29 | 52 | 62 | 2800 | 70 | 1300 | | | | | | | | | 563 |
| C1T□-11 | 11 | 4175 | 1/35 | 43 | 51 | 3000 | 80 | 1500 | 300 mm | 445 | 400 | 25 | 8 | 16 | 75000 | 35000 | 617 |
| | | 4180 | 1/43 | 35 | 42 | | | 1600 | | | | | | | | | 670 |
| | | 4190 | 1/59 | 25 | 31 | 3500 | 100 | 1950 | 350 mm | 490 | 445 | 25 | 8 | 16 | | | 1038 |
| | | 4195 | 1/87 | 17 | 21 | 3800 | 110 | 2450 | 450 mm | 620 | 565 | 27 | 10 | 20 | | | 1461 |
| | | 4160 | 1/11 | 136 | 164 | 2800 | 70 | 800 | | | | | | | | | 549 |
| | | 4165 | 1/17 | 88 | 106 | | | 1100 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 562 |
| | | 4180 | 1/29 | 52 | 62 | | | 1400 | | | | | | | | | 693 |
| C1T□-15 | 15 | | 1/35 | 43 | 51 | 3000 | 80 | 1600 | | | | | | | 100000 | 50000 | 732 |
| | | 4185 | 1/43 | 35 | 42 | 3500 | 100 | 1700 | 350 mm | 490 | 445 | 25 | 8 | 16 | | | 987 |
| | | 4195 | 1/59 | 25 | 31 | 3800 | 110 | 2050 | 450 mm | 620 | 565 | 27 | 10 | 20 | | | 1427 |
| | | 4215 | 1/87 | 17 | 21 | | | 2600 | | | | | | | | | 1687 |
| | | 4170 | 1/11 | 136 | 164 | 3000 | 80 | 850 | 300 mm | 445 | 400 | 25 | 8 | 16 | | | 701 |
| C1T□-30 | 22 | 4180 | 1/17 | 88 | 106 | | | 1100 | | | | | | | 150000 | 75000 | 740 |
| | | 4190 | 1/29 | 52 | 62 | 3500 | 100 | 1500 | 350 mm | 490 | 445 | 25 | 8 | 16 | | | 1092 |
| | | 4205 | 1/43 | 43 | 51 | 3800 | 110 | 1900 | 450 mm | 620 | 565 | 27 | 10 | 20 | | | 1518 |

- Contact your dealer when racing may occur.
- The standard paint color is Munsell 7.5GY-5/5.5.
- The standard liquid contact materials are SUS304 and SUS316. Linings can also be made in various materials.
- The standard motor is a totally enclosed fan-cooled outdoor type.

## 5.6. Flokulasi

**Kriteria Perencanaan :**

1. Debit : 1,97 $m^3$/dtk
2. Jumlah bak : 4 bak
3. Kedalaman : 5 m
4. Kompartemen : 3 buah
5. Waktu detensi (Air Sungai) : 1200 detik

   (*Sumber : Masduqi & Assomadi, 2012:110*)
6. Gradient kecepatan kompartemen 1 : 50/dtk
7. Gradient kecepatan kompartemen 2 : 20/dtk
8. Gradient kecepatan kompartemen 3 : 10/dtk
9. Massa jenis air (ρ), T (28°C) : 0,9963 g/cm3→996,3 kg/m3
10. Viskositas Absolut (μ) T (28°C) : 0,8363 x $10^{-3}$ N.s/$m^2$

    (*Sumber: Reynolds & Richards, 1996:762.*)
11. Nilai koefisien kekasaran dinding : 0,3

**Perhitungan :**

**a) Bangunan Flokulasi**

- Debit tiap bak $= \frac{Q}{jumlah\ bak} = \frac{1{,}97\ m^3/dtk}{4}$ = 0,5 $m^3$/dtk
- Td total = Td × Jumlah Kompartemen

  = 1200 dtk × 3 = 3600 dtk
- Volume total = Q tiap bak × Td

  = 0,5 $m^3$/dtk × 3600 dtk= 1800 $m^3$
- Luas penampang (A) $= \frac{volume}{kedalaman} = \frac{1800\ m^3}{5\ m}$ = 360 $m^2$
- Dimensi bak

  Asumsi Panjang : Lebar = 2 : 1

  Volume = P × L × H

  1800 $m^3$ = 2L × L × 5 m

  L = 13,42 m

Panjang = 2 L

= 2 × 13,42 m = 26,84 m

- Sehingga untuk tiap kompartemen

Panjang = 26,84 m

Lebar = $\frac{lebar\ bak}{jumlah\ kompartemen} = \frac{13,42\ m}{3}$ = 4,47 m

**b) Dimensi Kompartemen**

- Perhitungan kompartemen 1

Jumlah baffle (n) = $\left[\left(\frac{2\times\mu\times Td}{\rho(1,44+f)}\right)\left(\frac{H\times P\times G}{Q}\right)^2\right]^{1/3}$

= $\left[\left(\frac{2\times0,8363\times10^{-3}\times1200}{996,3(1,44+0,3)}\right)\left(\frac{5\times26,84\times50}{0,5}\right)^2\right]^{1/3}$

= 59 baffle

Jarak antar sekat = $\frac{P}{n} = \frac{26,84\ m}{59}$ = 0,45 m

Headloss kompartemen 1 ($Hf_1$) = $\frac{\mu\times Td}{\rho\times g}\times G^2$

= $\frac{0,8363\times10^{-3}\times1200}{996,3\times9,81}\times 50^2$

= 0,257 m

- Perhitungan Kompartemen 2

Jumlah baffle (n) = $\left[\left(\frac{2\times\mu\times Td}{\rho(1,44+f)}\right)\left(\frac{H\times P\times G}{Q}\right)^2\right]^{1/3}$

= $\left[\left(\frac{2\times0,8363\times10^{-3}\times1200}{996,3(1,44+0,3)}\right)\left(\frac{5\times26,84\times20}{0,5}\right)^2\right]^{1/3}$

= 32 baffle

Jarak antar sekat = $\frac{P}{n} = \frac{26,84\ m}{32}$ = 0,84 m

Headloss kompartemen 1 ($Hf_2$) = $\frac{\mu\times Td}{\rho\times g}\times G^2$

= $\frac{0,8363\times10^{-3}\times1200}{996,3\times9,81}\times 20^2$

= 0,041 m

- Perhitungan Kompartemen 3

Jumlah baffle (n) $= \left[\left(\frac{2\times\mu\times Td}{\rho(1,44+f)}\right)\left(\frac{H\times P\times G}{Q}\right)^2\right]^{1/3}$

$= \left[\left(\frac{2\times0,8363\times10^{-3}\times1200}{996,3(1,44+0,3)}\right)\left(\frac{5\times26,84\times10}{0,5}\right)^2\right]^{1/3}$

= 20 baffle

Jarak antar sekat $= \frac{P}{n} = \frac{26,84\ m}{20}$ = 1,34 m

Headloss kompartemen 1 ($Hf_3$) $= \frac{\mu\times Td}{\rho\times g}\times G^2$

$= \frac{0,8363\times10^{-3}\times1200}{996,3\times9,81}\times10^2$

=0,01 m

- Total Headloss = $Hf_1 + Hf_2 + Hf_3$

= 0,257 + 0,041 + 0,01 = 0,308 m

**c) Pipa Inlet dan Outlet**

- Diameter pipa inlet outler

D $= \left(\frac{Q}{v\times\frac{1}{4}\times\pi}\right)^{1/2} = \left(\frac{0,5\ m^3/dtk}{0,6\times\frac{1}{4}\times3,14}\right)^{1/2}$ = 1,03 m ≈ 1 m

Memakai pipa berdiameter 1000 mm sesuai dengan pipa yang tersedia di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf.

- v cek $= \left(\frac{Q}{\frac{1}{4}\times\pi\times D^2}\right)$

$= \left(\frac{0,5\ m^3/dtk}{\frac{1}{4}\times3,14\times1^2}\right)$ = 0,64 m/s

- Headloss $= \left(\frac{10,67\times Q^{1,85}}{130^{1,85}\times D^{4,87}}\right)\times L$ m

$= \left(\frac{10,67\times0,5^{1,85}}{130^{1,85}\times1^{4,87}}\right)\times5$ m

= 0,00182 m

- Slope $= \frac{Hf}{L} = \frac{0,00182}{5}$ = 0,000364

**Resume :**

- Kedalaman bak flokulasi = 5 m
- Panjang bak flokulasi = 26,84 m
- Lebar bak flokulasi = 13,42 m
- Panjang tiap kompartemen = 26,84
- Lebar tiap kompartemen = 4,47 m
- Jumlah baffle kompartemen 1 = 59 baffle
- Jarak baffle kompartemen 1 = 0,45 m
- Jumlah baffle kompartemen 2 = 32 baffle
- Jarak baffle kompartemen 2 = 0,84 m
- Jumlah baffle kompartemen 3 = 20 baffle
- Jarak baffle kompartemen 3 = 1,34 m
- Pipa inlet dan outlet = 1 m

## 5.7. Sedimentasi 1

### a) Zona Inlet

**Kriteria Perencanaan :**

1. Debit air baku = 1,97 $m^3$/dtk
2. Debit tiap bak = 0,5 $m^3$/dtk
3. Kecepatan aliran = 0,6 m/dtk
4. Lebar Saluran = 5 m
5. Koefisien manning saluran beton = 0,013

(Tata Cara Perencanaan Sistem Drainase Perkotaan, Nomor 12/PRT/M/2014)

**Perhitungan :**

- Luas Permukaan $= \frac{Q}{v} = \frac{0{,}5\ m^3/dtk}{0{,}6\ m/dtk}$ = 0,83 $m^2$
- Diasumsikan Panjang : Kedalaman = 1 : 2

  A = L × H

  0,83 = 2H × H

  H = 0,65 m

  Htotal = Kedalaman saluran + Freeboard

  = 0,65 m + 0,3 m

  = 0,95 m

  Dimensi saluran (Panjang : Kedalaman = 2 : 1)

  Panjang = 2×0,95

  = 1,9 m

- Jari – jari hidrolis (R) $= \frac{Lebar \times Kedalaman}{(2 \times lebar) + kedalaman}$

  $= \frac{1{,}9\ m \times 0{,}95\ m}{(2 \times 1{,}9\ m) + 0{,}95\ m}$

  = 0,38 m

- Kecepatan aliran $= \frac{1}{n} \times R^{2/3} \times S^{1/2}$

  0,6 m/dtk $= \frac{1}{0{,}013} \times 0{,}38^{2/3} \times S^{1/2}$

  S = 0,00022

- Hf = Slope × L

  = 0,0002 × 1,9 m

  = 0,00038 m
- Headloss saat keluar dari pintu air

  (K gate valve = 0,2)

  Hf $= K \times \frac{v^2}{2 \times g} = 0,2 \times \frac{0,6^2}{2 \times 9,81} = 0,0037$ m

**Resume :**

- Panjang Saluran = 1,9 m
- tinggi air = 0,65 m
- Kedalaman saluran = 0,95 m
- Lebar saluran = 5 m

**b) Zona Pengendap**

**Kriteria Perencanaan**

1. Waktu detensi = 1,5 – 2,5 jam

   (*Sumber : Metcalf & Eddy, 2003:398*)
2. Suhu air = 30°C; $v$ = 0,8039×10-6 m2/dtk; $\rho$ = 995,68 kg/m3; $\mu$ = 0,008004 kg/m.s (Sumber : Reynold & Richards, 1996; 762.)
3. K = 0,05
4. Factor friksi Darcy-weisback (f) = 0,025
5. Specific gravity (Sg) = 2,65 (*Masduqi & Assomadi, 2012*)

**Data Perencanaan**

1. Bak berbentuk rectangular
2. Debit = 1,97 $m^3$/dtk
3. Jumlah bak = 4
4. Debit tiap bak = 0,5 $m^3$/dtk
5. Waktu detensi = 1,5 jam

6. Kedalaman = 5 m
7. Good Performance = 1/3
8. Persen removal = 90%

**Perhitungan**

- Volume bak pengendap = Q × Td
  = 0,5 $m^3$/dtk × 5400 detik
  = 2700 $m^3$
- Luas bak (A) $= \frac{Volume}{H} = \frac{2700}{5} = 540\ m^2$
- Diasumsikan Panjang (L) : Lebar (B) = 5 : 1

  Asumsi L = B, maka :

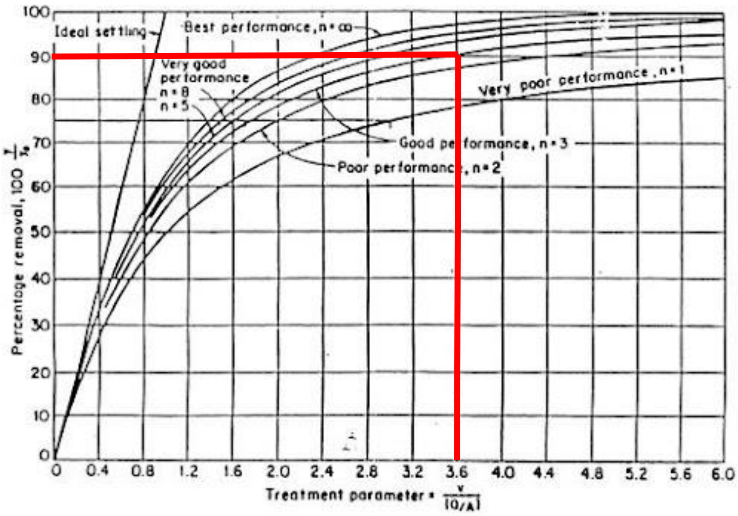
  A = L × B

  540 = 5B × B

  540 = $5B^2$

  B = 10,39m

  Panjang (L) = 5B
  = 5 × 10,39
  = 52 m
- Kecepatan pengendapan ($v_s$)



Berdasarkan grafik diatas untuk persen removal 90% maka :

$\frac{t}{td} = \frac{V_0}{Q/A} = 3{,}6$

$V_0 = \frac{Q}{A} \times 3{,}6 = \frac{0{,}5\ m^3/dtk}{540\ m^2} \times 3{,}6 = 0{,}000333$ m/s

- Jari – jari hidrolis (R) $= \frac{Lebar \times Kedalaman}{(2 \times lebar) + kedalaman}$

  $= \frac{10{,}39\ m \times 5\ m}{(2 \times 10{,}39\ m) + 5\ m}$

  = 2,02 m

- Kecepatan horizontal (Vh) $= \frac{Q}{L \times H} = \frac{0{,}5\ m^3/s}{52\ \text{m} \times 5\ \text{m}}$ = 0,0019 m/detik

- Diameter partikel (d) $= \left(\frac{18 \times v_0 \times \mu}{(Sg-1)g}\right)^{1/2}$

  $= \left(\frac{18 \times 0{,}000333 \times 0{,}008004}{(2{,}65-1)9{,}81}\right)^{1/2}$

  = 0,001722 m

- Kecepatan scoring ($V_{sc}$) $= \left(\frac{8.k(Sg-1)d.g}{f}\right)^{1/2}$

  $= \left(\frac{8 \times 0{,}05(2{,}65-1)0{,}002723 \times 9{,}81}{0{,}025}\right)^{1/2}$

  = 0,8398 m/detik

- Jika nilai vh< vsc maka tidak terjadi penggerusan

- Kontrol Froud Number (Nfr) $= \frac{{v_h}^2}{g \times R}$

  $= \frac{0{,}0019^2}{9{,}81 \times 2{,}02}$

  $= 0{,}18 \times 10^{-6}$

- Kontrol Reynold Number (Nre) $= \frac{v_h \times R}{v}$

  $= \frac{0{,}0019 \times 2{,}02}{0{,}8039 \times 10^{-6}}$ = 4832

Nilai $N_{re}$<2000 dan $N_{fr}$> $10^{-5}$, jika tidak sesuai maka aliran dapat dikatakan turbulen. Pada perhitungan di atas nilai $N_{re}$> 2000 dan $N_{fr}$< $10^{-5}$, perlu direncanakan perforated baffle pada bak sedimentasi agar aliran menjadi laminar.

**Resume**

- Luas bak pengendap (A) = 540 $m^2$
- Panjang bak pengendap (L) = 52 m
- Lebar bak pengendap (B) = 10,39 m
- Kedalaman pengendap = 5 m

**c) Perforated Baffle**

**Kriteria Perencanaan :**

1. *Perforated baffle* dipasangkan di zona inlet
2. Diameter lubang (Dlubang) = 0,15 m
3. Panjang baffle = Lebar zona inlet = 5 m
4. Tinggi baffle = tinggi zona inlet = 0,95 m
5. Asumsi kecepatan aliran melalui lubang (v) = 0,6 m/detik

**Perhitungan**

- Luas tiap lubang (A) $= \frac{1}{4} \times \pi \times D_{lubang}^2$

  $= \frac{1}{4} \times 3,14 \times 0,15^2$

  $= 0,018\ m^2$

- Luas total lubang $= \frac{Q_{tiap\ bak}}{0,6 \times v}$

  $= \frac{0,5\ m^3/detik}{0,6 \times 0,6\ m/detik}$

  $= 1,38\ m^2$

- Jumlah lubang (n) $= \frac{Luas\ total\ lubang}{Luas\ tiap\ lubang} = \frac{1,38}{0,15} = 9,2$ lubang

  Sehingga jumlah lubang horizontal = 5, jumlah lubang vertical = 2

- Jarak horizontal antar lubang (sh) $= \frac{panjang\ buffle - (\sum lubang \times d)}{(\sum lubang + 1)}$

  $= \frac{5-(5 \times 0,15)}{(5+1)}$

  $= 0,71$ m

- Jarak vertikal antar lubang (sv) $= \frac{tinggi\ buffle - (\sum lubang \times d)}{(\sum lubang + 1)}$

  $= \frac{0,95 - (2 \times 0,15)}{(2 + 1)}$

  $= 0,217$ m
- Jari – jari hidrolis (R) $= \frac{1}{4} \times D$

  $= \frac{1}{4} \times 0,15 = 0,0375$ m
- Kontrol bilangan froud (Nfr) $= \frac{{v_h}^2}{g \times R}$

  $= \frac{0,0019^2}{9,81 \times 0,0375}$

  $= 1 \times 10^{-4} > 10^{-5}$ (memenuhi)
- Kontrol bilangan Reynold ($N_{re}$) $= \frac{v_h \times R}{v}$

  $= \frac{0,0019 \times 0,0375}{0,8039 \times 10^{-6}}$

  $= 88,63 < 2000$ (memenuhi)
- Headloss *perforated baffle* (hv) $= \frac{v^2}{2.g}$

  $= \frac{0,0019^2}{2 \times 9,81} = 0,18 \times 10^{-6}$ m

**Resume :**

- Panjang perforated baffle = 5 m
- Tinggi perforated baffle = 0,95 m
- Diameter tiap lubang = 0,15 m
- Jumlah lubang = 10 lubang
- Jarak lubang horizontal = 0,71 m
- Jarak lubang vertical = 0,13 m

**e) Plate settler**

**Data perencanaan :**

1. Debit plate settler
2. Panjang area plate settler = 2/3 zona settling = 34,7 m
3. Lebar area plate settler = lebar zona settling = 10,39
4. Jarak antar plat = 0,1 m

5. Kemiringan plate settler = 60°
6. Tebal plate settler = 0,005 m
7. Tinggi plate settler = 1,5 m
8. Suhu air = 30°C; $\upsilon$ = 0,8039×$10^{-6}$ $m^2$/dtk; $\rho$ = 995,68 kg/m3; $\mu$ = 0,008004 kg/m.s (Sumber : Reynold & Richards, 1996; 762.)

**Perhitungan**

- Jumlah plate settler $= \left(\frac{Panjang\ plate\ settler}{(jarak\ antar\ plate + tebal\ plate/sin\ \alpha)}\right) + 1$

  $= \left(\frac{34{,}7\ m}{(0{,}1\ m + 0{,}005\ m/sin\ 60)}\right) + 1$

  = 286 plate settler

- Debit melalui plate $= \frac{Q\ bak}{n\ plate - 1}$

  $= \frac{0{,}5\ m^3/dtk}{286-1} = 0{,}0018\ m^3/dtk$

- Luas plate $= \frac{w}{sin\ \alpha} \times L$

  $= \frac{0{,}1\ m}{sin\ 60} \times 10{,}39\ m = 1{,}2\ m$

- Jari – jari hidrolis $= \frac{A\ plate}{2\ (panjang + Lebar)}$

  $= \frac{1{,}2\ m}{2\ (34{,}7+10{,}39)} = 0{,}0133$

- Beban pengaliran pada plat

  Vh $= \frac{Qplate}{A_{plate} \times sin\alpha} = \frac{0{,}0018}{1{,}2\ m \times \sin 60} = 0{,}0017$ m/dtk

- Diameter partikel (d) $= \left(\frac{18 \times v_0 \times \mu}{(Sg-1)g}\right)^{1/2}$

  $= \left(\frac{18 \times 0{,}000417 \times 0{,}008004}{(2{,}65-1)9{,}81}\right)^{1/2} = 0{,}002723$ m

- Kecepatan scoring ($V_{sc}$) $= \left(\frac{8.k(Sg-1)d.g}{f}\right)^{1/2}$

  $= \left(\frac{8 \times 0{,}05(2{,}65-1)0{,}002723 \times 9{,}81}{0{,}025}\right)^{1/2}$

  = 0,8398 m/detik

  Jika nilai vh< vsc maka tidak terjadi penggerusan

- Kontrol Froud Number $= \frac{v_h{}^2}{g \times R}$

$= \frac{0{,}0017^2}{9{,}81 \times 0{,}0133}$

$= 2{,}2 \times 10^{-5}$ (memenuhi)

- Kontrol Reynold Number $= \frac{v_h \times R}{v}$

$= \frac{0{,}0017 \times 0{,}0133}{0{,}8039 \times 10^{-6}}$

$= 28{,}13 < 2000$ (memenuhi)

**d) Zona Lumpur**

➢ Bak Penampung Lumpur

Zona lumpur merupakan area yan digunakan untuk menyimpan lumpur hasil pengendapan. Desain dari zona lumpur didasarkan dari besaran lumpur yang akan dihasilkan dan periode pengurasannya.

**Kriteria perencanaan :**

1. Ruang lumpur berbentuk limas terpancung dengan periode pengurasan 2 kali sehari ( ½ hari = 43.200 detik)
2. Debit = 0,5 m/s
3. Kadar TSS = 3.600 mg/L
4. Kadar BOD = 30 mg/L
5. Efisiensi pengendapan TSS = 90%
6. Efisiensi pengendapan BOD = 80%
7. Berat jenis lumpur = 2650 kg/m$^3$
8. Berat jenis air = 995,94 kg/m$^3$
9. Kadar air dalam lumpur = 95%
10. Kadar SS kering = 5%
11. Panjang permukaan (P1) = lebar bak pengendap = 10,39 m
12. Lebar permukaan (L1) = 10,39 m
13. Panjang dasar (P2) = 6 m
14. Lebar dasar (L2) = 6 m

**Perhitungan :**

- Sludge

Kons. effluent TSS = (100%-90%) × Konsentrasi TSS

= 10% × 3.600

= 360 mg/l

Kons. Effluent BOD = (100% - 80%) × Konsentrasi BOD

= 20% × 30 mg/L

= 6 mg/L

TSS teremoval = 90% × konsentrasi TSS

= 90% × 3600

= 3.240 mg/l =3,24 Kg/m$^3$

BOD teremoval = 80% × Konsentrasi BOD

= 80% × 30 mg/L

= 24 mg/L = 0,024 kg/m$^3$

Berat lumpur (Ws) = Q × TSS Teremoval × BOD Teremoval

= 0,5 m$^3$/s × 3,24 kg/m$^3$ × 0,024 kg/m$^3$

= 0,03888 kg/dtk

= 3359,23 kg/hari

Berat air $= \frac{95\%}{5\%} \times$ Ws

$= \frac{95\%}{5\%} \times 3359{,}23 = 63825{,}37$ kg/hari

Berat jenis lumpur = (ρ lumpur × 5%) +(ρ air × 95%)

= (2650 × 5%) + (995,94 × 95%)

= 1078.643 kg/m$^3$

- Ruang lumpur

Volume ruang lumpur $= \frac{berat\ lumpur + berat\ air}{berat\ jenis\ lumpur}$

$= \frac{3359{,}23 + 63825}{1078{,}634}$

= 62,29 m$^3$

Debit sekali pengurasan = 62,29 $m^3$/hari × 3 hari

= 249,16 $m^3$/hari

Dimensi ruang lumpur :

Panjang permukaan zona lumpur (*P1*) = 10,39 m

Lebar permukaan zona lumpur (L1) = 10,39 m

Panjang dasar zona lumpur (P2) = 6 m

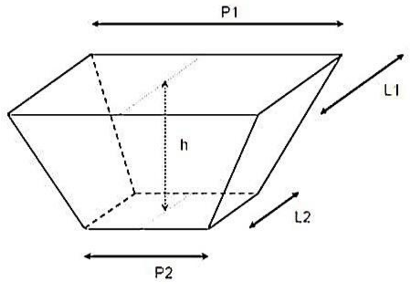
Lebar dasar zona lumpur (L1) = 6 m

$A_1 = P_1 \times L_1$

= 10,39 m × 10,39 m = 107,95 $m^2$

A2 = P2 × L2

= 6 m × 6 m = 25 $m^2$




Volume grit storage $= \frac{1}{3} \times h\ (A_1 + A_2 + \sqrt{A_1 \times A_2}\ )$

$$h = \frac{volume}{\frac{1}{3} \times (A1 + A2 + \sqrt{A_1 \times A_2})}$$

$$h = \frac{249{,}16\ m^3}{\frac{1}{3} \times (107{,}95 + 36 + \sqrt{107{,}95 \times 36})}$$

h = 3,6 m

- Dimensi pipa penguras

**Data perencanaan :**

1. Jumlah pipa = 1 buah
2. Volume sludge = 249,16 $m^3$
3. Kecepatan aliran pipa = 0,6 m/s
4. Waktu pengurasan = 1800 s = 30 mnt

**Perhitungan :**

- Debit tiap pengurasan

Qp $= \frac{volume\ sludge}{waktu\ pengurasan} = \frac{249{,}16\ m^3}{1800\ detik} =$ 0,14 $m^3$/dtk

- Luas permukaan pipa penguras

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

$= \frac{0{,}14\ m^3/dtk}{0{,}6\ m/detik} = 0{,}23\ m^2$

- Diameter pipa penguras

Dp $= \left(\frac{4 \times A}{3{,}14}\right)^{0{,}5}$

$= \left(\frac{4 \times 0{,}23}{3{,}14}\right)^{0{,}5}$

= 0,54 m

Memakai pipa berdiameter 500 mm sesuai dengan pipa yang tersedia di vendor https://www.rucika.co.id/wp-content/uploads/2019/08/Brosur-Rucika-Black-2018.pdf.

- Cek kecepatan

V $= \frac{Q}{\frac{1}{4} \times \pi \times D^2}$

$= \frac{0{,}14\ m^3/dtk}{\frac{1}{4} \times 3{,}14 \times 0{,}5^2} =$ 0,71 m/s

**Resume :**

- Panjang permukaan zona lumpur (*P1*) = 10,39 m
- Lebar permukaan zona lumpur (L1) = 10,39 m
- Panjang dasar zona lumpur (P2) = 6 m
- Lebar dasar zona lumpur (L1) = 6 m
- Tinggi = 3,6 m
- Diameter pipa penguras = 0,5 m

f) **Zona Outlet**

Outlet zone merupakan tempat yang digunakan untuk mengalirkan air bau hasil dari proses pengendapan di settling zone. Berikut ini merupakan perhitungan dari outlet zone.

**Kriteria perencanaan :**

1. Zona outlet bak sedimentasi ini berupa weir bergerigi (v-notch)
2. Bentuk gutter persegi panjang
3. Jumlah gutter 3, 1 gutter dilengkapi dengan 2 buah weir.
4. Lebar v-notch = 0,1 m
5. Jarak v-notch = 0,3 m
6. Sudut v-notch = 45°
7. Koefisien drag (Cd) = 0,584
8. Weir loading = 350 m3/m2.hari
   = 4,1 × 10-3 m3/m2.detik
9. Debit tiap unit = 0,5 $m^3$/detik

**Perhitungan**

➢ Gutter dan Weir

- Debit tiap gutter $= \frac{debit}{jumlah\ gutter} = \frac{0{,}5\ m^3/detik}{3}$ = 0,167 $m^3$/detik
- Panjang weir dibutuhkan $= \frac{debit}{WLR}$
  $= \frac{0{,}167\ m^3/detik}{4{,}1 \times 10^{-3} m^3/m^2.\text{detik}}$
  = 40,7 $m^2$
- Panjang tiap weir $= \frac{panjang\ weir\ dibutuhkan}{jumlah\ weir}$
  $= \frac{40{,}7\ m^2}{6}$
  = 6,8 m
- Debit tiap pelimpah $= \frac{0{,}5\ m^3/detik}{6}$ = 0,0833 $m^3$/dtk

- Luas saluran pelimpah (A) $= \frac{Q/jumlah\ weir}{v}$

  $= \frac{0{,}5\frac{m^3}{dtk}/8}{0{,}6\ m/dtk}$

  = 0,104 $m^2$

- Tinggi (h) dan lebar (w) pelimpah

  Direncanakan h : w = 1 : 2, maka :

  A = h × w

  0,104 = h × 2h

  0,104 = $2h^2$

  h = 0,23 m

  lebar (w) = 2h

  = 2 × 0,23 m

  = 0,46 m

- Tinggi air pada gutter

  H air $= \left(\frac{Q\ gutter}{1{,}38 \times lebar\ gutter}\right)^{2/3}$

  $= \left(\frac{0{,}167}{1{,}38 \times 0{,}46}\right)^{2/3}$

  = 0,4 m

- Tinggi gutter = H air + (Hair × 30%)

  = 0,4 + (0,4 × 30%)

  = 0,52 m

- Lebar saluran gutter

  Direncanakan lebar gutter = 2 × tinggi gutter

  Maka = 2 × 0,52 m = 1,04 m

- Jari – jari hidrolis

  R gutter $= \frac{H\ air \times lebar\ gutter}{(2 \times Hair) + lebar\ gutter}$

  $= \frac{0{,}4 \times 1{,}04}{(2 \times 0{,}4) + 1{,}04}$

  = 0,21 m

- Luas basah gutter = lebar gutter × Hair

  = 1,04 m × 0,4 m = 0,42 m

- Slope gutter $= \left(\frac{Q\ gutter \times n}{A\ gutter \times (R\ guter)^{\frac{2}{3}}}\right)^2$

  $= \left(\frac{0{,}167 \times 0{,}013}{0{,}42 \times (0{,}21)^{\frac{2}{3}}}\right)^2$ = 0,00021

- Headloss pada gutter = panjang gutter × Slope gutter

  = 6,8 m × 0,00021

  = 0,0014

➢ V notch

- Jumlah v notch

  Dimana : panjang weir 6,8 m,

  jumlah v notch $= \frac{panjang\ weir}{jarak\ antar\ v\ notch + lebar\ v\ notch}$

  $= \frac{6{,}8\ m}{0{,}3\ m + 0{,}1\ m}$

  = 17

- Debit tiap v notch $= \frac{Q\ tiap\ weir}{jumlah\ v\ notch}$

  $= \frac{0{,}0625}{17}$= 0,0037 $m^3$/dtk

- Tinggi peluapan melalui v-notch

  Q $= \frac{8}{15} \times$ (cd) $\sqrt{2 \times g} \times$ tan $\frac{\theta}{2} \times H^{5/2}$

  0,0625 $m^3$/dtk $= \frac{8}{15} \times$ (0,584) $\sqrt{2 \times 9{,}81} \times$ tan $\frac{45}{2} \times H^{5/2}$

  H = 0,41 m

➢ Saluran Pengumpul

**Kriteria Perencanaan**

1. Q saluran : 0,5 $m^3$/dtk
2. Kecepatan : 0,6 m/s
3. Lebar saluran = lebar settling : 17,3 m
4. Kedalaman = kedalaman settling : 3 m
5. Waktu detensi : 600 dtk = 10 mnt

**Perhitungan**

- Volume saluran = Q × td

  = 0,5 $m^3$/dtk × 600 dtk

  = 300 $m^3$

- Luas penampang $= \frac{Q}{v} = \frac{0,5\ m^3/dtk}{0,6\ m/dtk}$ = 0,833 $m^2$

- Dimensi saluran pengumpul

  Volume = L × W × H

  L $= \frac{V}{W \times H}$

  $= \frac{300}{17,3 \times 3}$

  = 5,8 m

- Jari – jari hodrolis

  R $= \frac{luaskelilingbasah}{luaspenampangbasah}$

  $= \frac{W \times H}{W + 2H}$

  $= \frac{17,3 \times 3\ m}{17,3 + (2 \times 3\ m)}$

  = 0,5 m

- Slope saluran $= \left(\frac{v \times n}{R^{2/3}}\right)^2$

  $= \left(\frac{0,6 \times 0,013}{0,5^{2/3}}\right)^2$ = 0,00015 m/m

- Headloss saluran pembawa (Hf)

  Hf = S × L

  = 0,00015 × 3 m

  = 0,00045

➢ <u>Saluran outlet</u>

**Data Perencanaan :**

1. Debit air baku = 1,97 $m^3$/dtk
2. Debit tiap bak = 0,5 m3/dtk
3. Kecepatan aliran = 0,6 m/dtk

4. Panjang Saluran = 5 m
5. Koefisien manning saluran beton = 0,013

   (Tata Cara Perencanaan Sistem Drainase Perkotaan, Nomor 12/PRT/M/2014)

**Perhitungan :**

- Diameter pipa inlet outler

$$D = \left(\frac{Q}{v \times \frac{1}{4} \times \pi}\right)^{1/2} = \left(\frac{0,5\ m^3/dtk}{0,6 \times \frac{1}{4} \times 3,14}\right)^{1/2} = 1,03\ \text{m} \approx 1\ \text{m}$$

Memakai pipa berdiameter 1000 mm sesuai dengan pipa yang tersedia di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf.

- v cek $= \left(\frac{Q}{\frac{1}{4} \times \pi \times D^2}\right)$

$$= \left(\frac{0,5\ m^3/dtk}{\frac{1}{4} \times 3,14 \times 1^2}\right) = 0,64\ \text{m/s}$$

- Headloss $= \left(\frac{10,67 \times Q^{1,85}}{130^{1,85} \times D^{4,87}}\right) \times \text{L m}$

$$= \left(\frac{10,67 \times 0,5^{1,85}}{130^{1,85} \times 1^{4,87}}\right) \times 5\ \text{m}$$

$$= 0,00182\ \text{m}$$

Slope $= \frac{Hf}{L} = \frac{0,00182}{5} = 0,000364$

**Resume zona outlet**

- Jumlah gutter : 3 gutter
- Tinggi gutter :0,52 m
- Lebar gutter : 1,04 m
- Slope gutter : 0,00021 m
- Panjang tiap weir : 6,8 m
- Tinggi weir : 0,23 m

- Lebar weir : 0,46 m
- Jumlah v-notch : 17
- Lebar v-notch : 0,1 m
- Jarak antar v-notch : 0,3 m
- Tinggi peluapan : 0,41 m
- Panjang saluran pengumpul : 5,8 m
- Lebar saluran pengumpul : 17,3 m
- Tinggi saluran pengumpul : 3 m
- Diameter pipa inlet outlet : 1 m

## 5.8. Sedimentasi 2

### a) Zona Lumpur

➢ Bak Penampung Lumpur

Zona lumpur merupakan area yan digunakan untuk menyimpan lumpur hasil pengendapan. Desain dari zona lumpur didasarkan dari besaran lumpur yang akan dihasilkan dan periode pengurasannya.

Dikarenakan pada kadar TSS pada sedimentasi 1 belum memenuhi baku mutu, maka perlu dibuat satu bak sedimentasi untuk menurunkan kadar TSS hingga memenuhi baku mutu.

**Kriteria perencanaan :**

1. Ruang lumpur berbentuk limas terpancung dengan periode pengurasan 2 kali sehari ( ½ hari = 43.200 detik)
2. Debit = 0,5 m/s
3. Kadar TSS = 360 mg/L
4. Kadar BOD = 6 mg/L
5. Efisiensi pengendapan TSS = 90%
6. Efisiensi pengendapan BOD = 80%
7. Berat jenis lumpur = 2650 kg/$m^3$
8. Berat jenis air = 995,94 kg/$m^3$
9. Kadar air dalam lumpur = 95%
10. Kadar SS kering = 5%

**Perhitungan :**

- Sludge

  Kons. effluent TSS = (100% - 90% × Konsentrasi TSS
  = 10% × 360= 36 mg/l
  (memenuhi baku mutu <50 mg/L)

  Kons. Effluent BOD = (100% - 80%) × Konsentrasi BOD
  = 20% × 6 mg/L= 1,2 mg/L
  (memenuhi baku mutu < 2 mg/L)

TSS teremoval = 90% × konsentrasi TSS

= 90% × 360

= 324 mg/l

BOD teremoval = 80% × Konsentrasi BOD

= 80% × 6 mg/L

= 4,8 mg/l

Berat lumpur (Ws) = Q × TSS Teremoval × BOD Teremoval

= 0,5 $m^3/s$ × 0,324 $kg/m^3$ × 0,0012 $kg/m^3$

= 0,00001944 kg/dtk

= 16,8 kg/hari

Berat air = $\frac{95\%}{5\%} \times Ws$

= $\frac{95\%}{5\%} \times 16,8 = 319,2$ kg/hari

Berat jenis lumpur = (ρ lumpur × 5%) + (ρ air × 95%)

= (2650 × 5%) + (995,94 × 95%)

= 1078.643 $kg/m^3$

Volume ruang lumpur = $\frac{berat\ lumpur + berat\ air}{berat\ jenis\ lumpur}$

= $\frac{16,8 + 319,2}{1078,634}$

= 0,38 $m^3$/hari

## 5.9. Filtrasi

Pada perencanaan ini dipilih filter pasir cepat dengan multi media, yaitu media pasir, anthrasit, dan garnet.

**a) Pipa Inlet**

**Kriteria Perencanaan :**

1. Kecepatan aliran : 0,3 – 0,6 m/dtk

**Data Perencanaan**

1. Debit air baku = 1,97 $m^3$/dtk
2. Jumlah pipa = 4 buah
3. Debit tiap bak = 0,5 $m^3$/dtk
4. Kecepatan aliran = 0,6 m/dtk

**Perhitungan :**

- Diameter pipa inlet outlet

$$D = \left(\frac{Q}{v\times\frac{1}{4}\times\pi}\right)^{1/2} = \left(\frac{0{,}5\ m^3/dtk}{0{,}6\times\frac{1}{4}\times 3{,}14}\right)^{1/2} = 1{,}03\ \text{m} \approx 1\ \text{m}$$

Memakai pipa berdiameter 1000 mm sesuai dengan pipa yang tersedia di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf.

- v cek

$$= \left(\frac{Q}{\frac{1}{4}\times\pi\times D^2}\right)$$

$$= \left(\frac{0{,}5\ m^3/dtk}{\frac{1}{4}\times 3{,}14\times 1^2}\right) = 0{,}64\ \text{m/s}$$

- Headloss

$$= \left(\frac{10{,}67\times Q^{1{,}85}}{130^{1{,}85}\times D^{4{,}87}}\right)\times L\ \text{m}$$

$$= \left(\frac{10{,}67\times 0{,}5^{1{,}85}}{130^{1{,}85}\times 1^{4{,}87}}\right)\times 5\ \text{m}$$

$$= 0{,}00182\ \text{m}$$

Slope $= \frac{Hf}{L} = \frac{0{,}00182}{5} = 0{,}000364$

**b) Dimensi unit filtrasi**

**Kriteria Perencanaan**

1. Kecepatan penyaringan : 6 – 11 jam
   (*Sumber : Masduqi & Assomadi, 2012:172*)
2. Perbandingan bak filtrasi : L : W = 1 : 1 sampai 2 : 1
   (*Sumber : Masduqi & Assomadi, 2012:188*)

**Data Perencanaan**

1. Debit : 1,97 $m^3$/dtk
2. Kecepatan Penyaringan : 8 m/jam = 0,002222 m/dtk
3. Perbandingan bak : L : W = 1 : 1

**Perhitungan**

- Jumlah bak $= 12 \times Q^{0,5}$
  $= 12 \times 1,97^{0,5}$
  = 16,8 bak ≈ 17 bak

  Digunakan 15 unit sebagai unit operasional dan 2 unit sebagai maintenance
- Debit tiap bak filtrasi

  Qf $= \frac{1,97\ m^3/dtk}{15} = 0,1333\ m^3/dtk$
- Luas tiap unit filtrasi

  Af $= \frac{Q}{v} = \frac{0,1333\ m^3/dtk}{0,002222\ m/dtk} = 59,11\ m^2$

  Dimensi bak (L : W = 1 : 1)

  A $= L \times W$

  $59,11\ m^2 = L^2$

  L = 7,7 m

  L = W maka,

  W = 7,7 m

**Resume**

- Jumlah bak : 15 unit operasional + 2 unit maintenance
- Luas tiap bak : 59,11 $m^2$
- Panjang tiap bak : 7,7 m
- Lebar tiap bak : 7,7 m

**c) Kehilangan tekanan media filter**

**1) Antrasit**

**Kriteria Perencanaan**

1. Debit : 1,97$m^3$/dtk
2. Massa jenis air :996,26 kg/$m^3$
3. Viskositas absolut :0,008004 kg/m.s

   (*Sumber : Reynold & Richards, 1996:762.*)
4. Diameter media antrasit (d) : 1 mm = 0,001 m
5. Rate filtrasi : 4,08 L/dtk.$m^2$
6. Kecepatan filtrasi : 0,00408 m/dtk
7. Kedalaman media (D) : 460 mm = 0,46 m

   (*Sumber : Reynold & Richards, 1996:317*)
8. *Shape factor*(ø) : 1,57

   (*Sumber : Davis, 2010:317*)
9. Porositas (ε) : 0,6

   (*Sumber : Masduqi & Assomadi, 2012:179*)

**Perhitungan**

- $N_{RE}$ $= \frac{\emptyset \times \rho\ air \times d \times kec.\ filtrasi}{\mu}$

  $= \frac{1,57 \times 995,68\ kg/m^3 \times 0,001 \times 0,00408\ m/dtk}{0,008004 kg/m.s}$

  $= 0,79 < 2000$

- Cd $= \frac{24}{N_{RE}} + \frac{3}{\sqrt{N_{RE}}} + 0,34$

  $= \frac{24}{0,79} + \frac{3}{\sqrt{0,79}} + 0,34$

  $= 34,09$

- $Hf_1$ $= \frac{1,067}{\emptyset} \times \frac{D}{g} \times \frac{{V_a}^2}{\epsilon^4} \times \frac{Cd^2}{d}$

  $= \frac{1,067}{1,57} \times \frac{0,46}{9,81} \times \frac{0,00408^2}{0,6^4} \times \frac{34,09}{0,001}$

  $= 0,138$

**2) Pasir**

**Kriteria Perencanaan**

1. Debit : 1,97 $m^3$/dtk
2. Massa jenis air : 995,68 kg/m3
3. Viskositas absolut :0,008004 kg/m.s

   (*Sumber : Reynold & Richards, 1996:762.*)
4. Diameter media antrasit (d) : 0,5 mm = 0,0005 m
5. Rate filtrasi : 4,08 L/dtk.m2
6. Kecepatan filtrasi : 0,00408 m/dtk
7. Kedalaman media (D) : 230 mm = 0,23 m

   (*Sumber : Reynold & Richards, 1996:317*)
8. *Shape* factor(ø) : 0,82

   (*Sumber : Davis, 2010:317*)
9. Porositas (ε) : 0,4

   (*Sumber : Masduqi & Assomadi, 2012:179*)

**Perhitungan**

- $N_{RE}$ $= \frac{\emptyset \times \rho\ air \times d \times kec.\ filtrasi}{\mu}$

  $= \frac{0,82 \times 995,68\ kg/m^3 \times 0,0005 \times 0,00408\ m/dtk}{0,008004 kg/m.s}$

  $= 0,2 < 2000$ (Memenuhi)

- Cd $= \frac{24}{N_{RE}} + \frac{3}{\sqrt{N_{RE}}} + 0,34$

  $= \frac{24}{0,2} + \frac{3}{\sqrt{0,2}} + 0,34$

  $= 127,05$

- $Hf_2$ $= \frac{1,067}{\emptyset} \times \frac{D}{g} \times \frac{{V_a}^2}{\epsilon^4} \times \frac{Cd^2}{d}$

  $= \frac{1,067}{0,82} \times \frac{0,23}{9,81} \times \frac{0,00408^2}{0,4^4} \times \frac{127,05}{0,0005}$

  $= 5,04$

**3) Garnet**

**Kriteria Perencanaan**

1. Debit : 1,97 $m^3$/dtk
2. Massa jenis air : 995,68 kg/m3
3. Viskositas absolut :0,008004 kg/m.s

   (*Sumber : Reynold & Richards, 1996:762.*)
4. Diameter media antrasit (d) : 0,2 mm = 0,0002 m
5. Rate filtrasi : 4,08 L/dtk.m2
6. Kecepatan filtrasi : 0,00408 m/dtk
7. Kedalaman media (D) : 150 mm = 0,15 m

   (*Sumber : Reynold & Richards, 1996:317*)
8. *Shape* factor(ø) : 0,6

   (*Sumber : Davis, 2010:317*)
9. Porositas (ε) : 0,38

   (*Sumber : Masduqi & Assomadi, 2012:179*)

**Perhitungan**

- $N_{RE}$ $= \frac{\emptyset \times \rho\ air \times kec.\ filtrasi}{\mu}$

  $= \frac{0,6 \times 995,68\ kg/m^3 \times 0,0002 \times 0,00408\ m/dtk}{0,008004 kg/m.s}$

  $= 0,006 < 2000$

- Cd $= \frac{24}{N_{RE}} + \frac{3}{\sqrt{N_{RE}}} + 0,34$

$= \frac{24}{0,006} + \frac{3}{\sqrt{0,006}} + 0,34 = 406,55$

- $Hf_3$ $= \frac{1,067}{\emptyset} \times \frac{D}{g} \times \frac{{V_a}^2}{\epsilon^4} \times \frac{Cd^2}{d}$

  $= \frac{1,067}{0,6} \times \frac{0,15}{9,81} \times \frac{0,00408^2}{0,38^4} \times \frac{406,55}{0,0002}$

  $= 44,13$

**d) Backwash**

**1) Antrasit**

**Kriteria desain**

1. Debit : 1,97 $m^3$/dtk
2. Viskositas absolut (μ) :0,008004 kg/m.s

   (*Sumber : Reynold & Richards, 1996:762.*)
3. Diameter media (d) : 1 mm = 0,001 m
4. Kecepatan filtrasi ($V_A$) : 0,00408 m/dtk
5. Kedalaman media (D) : 460 mm = 0,46 m

   (*Sumber : Reynold & Richards, 1996:317*)
6. Massa jenis media (ρ) : 1,35 kg/L = 1350 kg/m
7. Porositas (ε) : 0,6

   (*Sumber : Masduqi & Assomadi, 2012 : 179*)
8. Shape factor (ø) : 1,57
9. Specify gravity (Sg) : 1,6

   (*Sumber : Davis, 2010:11-43*)

**Perhitungan**

- $N_{RE}$ $= \frac{\emptyset \times \rho\ media \times d \times V_A}{\mu}$

  $= \frac{1,57 \times 1350 \times 0,001 \times 0,00408}{0,008004}$

  $=1,08 < 2000$

- Cd $= \frac{24}{N_{RE}} + \frac{3}{\sqrt{N_{RE}}} + 0,34$

  $= \frac{24}{1,08} + \frac{3}{\sqrt{1,08}} + 0,34 = 25,45$

- $Vs_1$ $= \left[\frac{4 \times g}{3 \times Cd}(Sg - 1) \times d\right]^{1/2}$

  $= \left[\frac{4 \times 9{,}81}{3 \times 25{,}45}(1{,}6 - 1) \times 0{,}001\right]^{1/2}$ = 0,018 m/s
- Kecepatan backwash

  $V_b$ = Vs × $\varepsilon^{4,5}$

  = 0,0018 × $0{,}6^{4,5}$ = 0,000181 m/s
- Debit backwash

  Qb = 0,00018 m/s × 1000 L/$m^3$= 0,181 L/s-$m^2$
- Kehilangan tekanan awal backwash

  $H_L$ = (Sg – 1) × (1 – ε) × D

  = (1,6 – 1) × (1 – 0,6) × 0,46 = 0,11 m
- Tinggi ekspansi media

  Le $= D \times \frac{(1-d)}{1-\left(\frac{V_A}{V_s}\right)^{0,22}}$

  $= 0{,}6 \times \frac{(1-0{,}001)}{1-\left(\frac{0{,}00408}{0{,}018}\right)^{0,22}}$= 2,15 m

**2) Pasir**

**Kriteria desain**

1. Debit : 1,97 $m^3$/dtk
2. Viskositas absolut (µ) :0,008004 kg/m.s

   (*Sumber : Reynold & Richards, 1996:762.*)
3. Diameter media (d) : 0,5 mm = 0,0005 m
4. Kecepatan filtrasi ($V_A$) : 0,00408 m/dtk
5. Kedalaman media (D) : 230 mm = 0,23 m

   (*Sumber : Reynold & Richards, 1996:317.*)
6. Massa jenis media (ρ) : 2,65 kg/L = 2650 kg/m
7. Porositas (ε) : 0,4

   (*Sumber : Masduqi & Assomadi, 2012 : 179*)
8. Shape factor (ø) : 0,82
9. Specify gravity (Sg) : 2,65

   (*Sumber : Davis, 2010:11-43*)

**Perhitungan**

- $N_{RE}$ $= \frac{\emptyset \times \rho\ media \times d \times V_A}{\mu}$

  $= \frac{0,82 \times 2650 \times 0,0005 \times 0,00408}{0,008004}$

  = 0,55 < 2000

- Cd $= \frac{24}{N_{RE}} + \frac{3}{\sqrt{N_{RE}}} + 0,34$

  $= \frac{24}{0,55} + \frac{3}{\sqrt{0,55}} + 0,34 = 48,02$

- $Vs_2$ $= \left[\frac{4 \times g}{3 \times Cd}(Sg - 1) \times d\right]^{1/2}$

  $= \left[\frac{4 \times 9,81}{3 \times 48,02}(2,65 - 1) \times 0,0005\right]^{1/2}$ = 0,015 m/s

- Kecepatan backwash

  $V_b$ = Vs × $\varepsilon^{4,5}$

  = 0,0015 × $0,4^{4,5}$= 0,000024 m/s

- Debit backwash

  Qb = 0,000024 m/s × 1000 L/$m^3$= 0,019 L/s-$m^2$

- Kehilangan tekanan awal backwash

  $H_L$ = (Sg – 1) × (1 – ε) × D

  = (2,65 – 1) × (1 – 0,4) × 0,23 = 0,024 m

- Tinggi ekspansi media

  Le $= D \times \frac{(1-d)}{1-\left(\frac{V_A}{V_S}\right)^{0,22}}$

  $=0,23 \times \frac{(1-0,0005)}{1-\left(\frac{0,00408}{0,015}\right)^{0,22}}$ = 0,92 m

**3) Garnet**

**Kriteria Perencanaan**

1. Debit : 1,97 $m^3$/dtk
2. Viskositas absolut (μ) :0,008004 kg/m.s

   (*Sumber : Reynold & Richards, 1996:762.*)
3. Diameter media (d) : 0,2 mm = 0,0002 m

4. Kecepatan filtrasi ($V_A$) : 0,00408 m/dtk
5. Kedalaman media (D) : 150 mm = 0,15 m

   (*Sumber : Reynold & Richards, 1996:317.*)
6. Massa jenis media (ρ) : 1,95 kg/L = 1950 kg/m
7. Porositas (ε) : 0,38

   (*Sumber : Masduqi & Assomadi, 2012 : 179*)
8. Shape factor (ø) : 0,6
9. Specify gravity (Sg) : 3,9

   (*Sumber : Davis, 2010:11-43*)

**Perhitungan**

- $N_{RE}$ $= \frac{\emptyset \times \rho\ media \times d \times V_A}{\mu}$

  $= \frac{0{,}6 \times 1950 \times 0{,}0002 \times 0{,}00408}{0{,}008004}$

  $= 0{,}12 < 2000$
- Cd $= \frac{24}{N_{RE}}$

  $= \frac{24}{0{,}12} + \frac{3}{\sqrt{0{,}12}} + 0{,}34 = 209$
- $Vs_3$ $= \left[\frac{4 \times g}{3 \times Cd}(Sg - 1) \times d\right]^{1/2}$

  $= \left[\frac{4 \times 9{,}81}{3 \times 209}(3{,}9 - 1) \times 0{,}0002\right]^{1/2} = 0{,}006$
- Kecepatan backwash

  $V_b$ $= Vs \times \varepsilon^{4,5}$

  $= 0{,}006 \times 0{,}38^{4,5}$

  = 0,000077 m/s
- Debit backwash

  Qb = 0,000077 m/s × 1000 L/$m^3$

  = 0,077 L/s-$m^2$
- Kehilangan tekanan awal backwash

  $H_L$ = (Sg – 1) × (1 – ε) × D

  = (3,9 – 1) × (1 – 0,38) × 0,15 = 0,27

- Tinggi ekspansi media

Le $= D \times \frac{(1-d)}{1-\left(\frac{V_A}{V_S}\right)^{0,22}}$

$= 0,15 \times \frac{(1-0,0002)}{1-\left(\frac{0,00408}{0,006}\right)^{0,22}} = 1,84$

**e) Sistem manifold**

**1) Pipa manifold**

**Kriteria Perencanaan**

1. Debit : $1,97\ m^3$/dtk
2. Jumlah bak : 15 unit
3. Kecepatan aliran : 1,3 m/s
4. Jarak antar ujung manifold dengan dinding : 20 cm

**Perhitungan**

- Debit tiap bak filtrasi

Qf $= \frac{1,97\ m^3/dtk}{15} = 0,1313\ m^3/dtk$

- Luas penampang pipa

Af $= \frac{Q}{v} = \frac{0,1313\ m^3/dtk}{1,3\ m/dtk} = 0,1\ m^2$

- Diameter pipa manifold $= \sqrt{\frac{Qf}{v \times \frac{1}{4} \times \pi}}$

$= \sqrt{\frac{0,1313}{1,3 \times \frac{1}{4} \times 3,14}} = 0,358$ m

Menggunakan pipa berdiameter 355 mm sesuai dengan yang ada di vendor https://www.rucika.co.id/wp-content/uploads/2019/08/Brosur-Rucika-Black-2018.pdf .

- Panjang pipa manifold = panjang bak filtrasi

**2) Pipa Lateral**

**Kriteria Perencanaan**

1. Jarak antar lateral = 7,5 – 30 cm

(*Sumber : Masduqi & Assomadi, 2010:202*)

**Data Perencanaan**

1. Jarak antar lateral : 20 cm = 0,2 m
2. Kecepatan aliran : 1,3 m/dtk
3. Debit tiap bak : 0,1313 $m^3$/dtk
4. Diameter lateral : 1/3 diameter manifold

**Perhitungan**

- Diameter pipa lateral ($D_i$) = 1/3 × D manifold
  = 1/3× 0,355 m
  = 0,12 m
- Luas penampang pipa lateral
  $A_{Lateral}$ = ¼ × 3,14 × $D_i^2$
  = ¼ × 3,14 × $0,12^2$
  = 0,011 $m^2$
- Debit pipa lateral = v × A
  = 1,3 m/s × 0,011 $m^2$
  = 0,0147 $m^3$/s
- Jumlah pipa lateral $= \frac{Debit\ tiap\ bak}{Debit\ tiap\ pipa\ lateral}$
  $= \frac{0,1313}{0,0147}$
  = 8,9 buah ≈ 8 buah
- Jumlah lateral tiap sisi $= \frac{8}{2}$ = 4 buah
- Cek debit lateral $= \frac{Q}{jumlah\ lateral}$
  $= \frac{0,1313}{8}$ = 0,0164 $m^3$/s
- Panjang pipa lateral $= \frac{L\ bak - D\ manifold\ (2 \times D\ lateral)}{2}$
  $= \frac{7,7 - 0,355\ (2 \times 0,12)}{2}$
  = 3,81 m

3) **Orifice**

**Kriteria Perencanaan**

1. Jarak antar orifice : 7,5 – 30 cm

2. Diameter orifice : 0,6 – 2 cm

(*Sumber : Masduqi & Assomadi, 2010:202*)

**Data Perencanaan**

1. Jarak antar orifice : 15 cm = 0,15 m
2. Diameter pipa : 2 cm = 0,02 m
3. Luas tiap unit filter (Af) : 59,11 $m^2$

**Perhitungan**

- Luas lubang orifice

$A_{orifice}$ $= ¼ \times \pi \times D^2$

$= ¼ \times 3,14 \times 0,02$ m

$= 0,000314$ $m^2$

- Jumlah lubang tiap filter

$n_{orifice} = \frac{0,0025 \times A_f}{A\ orifice}$

$= \frac{0,0025 \times 59,11}{0,000314} = 470,62 \approx 471$

- Jumlah orifice tiap lateral

$n = \frac{n_{orifice}}{n_{lateral}} = \frac{471}{8} = 58,8 \approx 59$

**f) Saluran outlet**

**Kriteria Perencanaan**

1. Debit tiap bak (Qf) : 0,1313 $m^3$/dtk
2. Diameter pipa outlet (D) : diameter pipa manifold
   : 0,355 m
3. Kecepatan aliran : 1,3 m/s
4. Panjang pipa outlet : 5 m
5. Koef. Kekasaran pipa : 150 (PVC)
6. Koef . kehilangan energy belokan : 0,8
7. Koef. Kehilangan energy gate valve : 0,19
8. Koef. Kehilangan energy tee : 0,3

**Perhitungan**

- Kecepatan aliran pada pipa outlet

$V_{out}$ $= \frac{Qf}{A}$

$= \frac{0,1313}{\frac{1}{4} \times 3,14 \times 0,355^2} = 1,33$ m/s

- Headloss pipa outlet

$Hf_{out}$ $= \frac{(10,7 \times Q^{1,852})}{(C^{1,852} \times D^{4,87})} \times L$

$= \frac{(10,7 \times 0,1313^{1,852})}{(150^{1,852} \times 0,355^{4,87})} \times 5$ m

= 0,018 m

- Head kecepatan outlet

$Hv_{out}$ $= \frac{v^2}{2 \times g} = \frac{1,3^2}{2 \times 9,81} = 0,066$

- Minorloss elbow

$Hm_{curve}$ $= \left(\frac{k \times v^2}{2 \times g}\right) = \left(\frac{0,8 \times 0,066^2}{2 \times 9,81}\right) = 0,00018$

- Minorloss gate valve

$Hm_{valve}$ $= \left(\frac{k \times v^2}{2 \times g}\right) = \left(\frac{0,19 \times 0,066^2}{2 \times 9,81}\right) = 0,000042$

- Minorloss tee

$Hm_{tee}$ $= \left(\frac{k \times v^2}{2 \times g}\right) = \left(\frac{0,3 \times 0,066^2}{2 \times 9,81}\right) = 0,000067$

- Headloss total outlet

Hf otal $= Hf_{out} + Hv_{out} + Hm_{curve} + Hm_{valve} + Hm_{tee}$

= 0,018 + 0,066 + 0,00018 + 0,000042 + 0,000067

= 0,0843 m

**g) Volume air pencucian**

**Kriteria Perencanaan**

1. Kecepatan pencucian ($V_{wash}$) = 45 m/jam = 0,0125 m/s
   (*Sumber : Masduqi & Assomadi, 2010:172*)
2. Lebar bak = 7,7 m
3. Panjang bak = 7,7 m

4. Durasi surfacewash = 300 dtk
5. Durasi backwash = 600 dtk

(*Sumber : Masduqi & Assomadi, 2012:*)

**Perhitungan**

- Luas bak filtrasi = panjang bak × lebar bak
  = 7,7 m × 7,7 m
  = 59,29 $m^2$
- Volume air untuk surfacewash = $A_{filtrasi} \times V_{wash} \times t_{wash}$
  = 59,29 × 0,0125 × 300
  = 222,34 $m^3$
- Volume air untuk backwash = $A_{filtrasi} \times V_{wash} \times t_{bw}$
  = 59,29 × 0,0125 × 600
  = 444,68 $m^3$
- Volume air pencucian = $V_{surface} + V_{backwash}$
  = 222,34 + 444,68
  = 667,02 $m^3$
- Debit suface $= \frac{volume\ surface}{durasi}$
  $= \frac{222,34}{300}$ = 0,741 $m^3/s$
- Debit backwash $= \frac{volume\ backwash}{durasi}$
  $= \frac{444,68}{600}$ = 0,741 $m^3/s$
- Debit total air pencucian = $Q_{Sf} + Q_{BW}$
  = 0,741 $m^3/s$ + 0,741 $m^3/s$
  = 1,482 $m^3/s$

**h) Saluran pelimpah**

**Kriteria Perencanaan**

1. Jumlah gutter : 1 buah
2. Q gutter : debit total air pencucian

3. Panjang gutter : panjang bak filtrasi = 7,7 m

**Perhitungan**

- $H_{air\ gutter}$ $= 1{,}73 \times \left(\frac{Q^2}{g \times b}\right)^{1/3} = 1{,}73 \times \left(\frac{1{,}482^2}{9{,}81 \times L}\right)^{1/3} = 2{,}37$
- Lebar gutter $= 1{,}5 \times H_{air\ gutter}$
  $= 1{,}5 \times 2{,}37$ m
  = 3,56 m
- Tinggi gutter $= H_{air\ gutter}$ + Freeboard
  = 2,37 m + 0,3 m
  = 2,67 m

**i) Tinggi bak filter**

**Diketahui dari perhitungan sebelumnya**

1. Tinggi ekspansi media antrasir : 2,15 m
2. Tinggi ekspansi media pasir : 0,92 m
3. Tinggi ekspansi media garmet : 1,84 m
4. Tinggi gutter : 2,67 m
5. Tinggi air atas gutter (h) : 0,15 m
6. Diameter manifold : 0,355 m
7. Freeboard : 0,3 m

**Perhitungan**

- Tinggi bak
  = Tebal underdrain + H.eks.Antrasit + H.eks.pasir + H.eks.garmet + Hgutter + Hair gutter
  = 0,355 m + 2,15 m + 0,92 m + 1,84 m + 2,67 m + 0,15 m
  = 8,09 m
- Tinggi total = tinggi bak filter + Freeboard
  = 8,09 m + 0,3 m
  = 8,39 m

j) **Ruang Penampung Backwash**

**Kriteria Perencanaan**

1. Volume air pencucian : 667,02 $m^3$
2. tinggi bak : 8,39 m

**Perhitungan**

- Volume = P × L × T

  667,02 = 2 L × L × 8,39

  L = 6,3

  P = 12,6

k) **Pipa Drain Backwash**

**Kriteria Perencanaan**

1. Jumlah pipa backwash : 1 buah
2. Kecepatan aliran pipa : 1 m/s
3. Debit air : 1,482 $m^3$/s

**Perhitungan**

- Debit tiap bak $= \frac{Qf}{jumlah\ bak} = \frac{1,482}{15}$ = 0,099 $m^3$/s
- L penampang pipa $= \frac{Q\ bak}{v} = \frac{0,099}{1,3}$ = 0,08 $m^2$
- L penampang = ¼ × π × $D^2$

  D $= \sqrt{\frac{A}{\frac{1}{4} \times \pi}}$

  $= \sqrt{\frac{0,08}{\frac{1}{4} \times 3,14}}$ = 0,1 m

  Menggunakan pipa berdiameter 100 mm sesuai dengan yang tersedia di vendor https://www.rucika.co.id/wp-content/uploads/2019/08/Brosur-Rucika-Black-2018.pdf .

**Resume :**

- Diameter pipa inlet outlet = 1 m
- Jumlah bak = 15 dengan 2 bak maintenance

- Lebar bak = 7,7 m
- Panjang bak = 7,7 m
- Kedalaman media antrasit = 0,46 m
- Kedalaman media pasir = 0,23 m
- Kedalaman media garmet = 0,15 m
- Tinggi ekspansi media antrasit = 2,15
- Tinggi ekspansi media pasir = 0,92
- Tinggi ekspansi media garmet = 1,84
- Diameter pipa manifold = 0,355 m
- Panjang pipa manifold = 7,7 m
- Diameter pipa lateral = 0,12 m
- Jumlah pipa lateral = 8 buah
- Jumlah lateral tiap sisi = 4 buah
- Panjang pipa lateral = 3,81 m
- Diameter orifice = 0,02 m
- Jumlah orifice = 471 lubang
- Jumlah orifice tiap pipa lateral = 59 lubang
- Jumlah gutter = 1 buah
- Kedalaman air pada gutter = 2,37 m
- Lebar gutter = 3,56 m
- Tinggi gutter = 2,67 m
- Panjang gutter = 7,7 m
- Tinggi total bak filtrasi = 8,39 m
- Jumlah pipa underdrain = 1 buah
- Diameter pipa underdrain = 0,1 m
- Panjang penampung backwash = 6,3 m
- Lebar penampung backwash = 12,6 m
- Tinggi penampung backwash = 8,39 m

## 5.10. Reservoar

Pada penyaluran air baku dari bangunan filtrasi diperlukan pipa inlet untuk mengalirkan air ke bangunan dan pipa outlet untuk mengalirkan air ke pipa distribusi. Berikut data – data yang direncanakan untuk pipa inlet dan outlet air baku :

### a) Pipa inlet dan outlet

**Kriteria Perencanaan**

1. Kecepatan pipa = 0,6 – 1,5 m/s
   (*Sumver : Al-Layla,1978:67*)

**Perhitungan**

- Luas Penampang

  A $= \frac{Q}{v} = \frac{0{,}5\ m^3/s}{0{,}6\ m/s}$ = 0,83 $m^2$

- Diameter pipa

  A = ¼ × π × $D^2$

  0,83 $m^2$ = ¼ × 3,14 × $D^2$

  D = 1 m

  Memakai pipa berdiameter 1000 mm sesuai dengan pipa yang tersedia di vendor https://ammara.co.id/downloads/brosur-pipa-hdpe-mdpe-vinilon.pdf.

- v cek $= \left(\frac{Q}{\frac{1}{4}\times\pi\times D^2}\right)$

  $= \left(\frac{0{,}5\ m^3/dtk}{\frac{1}{4}\times 3{,}14\ \times 1^2}\right)$ = 0,64 m/s

- Headloss $= \left(\frac{10{,}67\times Q^{1{,}85}}{130^{1{,}85}\times D^{4{,}87}}\right)$ × L m

  $= \left(\frac{10{,}67\times 0{,}5^{1{,}85}}{130^{1{,}85}\times 1^{4{,}87}}\right)$ × 5 m

  = 0,00182 m

  Slope $= \frac{Hf}{L} = \frac{0{,}00182}{5}$ = 0,000364

**b) Dimensi Bak Reservoar**

**Kriteria Perencanaan**

1. Td : 20 mnt = 1200 dtk
2. Q : 1,97 $m^3$/dtk
3. Direncanakan menggunakan 4 bak reservoir
4. Ketinggian bak : 4 m

**Perhitungan**

- Q tiap bak $= \frac{Q\ air\ baku}{Jumlah\ bak} = \frac{1{,}97\ m^3/dtk}{4}$ = 0,5 $m^3$/dtk
- Volume bak = Q bak × 1200 dtk

  = 0,5 $m^3$/dtk × 1200 dtk = 600 $m^3$
- Asumsi Panjang : Lebar = 2 : 1

  V = P × L × T

  600 $m^3$ = 2L × L × 4

  L = 8,66 m

  P = 2 L

  = 2 × 8,66 = 17,32

  Tinggi total = T + Freeboard

  = 4 m + 0,3 m

  = 4,3 m

## 5.11. Sludge Drying Bed

**Kriteria Perencanaan**

1. Ketebalan lapisan lumpur : 300 – 450 mm
2. Kecepatan aliran lumpur dalam pipa : > 0,75 m/s
3. Ketebalan total kerikil : 355 mm
4. Ketebalan lapisan pasir : 300 mm
5. Kadar solid : 60%
6. Kadar air : 40%
7. Berat air dalam cake : 20 - 50%
8. Waktu pengeringan : 10 – 15 hari

(*Sumber : Metcalf & Eddy Fourth Edition, 2003:1572*)

**Data Perencanaan**

1. Tebal lapisan lumpur : 0.45 m
2. Tebal lapisan pasir : 0,35 m
3. Tebal lapisan kerikil : 0,3 m
4. Waktu pengeringan : 10 hari
5. Kadar solid : 60%
6. Kadar air (P) : 40%
7. Berat air dalam cake (Pi) : 20%
8. Volume lumpur dari prasedimentasi : 2738,8 $m^3$
9. Volume lumpur dari sedimentasi 1 & 2 : 62,67 $m^3$
10. Kecepatan alir lumpur dalam pipa : 0,75
11. Menggunakan 18 unit sludge drying bed (18 bed operasional, 1 maintenance)

**Perhitungan**

- Debit lumpur $= \frac{Q_{lumpur\ bak\ sedimentasi} + Q_{lumpur\ bak\ prasedimentasi}}{jumlah\ unit}$

  $= \frac{62,67 + 2738,8}{18}$

  = 155,64 $m^3$/hari

- Tebal media = tebal pasir + tebal kerikil

  = 0,35 m + 0,35 m

  = 0,65 m
- Debit cake sludge $= \frac{Debit\ \ Lumpur \times (1-P)}{1-Pi}$

  $= \frac{155{,}64 \times (1-0{,}4)}{1-0{,}2}$ = 116,73 $m^3$/hari
- Vol. SDB = debit cake sludge × Td

  = 116,73$m^3$/hari × 10 hari

  = 1167,3 $m^3$
- Volume tiap bed $= \frac{Vol.SDB}{jumlah\ bed}$

  $= \frac{1167{,}3}{18}$ = 64,85 $m^3$
- Dimensi tiap bed

  A $= \frac{Volume\ tiap\ bed}{tebal\ cake}$

  $= \frac{64{,}85}{0{,}45}$ = 144,11 $m^2$

  A = P × L

  144,11 = 2L × L

  L = 8,5 m

  P = 2 L

  = 2 × 8,5 = 17
- Kedalaman total cake = kedalaman cake + kedalaman media

  = 0,45 + 0,65

  = 1,1 m

  H total = 1,1 m + (20% × 1,1 m)

  = 1,1 m + 0,22 = 1,62 m
- Volume air (Va) $= \frac{debit\ lumpur - Debit\ Cake\ Sludge}{jumlah\ bed}$ × Td

  $= \frac{155{,}64 - 116{,}73}{18}$ ×10 hari

  = 151,32 $m^3$

- Kedalaman underdrain (H) = $\frac{Volume\ air}{A}$ = $\frac{151,32}{144,11}$ = 1,05 m
- H total = H cake + H pasir + H kerikil + H underdrain

  = 0,45 m + 0,35 m + 0,3 m + 1,05 m

  = 2,15 m
- Diameter pipa inlet

  Debit = $\frac{V\ lumpur}{Td}$ = $\frac{155,64}{86400}$ = 0,0018 $m^3$/dtk

  A pipa = $\frac{Q}{v}$ = $\frac{0,0018\ m^3/dtk}{0,6\ m/s}$ = 0,003 $m^2$

  D pipa = $\sqrt{\frac{4\times A}{\pi}}$ = $\sqrt{\frac{4\times 0,003}{\pi}}$ = 0,062
- Diameter pipa outlet

  Debit = $\frac{V\ air}{Td}$ = $\frac{151,32}{86400}$ = 0,0017 $m^3$/dtk

  A pipa = $\frac{Q}{v}$ = $\frac{0,0017\ m^3/dtk}{0,6\ m/s}$ = 0,003 $m^2$

  D pipa = $\sqrt{\frac{4\times A}{\pi}}$ = $\sqrt{\frac{4\times 0,003}{\pi}}$ = 0,062
- Headpompa

  Head statis = 10 m

  L pipa discharge = 2,5 m

  H suction = 6 m

  Hf discharge = $\left(\frac{Q}{0,2785\times C\times D^{2,63}}\right)^{1,85}$ × L

  = $\left(\frac{0,0018\ m^3/dtk}{0,2785\times 130\times 0,062^{2,63}}\right)^{1,85}$ × 2,5 m = 0,0205 m

  Hf suction = $\left(\frac{Q}{0,2785\times C\times D^{2,63}}\right)^{1,85}$ × L

  = $\left(\frac{0,0018\ m^3/dtk}{0,2785\times 130\times 0,062^{2,63}}\right)^{1,85}$ × 6 m = 0,0492 m

  Hf mayor total = 0,0205 m + 0,0492 m = 0,0697 m

  Head kecepatan suction dan discharge = $\frac{v^2}{2\times g}$ = $\frac{0,6^2}{2\times 9,81}$ = 0,018

Hf belokan $\quad$ K = 0,3

$= 2 \times K \times \frac{v^2}{2 \times g}$

$= 2 \times 0,3 \times \frac{0,6^2}{2 \times 9,81} = 0,011$

Hf gate valve $\quad$ K = 0,19

$= 2 \times K \times \frac{v^2}{2 \times g}$

$= 2 \times 0,19 \times \frac{0,6^2}{2 \times 9,81} = 0,007$

Hf check valve $\quad$ K = 2,5

$= 2 \times K \times \frac{v^2}{2 \times g}$

$= 2 \times 2,5 \times \frac{0,6^2}{2 \times 9,81} = 0,092$

Hf Minor total $\quad$ = 0,011 + 0,07 + 0,092

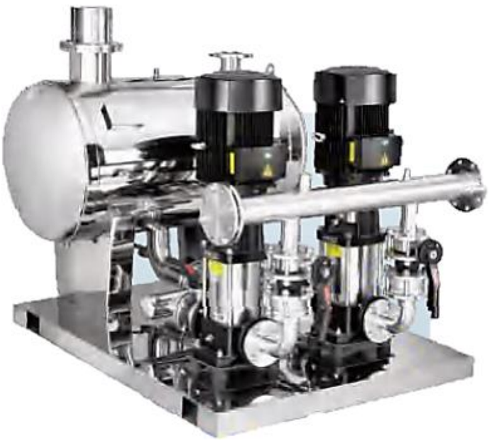
= 0,1122

Headloass total $\quad$ = Hf Mayor total + Hf minor total

= 0,0697 +0,1122

= 0,8092 m

Menggunakan pompa tipe PBWS dengan nama produk PBWS15/8-2C sesuai dengan yang tersedia di vendor https://www.linkjoint.cn/uploads/7_PURITY_50HZ_PUMP_CATALOG_202003-2.pdf?gclid=Cj0KCQiA47GNBhDrARIsAKfZ2rBar6kP8RAHHrckov6uA_5GMmZrjnuR-9voIgXWcekDowbVeMIUziEaAhZkEALw_wcB .



## TECHNICAL DATA/*DATOS TÉCNICOS/DONNÉES TECHNIQUES*

| MODEL *MODELO* *MODÈLE* | Flow *Caudal* *Débit* $m^3/h$ | Head *Altura* *Hauteur* m | Pump *Bomba* *Pompe* | Power *Potencia* *Puiss.* kw | Tank size ΦxL | User no. |
|---|---|---|---|---|---|---|
| PBWS15/8-2C | 8 | 15 | CDL4-2 | 0.37 | Φ600x1.3 | 25 |
| PBWS24/8-2C | 8 | 24 | CDL4-3 | 0.55 | Φ600x1.3 | 25 |
| PBWS32/8-2C | 8 | 32 | CDL4-4 | 0.75 | Φ600x1.3 | 25 |
| PBWS40/8-2C | 8 | 40 | CDL4-5 | 1.1 | Φ600x1.3 | 25 |
| PBWS48/8-2C | 8 | 48 | CDL4-6 | 1.1 | Φ600x1.3 | 25 |
| PBWS56/8-2C | 8 | 56 | CDL4-7 | 1.5 | Φ600x1.3 | 25 |
| PBWS64/8-2C | 8 | 64 | CDL4-8 | 1.5 | Φ600x1.3 | 25 |
| PBWS81/8-2C | 8 | 81 | CDL4-10 | 2.2 | Φ600x1.3 | 25 |
| PBWS95/8-2C | 8 | 95 | CDL4-12 | 2.2 | Φ600x1.3 | 25 |
| PBWS112/8-2C | 8 | 112 | CDL4-14 | 3 | Φ600x1.3 | 25 |
| PBWS129/8-2C | 8 | 129 | CDL4-16 | 3 | Φ600x1.3 | 25 |
| PBWS153/8-2C | 8 | 153 | CDL4-19 | 4 | Φ600x1.3 | 25 |
| PBWS178/8-2C | 8 | 178 | CDL4-22 | 4 | Φ600x1.3 | 25 |
| PBWS18/16-2C | 16 | 18 | CDL8-2 | 0.75 | Φ600x1.3 | 80 |
| PBWS27/16-2C | 16 | 27 | CDL8-3 | 1.1 | Φ600x1.3 | 80 |
| PBWS36/16-2C | 16 | 36 | CDL8-4 | 1.5 | Φ600x1.3 | 80 |
| PBWS45/16-2C | 16 | 45 | CDL8-5 | 2.2 | Φ600x1.3 | 80 |
| PBWS54/16-2C | 16 | 54 | CDL8-6 | 2.2 | Φ600x1.3 | 80 |
| PBWS73/16-2C | 16 | 73 | CDL8-8 | 3 | Φ600x1.3 | 80 |
| PBWS92/16-2C | 16 | 92 | CDL8-10 | 4 | Φ600x1.3 | 80 |
| PBWS111/16-2C | 16 | 111 | CDL8-12 | 4 | Φ600x1.3 | 80 |
| PBWS130/16-2C | 16 | 130 | CDL8-14 | 5.5 | Φ600x1.3 | 80 |
| PBWS148/16-2C | 16 | 148 | CDL8-16 | 5.5 | Φ600x1.3 | 80 |
| PBWS167/16-2C | 16 | 167 | CDL8-18 | 7.5 | Φ600x1.3 | 80 |
| PBWS186/16-2C | 16 | 186 | CDL8-20 | 7.5 | Φ600x1.3 | 80 |
| PBWS20/24-2C | 24 | 20 | CDL12-2 | 1.5 | Φ800x1.5 | 150 |
| PBWS30/24-2C | 24 | 30 | CDL12-3 | 2.2 | Φ800x1.5 | 150 |
| PBWS40/24-2C | 24 | 40 | CDL12-4 | 3 | Φ800x1.5 | 150 |
| PBWS50/24-2C | 24 | 50 | CDL12-5 | 3 | Φ800x1.5 | 150 |
| PBWS60/24-2C | 24 | 60 | CDL12-6 | 4 | Φ800x1.5 | 150 |
| PBWS70/24-2C | 24 | 70 | CDL12-7 | 5.5 | Φ800x1.5 | 150 |
| PBWS80/24-2C | 24 | 80 | CDL12-8 | 5.5 | Φ800x1.5 | 150 |

# BAB 6
# PERHITUNGAN PROFIL HIDROLIS

Profil hidrolis dapat menunjukkan ketinggian muka air masing – masing unit. Penggambaran profil hidrolis ini menggunakan elevasi muka tanah unit pengolahan dan headloss pada masing – masing bangunan. Berikut ini perhitungan profil hidrolis masing – masing pengolahan.

## 1. Pipa intake (River Intake)

- Direncanakanterdapat 3 pipasadap di bawahpermukaantanah, yaitu HWL, LWL, dan AWL.
- Kedalaman = 3,65 m
- Elevasiawal = -0,7 m
- Hfpipa HWL = 0,0005 m
- Level Muka Air = ElevasiAwal - H – Hf
  = (-0,7) m - 3,65 – 0,0005
  = -4,35
- Kedalaman = 6,35 m
- Elevasiawal = -0,7 m
- Hfpipa AWL = 0,0004 m
- Level Muka Air = ElevasiAwal - H – Hf
  = (-0,7) m – 6,35 – 0,0004
  = -7,05
- Kedalaman = -8,64
- Elevasiawal = -0,7 m
- Hfpipa LWL = 0,00025 m
- Level Muka Air = ElevasiAwal - H – Hf
  = (-0,7) - 8,64 – 0,00025
  = -9,34

## 2. Bak Penampung

- Kedalaman = 11,5 m
- Freeboard = 1
- Elevasiawal = -12,9 m
- H beton = 0,2 m
- Level muka air = Elevasiawal + H + Hbeton
  = (-12,9) + 11,5 - 0,2
  = -1,2 m
- Level mukabangunan = ElevasiAwal + H + Fb + Hbeton
  = (-12,9) + 11,5+ 1 + 0,2
  = -0,2 m

**3. Bak Prasedimentasi**

- Kedalaman = 6,29 m
- Freeboard = 0,3 m
- Elevasiawal = -5,54
- Hbeton = 0,2 m
- Level muka air = Elevasiawal + H + Hbeton
  = -5,54 + 6,29 + 0,2
  = +0,95 m
- Level mukabangunan = ElevasiAwal + H + Fb+ H beton
  = -5,54 + 6,29+ 0,3 + 0,2
  = +1,25 m

**4. Unit Netralisasi**

**BakPembubuh**

- Kedalaman : 1,7
- Freeboard : 0,3 m
- Elevasiawal : 0 m
- H beton : 0,2
- Menara : 1,6 m

- Level muka air = Elevasiawal + Hmenara + Hbak+ Hbeton

= 0 + 1,6 + 1,7 + 0,2 = -3,5 m

- Level mukabangunan = ElevasiAwal + Hmenara + Hbak + Fb + Hbeton
  = 0 + 1,6 + 1,7 + 0,3 + 0,2
  = +3,8 m

**Bak Netralisasi**

- Kedalaman : 3,3
- Freeboard : 0,3 m
- Elevasiawal : 0 m
- H beton : 0,2
- Level muka air = Elevasiawal + H + Hbeton
  = 0 + 2,8 + 0,2 = 3 m
- Level mukabangunan = ElevasiAwal + H + Fb + H beton
  = 0 + 2,8 + 0,3 + 0,2
  = +3,3 m

5. **Bak Aerasi**

- Kedalaman : 3 m
- Freeboard : 0,6 m
- Tinggi nozzle : 0,4
- Elevasiawal : 0
- H beton : 0,3
- Level muka air = Elevasiawal + H + Hbeton
  = 0 + 3 + 0,3= -3,3 m
- Level mukabangunan = ElevasiAwal+ Hnozzle + H + Fb + H beton
  = 0 + 0,4+ 3 + 0,6 + 0,3
  = +4,3 m

6. **Unit Koagulasi**

**BakPembubuh**

- Kedalaman : 2,8 m
- Freeboard : 0,3
- Elevasiawal : 0

- H beton : 0,3
- Level muka air = Elevasiawal + H + Hbeton
  = 0 + 2,8 + 0,3 = +3,1 m
- Level mukabangunan = ElevasiAwal + H + Fb + H beton
  = 0 + 2,8 + 0,3 + 0,3
  = +3,4 m

**Bak Koagulasi**

- Kedalaman : 1,8 m
- Freeboard : 0,3
- Elevasiawal : 0
- H beton : 0,2
- Level muka air = Elevasiawal + H + Hbeton
  = 0 + 1,8 + 0,2 = +2 m
- Level mukabangunan = ElevasiAwal + H + Fb + H beton
  = 0 + 1,8 + 0,3 + 0,2
  = +2,3 m

**7. Bak Flokulasi**

- Kedalaman : 5 m
- Freeboard : 0,3
- Elevasiawal : 0
- H beton : 0,2
- Level muka air = Elevasiawal + H + Hbeton
  = 0 + 4,8 + 0,2 = +5 m
- Level mukabangunan = ElevasiAwal + H + Fb + H beton
  = 0 + 4,8 + 0,3 + 0,2
  = +5,3 m

**8. Bak sedimentasi**

- Kedalaman : 8,4 m
- Freeboard : 0,3 m
- Elevasiawal : -7,65

- H beton : 0,2
- Level muka air = Elevasiawal + H + Hbeton

  = -7,65 + 8,4 + 0,2 = +0,95 m
- Level mukabangunan = ElevasiAwal + H + Fb + H beton

  = -7,65 + 8,4 + 0,3 + 0,2

  = +1,25 m

**9. Filtrasi**

- Kedalaman :,09 m
- Freeboard : 0,3
- Elevasiawal : 0
- H beton : 0,3
- Level muka air = Elevasiawal + H + Hbeton

  = 0 + 8,09 + 0,3

  = +8,39 m
- Level mukabangunan = ElevasiAwal + H + Fb + H beton

  = 0 + 8,09 + 0,3 + 0,2

  = +8,69 m

**10. Reservoir**

- Kedalaman : 4 m
- Freeboard : 0,6 m
- Elevasiawal : 0 m
- H beton : 0,3
- Level muka air = Elevasiawal + H + Fb + Hbeton

  = 0 + 4,3 + 0,3

  = +4,6 m
- Level mukabangunan = ElevasiAwal + H + Fb + H beton

  = 0 + 4,3 + 0,6 + 0,3

  = +5,2 m

**11. Sludge Drying Bed**

- Kedalaman : 1,25 m
- Freeboard : 0,37 m
- Elevasiawal : 0 m
- H beton : 0,2
- Level muka air = Elevasiawal + H + Hbeton

  = 0 + 1,25 + 0,2

  = +1,45 m
- Level mukabangunan = ElevasiAwal + H + Fb + H beton

  = 0 + 1,25 + 0,37 + 0,2

  = +1,92 m

# BAB 7
# BOQ dan RAB

Padaperencanaanproyekini,perhitungan *Bill Of Quantity* (BOQ) dan Rencana Anggaran Biaya (RAB) didasarkan pada kebutuhan bangunan yang ada pada IPAM. BOQ dan RAB pada perencanaan ini terdiri dari :

1. Intake
2. Prasedimentasi
3. Netralisasi
4. Aerasi
5. Koagulasi
6. Flokulasi
7. Sedimentasi 1 dan 2
8. Filtrasi
9. Reservoir
10. Sludge Drying Bed (SDB)

Yang perlu diperhatikan dalam BOQ dan RAB antara lain kebutuhan untuk penggalian tanah, pemasangan beton dan perlengkapan bangunan (Contoh : Pintu air, Pipa, Pompa, Paddle, dll).

## Tabel 7.1 BOQ dan RAB Penggalian

| Penggalian 1 m³ tanah biasa untuk konstruksi | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga Satuan (Rp) | |
| 1 | Pekerja | 0.75 | 1 | 0.75 | oh | Rp | 115,000 | Rp | 86,250 |
| 2 | Mandor | 0.25 | 1 | 0.25 | oh | Rp | 163,000 | Rp | 40,750 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 127,000 |

## Tabel 7.2 BOQ dan RAB Pembetonan

| Untuk Membuat 1 m³ Dinding Beton Bertulang | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga Satuan (Rp) | |
| 1 | Semen PC 40 kg | 8.4 | 1 | 8.4 | zak | Rp | 61,300 | Rp | 514,920 |
| 2 | Batu Pecah | 0.81 | 1 | 0.81 | m3 | Rp | 395,200 | Rp | 320,112 |
| 3 | Pasir Cor | 0.54 | 1 | 0.54 | m3 | Rp | 260,000 | Rp | 140,400 |
| 4 | Besi Beton Polos | 157.5 | 1 | 157.5 | kg | Rp | 13,000 | Rp | 2,047,500 |
| 5 | Paku Usuk | 3.2 | 1 | 3.2 | kg | Rp | 15,600 | Rp | 49,920 |
| 6 | Plywood | 2.8 | 1 | 2.8 | Lembar | Rp | 128,900 | Rp | 360,920 |
| 7 | Kawat Beton | 2.25 | 1 | 2.25 | kg | Rp | 26,500 | Rp | 59,625 |
| 8 | Kayu Meranti Bekisting | 0.24 | 1 | 0.24 | m3 | Rp | 3,484,000 | Rp | 836,160 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 4,329,557 |

## Tabel 7.3 BOQ dan RAB Unit Intake

| **1. INTAKE** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Uraian** | **Volume/ Panjang** | **Jumlah Unit** | **Total** | **Satuan** | **Harga Satuan (Rp)** | | **Total Harga** | |
| **Pipa Sadap** | | | | | | | | | |
| 1 | Pipa Ø 47" | 3 | 1 | 3 | buah | Rp | 2,999,750 | Rp | 2,999,750 |
| 2 | Gate Valve | 3 | 1 | 3 | buah | Rp | 1,000,000 | Rp | 3,000,000 |
| **Bar Screen** | | | | | | | | | |
| 1 | Kisi Berdiameter 1200 mm | 35 | 1 | 35 | buah | Rp | 150,000 | Rp | 5,250,000 |
| **Sumur Pengumpul** | | | | | | | | | |
| 1 | Volume Beton | 3.79 | 1 | 3.79 | m³ | Rp | 4,329,557 | Rp | 16,409,021 |
| 2 | Pipa Ø 24" | 1 | 1 | 1 | buah | Rp | 1,243,700 | Rp | 1,243,700 |
| 3 | Pompa Penguras Lumpur | 1 | 1 | 1 | buah | Rp | 25,000,000 | Rp | 25,000,000 |
| 4 | volume galian | 8.69 | 1 | 8.69 | m³ | Rp | 127,000 | Rp | 1,103,630 |
| **Rumah Pompa** | | | | | | | | | |
| 1 | Pompa Sentrifugal | 4 | 1 | 4 | buah | Rp | 35,000,000 | Rp | 140,000,000 |
| 2 | Pipa Ø 16" | 1 | 1 | 1 | buah | Rp | 829,000 | Rp | 829,000 |
| 3 | elbow 90° | 1 | 1 | 1 | buah | Rp | 100,000 | Rp | 100,000 |
| 4 | Strainer | 4 | 1 | 4 | buah | Rp | 1,000,000 | Rp | 4,000,000 |
| 5 | Volume Beton | 44.93 | 1 | 44.93 | m³ | Rp | 4,329,557 | Rp | 194,526,996 |
| **TOTAL RINCIAN BIAYA** | | | | | | | | Rp | 394,462,097 |

## Tabel 7. 4 BOQ dan RAB Unit Prasedimentasi

| 2. PRASEDIMENTASI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| Zona Inlet | | | | | | | | | |
| 1 | Volume Beton | 153.06 | 4 | 612.24 | m³ | Rp | 4,329,557 | Rp | 2,650,727,978 |
| 2 | Volume Galian | 1948.8 | 4 | 7795.2 | m³ | Rp | 127,000 | Rp | 989,990,400 |
| Zona Pengendap | | | | | | | | | |
| 1 | volume beton | 183.21 | 4 | 732.84 | m³ | Rp | 4,329,557 | Rp | 3,172,872,552 |
| 2 | volume galian | 246.1 | 4 | 984.4 | m³ | Rp | 127,000 | Rp | 125,018,800 |
| Zona Sludge | | | | | | | | | |
| 1 | volume beton | 169.3 | 4 | 677.2 | m³ | Rp | 4,329,557 | Rp | 2,931,976,000 |
| 2 | volume galian | 220.09 | 4 | 880.36 | m³ | Rp | 127,000 | Rp | 111,805,720 |
| 3 | Pipa Ø 36" | 1 | 4 | 4 | buah | Rp | 1,865,700 | Rp | 7,462,800 |
| Zona Outlet | | | | | | | | | |
| 1 | volume beton | 84.69 | 4 | 338.76 | m³ | Rp | 4,329,557 | Rp | 1,466,680,729 |
| 2 | Volume Galian | 1364.69 | 4 | 5458.76 | m³ | Rp | 127,000 | Rp | 693,262,520 |
| 3 | pipa Ø 28" | 1 | 4 | 4 | buah | Rp | 1,451,000 | Rp | 5,804,000 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 12,155,601,499 |

## Tabel 7.5 BOQ dan RAB Unit netralisasi

| 3. NETRALISASI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| Bak Pembubuh | | | | | | | | | |
| 1 | NaOH | 546.5 | 4 | 2186 | Kg | Rp | 350,000 | Rp | 765,100,000 |
| 2 | Motor Pengaduk | 1 | 4 | 4 | buah | Rp | 12,000,000 | Rp | 48,000,000 |
| 3 | pipa Ø 6" | 1 | 4 | 4 | m | Rp | 102,500 | Rp | 410,000 |
| 4 | dosing pump | 1 | 4 | 4 | buah | Rp | 45,000,000 | Rp | 180,000,000 |
| 5 | menara | 1 | 4 | 4 | buah | Rp | 4,000,000 | Rp | 16,000,000 |
| 7 | Volume beton | 2.1 | 4 | 8.4 | m³ | Rp | 4,329,557 | Rp | 36,368,279 |
| Bak Netralisasi | | | | | | | | | |
| 1 | Motor Pengaduk | 1 | 4 | 4 | buah | Rp | 7,000,000 | Rp | 28,000,000 |
| 3 | Volume Beton | 8.33 | 4 | 33.32 | m³ | Rp | 4,329,557 | Rp | 144,260,839 |
| Outlet | | | | | | | | | |
| 2 | pipa Ø 40" | 1 | 4 | 4 | m | Rp | 2,335,900 | Rp | 9,343,600 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 1,227,482,718 |

## Tabel 7. 6 BOQ dan RAB Unit Aerasi

| 4. AERASI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| 1 | Nozzle | 20 | 4 | 80 | buah | Rp | 250,000 | Rp | 20,000,000 |
| 2 | Blower | 1 | 4 | 4 | buah | Rp | 25,000,000 | Rp | 100,000,000 |
| 4 | Volume Beton | 87.12 | 4 | 348.48 | m³ | Rp | 4,329,557 | Rp | 1,508,764,023 |
| 5 | pipa Ø 6" | 1 | 4 | 4 | buah | Rp | 102,500 | Rp | 410,000 |
| 6 | pipa Ø 40" | 1 | 4 | 4 | buah | Rp | 2,335,900 | Rp | 9,343,600 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 1,638,517,623 |

## Tabel 7.7 BOQ dan RAB Unit Koagulasi

| 5. KOAGULASI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| Bak Pembubuh | | | | | | | | | |
| 1 | Koagulan PAC | 12960 | 4 | 51840 | Kg | Rp | 16,000 | Rp | 829,440,000 |
| 2 | Dosing Pump | 1 | 4 | 4 | buah | Rp | 45,000,000 | Rp | 180,000,000 |
| 3 | Menara | 1 | 4 | 4 | buah | Rp | 4,000,000 | Rp | 16,000,000 |
| 4 | Volume Beton | 4.67 | 4 | 18.68 | m³ | Rp | 4,329,557 | Rp | 80,876,125 |
| 5 | Motor Pengaduk | 1 | 4 | 4 | buah | Rp | 3,500,000 | Rp | 14,000,000 |
| 6 | pipa Ø 4" | 1 | 4 | 4 | buah | Rp | 95,500 | Rp | 382,000 |
| Bak Koagulasi | | | | | | | | | |
| 1 | Volume Beton | 8.1 | 4 | 32.4 | m³ | Rp | 4,329,557 | Rp | 140,277,647 |
| 2 | motor pengaduk | 1 | 4 | 4 | buah | Rp | 7,000,000 | Rp | 28,000,000 |
| Saluran Inlet outlet | | | | | | | | | |
| 1 | pipa Ø 40" | 1 | 4 | 4 | buah | Rp | 2,335,900 | Rp | 9,343,600 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 1,298,319,372 |

## Tabel 7. 8 BOQ dan RAB Unit Flokulasi

| 6. FLOKULASI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| Bak Flokulasi | | | | | | | | | |
| | Volume Beton | 115.46 | 4 | 461.84 | m³ | Rp | 4,329,557 | Rp | 1,999,562,605 |
| Kompartemen | | | | | | | | | |
| 1 | Volume Beton Komp. | 56.76 | 4 | 227.04 | m³ | Rp | 4,329,557 | Rp | 982,982,621 |
| 2 | Volume Beton Komp. | 56.76 | 4 | 227.04 | m³ | Rp | 4,329,557 | Rp | 982,982,621 |
| 3 | Volume Beton Komp. | 56.76 | 4 | 227.04 | m³ | Rp | 4,329,557 | Rp | 982,982,621 |
| Saluran Inlet dan Outlet | | | | | | | | | |
| 1 | pipa Ø 40" | 1 | 4 | 4 | buah | Rp | 2,335,900 | Rp | 9,343,600 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 4,957,854,069 |

## Tabel 7.9 BOQ dan RAB Unit Sedimentasi

| 7. SEDIMENTASI 1&2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| Zona Inlet | | | | | | | | | |
| 1 | Volume Galian | 12.56 | 8 | 100.48 | m³ | Rp | 127,000 | Rp | 12,760,960 |
| 2 | Volume Beton | 3.53 | 8 | 28.24 | m³ | Rp | 4,329,557 | Rp | 122,266,690 |
| Zona Pengendap | | | | | | | | | |
| 1 | Volume Galian | 2874.55 | 8 | 22996.4 | m³ | Rp | 127,000 | Rp | 2,920,542,800 |
| 2 | Volume Beton | 173.15 | 8 | 1385.2 | m³ | Rp | 4,329,557 | Rp | 5,997,302,356 |
| 3. | Plate Settler | 34.7 | 8 | 277.6 | m | Rp | 230,000 | Rp | 63,848,000 |
| Zona Sludge | | | | | | | | | |
| 1 | Volume Galian | 280.39 | 8 | 2243.12 | m³ | Rp | 127,000 | Rp | 284,876,240 |
| 2 | Volume Beton | 26.98 | 8 | 215.84 | m³ | Rp | 4,329,557 | Rp | 934,491,583 |
| 3 | pipa Ø 20" | 1 | 8 | 8 | buah | Rp | 1,010,000 | Rp | 8,080,000 |
| Zona Outlet | | | | | | | | | |
| 1 | Volume Galian | 336 | 8 | 2688 | m³ | Rp | 127,000 | Rp | 341,376,000 |
| 2 | Volume Beton | 34.98 | 8 | 279.84 | m³ | Rp | 4,329,557 | Rp | 1,211,583,231 |
| 3 | pipa Ø 40" | 1 | 8 | 8 | buah | Rp | 2,335,900 | Rp | 18,687,200 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 11,915,815,060 |

## Tabel 7.10 BOQ dan RAB Unit Filtrasi

| 8. FILTRASI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| Bak Filtrasi | | | | | | | | | |
| 2 | Volume Beton | 38.66 | 15 | 579.9 | m³ | Rp | 4,329,557 | Rp | 2,510,710,104 |
| Media Filtrasi | | | | | | | | | |
| 1 | Antrasit | 27.27 | 15 | 409.05 | m³ | Rp | 400,000 | Rp | 163,620,000 |
| 2 | Pasir | 13.64 | 15 | 204.6 | m³ | Rp | 350,000 | Rp | 71,610,000 |
| 3 | Garmet | 8.89 | 15 | 133.35 | m³ | Rp | 300,000 | Rp | 40,005,000 |
| Bak Penampung Backwash | | | | | | | | | |
| 2 | Volume Beton | 48.69 | 15 | 730.35 | m³ | Rp | 4,329,557 | Rp | 3,162,091,955 |
| 3 | pipa Ø 4" | 1 | 15 | 15 | buah | Rp | 102,500 | Rp | 1,537,500 |
| Sistem Underdrain | | | | | | | | | |
| 1 | Pipa Manifold Ø 14" | 1 | 15 | 15 | buah | Rp | 950,000 | Rp | 14,250,000 |
| 2 | Pipa Lateral Ø 5" | 8 | 15 | 120 | buah | Rp | 96,700 | Rp | 11,604,000 |
| 3 | Orifice | 471 | 15 | 7065 | buah | Rp | 65,000 | Rp | 459,225,000 |
| Outlet | | | | | | | | | |
| 1 | pipa Ø 40" | 1 | 15 | 15 | buah | Rp | 2,335,900 | Rp | 35,038,500 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 6,469,692,059 |

## Tabel 7.11 BOQ dan RAB Unit Reservoar

| 9. RESERVOAR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| 2 | Volume Beton | 53.56 | 4 | 214.24 | m³ | Rp | 4,329,557 | Rp | 927,564,292 |
| 3 | Gate Valve | 1 | 4 | 4 | buah | Rp | 1,000,000 | Rp | 4,000,000 |
| 4 | Check valve | 1 | 4 | 4 | buah | Rp | 1,250,000 | Rp | 5,000,000 |
| 5 | Pompa Distribusi | 1 | 4 | 4 | buah | Rp | 4,500,000 | Rp | 18,000,000 |
| 6 | pipa Ø 40" | 1 | 4 | 4 | buah | Rp | 2,335,900 | Rp | 9,343,600 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 963,907,892 |

## Tabel 7.12 BOQ dan RAB Sludge Drying Bed

| 10. SLUDGE DRYING BED | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Uraian | Volume/ Panjang | Jumlah Unit | Total | Satuan | Harga Satuan (Rp) | | Total Harga | |
| 1 | Volume Beton | 35.58 | 18 | 640.44 | m³ | Rp | 4,329,557 | Rp | 2,772,821,485 |
| 2 | pasir | 177.99 | 18 | 3203.82 | m132 | Rp | 350,000 | Rp | 1,121,337,000 |
| 3 | kerikil | 207.66 | 18 | 3737.88 | m133 | Rp | 395,200 | Rp | 1,477,210,176 |
| 4 | Pompa SDB | 1 | 18 | 18 | buah | Rp | 30,000,000 | Rp | 540,000,000 |
| TOTAL RINCIAN BIAYA | | | | | | | | Rp | 5,911,368,661 |

**Tabel 7.13 Rekapitulasi Anggaran Biaya**

| REKAPITULASI ANGGARAN BIAYA | | |
|---|---|---|
| No. | Unit | Anggaran Biaya |
| 1 | Intake | Rp 394,462,097 |
| 2 | Prasedimentasi | Rp 12,155,601,499 |
| 3 | Netralisasi | Rp 1,227,482,718 |
| 4 | Aerasi | Rp 1,638,517,623 |
| 5 | Koagulasi | Rp 1,298,319,372 |
| 6 | Flokulasi | Rp 4,957,854,069 |
| 7 | Sedimentasi 1&2 | Rp 11,915,815,060 |
| 8 | Filtrasi | Rp 6,469,692,059 |
| 9 | Reservoar | Rp 963,907,892 |
| 10 | Sludge Drying Bed | Rp 5,911,368,661 |
| TOTAL ANGGARAN | | Rp 46,933,021,050 |