WTP-PD.Pro

Water Demand

Present Population of the city (P0)= 120000

Growth Rate of population per Decade (r/100)= 23 %

Number of Decades (n)= 3

future population After 'n' Decades (Pn)=

Formula :

$$\mathbf{P_n = P_0 \left(1 + \frac{r}{100}\right)^n}$$

WHERE ,

P0 = 120000

r = 23

n = 3

So, Pn = 120000 *(1+(23 /100))^ 3

Pn = 223304

Per Capita Demand of Water = 135.00 lit/day

Water Supplied per day to city(WD) =

Formula :

$$= \frac{\mathbf{P_n * PerCapitaWaterDemand}}{\mathbf{10^6}}$$

WHERE ,

Pn = 223304

Per Capita Demand of Water = 135.00 lit/day

So,   WD= (223304 * 135.00)/1000000

WD= 30.15 MLD

Fire Demand (Fd) =

Formula :

$$\mathbf{FD} = 100\sqrt{\frac{\mathbf{P_n}}{1000}} * 10^{-3}$$

WHERE ,

Pn = 223304

So,   Fd = (100*sqrt(223304 /1000)/1000)

Fd = 1.49 MLD

Discharge (Q) = Water Demand + Fire demand

Q = 30.15 + 1.49

Q = 34.00 MLD

Inflow at rapid gravity filter considering 3% loss for backwashing (q1)=

Formula :

$$\mathbf{q_1} = \left(\mathbf{Q} + \frac{3}{100}\mathbf{Q}\right)$$

WHERE ,

Q = 34.00 MLD

So,   q1= (34.00 (0.03 * 34.00))

q1= 32.59 MLD

Infiow at clariflocculator tank considering 2% loss for desludging (q2)=

Formula :

$$\mathbf{q_2} = \left(\mathbf{q_1} + \frac{2}{100}\mathbf{q_1}\right)$$

WHERE ,

q1 = 32.59 MLD

So, q2= (32.59 (0.02 * 32.59))

q2= 33.24 MLD

Infiow at pre-sedimentation tank considering 2% loss for desludging (q3)=

Formula :

$$q_3 = \left(q_2 + \frac{2}{100} q_2\right)$$

WHERE ,

q2 = 33.24 MLD

So, q3= (33.24 (0.02 * 33.24))

q3= 33.90 MLD

So, Total Water demand per Day= 34.00 MLD

Intake Well

Quantity of water required per day (Q')= 34.00 MLD

Velocity of water at inlet opening (V)= 0.4 m/Sec

Discharge Required per sec (Q) =

Formula :

$$Q = \frac{Q' * 1000}{24 * 60 * 60}$$

WHERE ,

Q'= 34.00 MLD

So, Q = (34.00 * 1000)/(24*60*60)

Q = 0.39 m3/sec

Area required for opening in the screen (A)=

Formula :

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

WHERE ,

Q = 0.39 MLD

V = 0.4 m/Sec

So, A = 0.39 / 0.4 m2

A = 0.98 m2

Half area is required for placing of bars, total opening area is (Ah) =

Formula :

$$\mathbf{A_h = 2 * A}$$

WHERE ,

A = 0.98 m2

So, = 2 * 0.98

Ah= 1.96 m2

providing two openings,Area of one Screen =

Formula :

$$\mathbf{AreaofOneScreen = \frac{A_h}{2}}$$

WHERE ,

Ah = 1.96 m2

So, = 1.96 / 2

= 0.98 m2

Providing bars of diameter = 20 mm

providing Spacing of Bars (S)= 20 mm

Width of screen (W)= 1 m

Height of Screen (h)=

Formula :

$$h = \frac{A}{W}$$

WHERE ,

A = 0.98 m2

W = 1 m

So, h = 0.98 / 1

= 0.98 m

Diameter of Intake Well (D)= 5 m

Depth of Well Below Water level is (d1)= 3.5 m

Depth of Well Above water level is (d2)= 5 m

Gravity Main (GM)

Velocity of water in gravity main (v)= 0.4 m/sec

Discharge Required per sec (Q)= 0.39 m3/sec

Cross Sectional Area of Gravity main (A)=

Formula :

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

WHERE ,

Q= 0.39 m3/sec

V=0.4 m/sec

So,A= 0.39 / 0.4

= 0.975 m2

Diameter of Gravity main (Dia)=

Formula :

$$\phi = \frac{\mathbf{4A}}{\boldsymbol{\pi}}$$

WHERE ,

A= 0.975 m2

So, = sqrt(4 * 0.975 / 3.14)

= 1.11 m

Maximum Diameter of pipe = 0.5 m

Perimeter of Gravity Main (P)=

Formula :

$$\mathbf{P} = \boldsymbol{\pi} * \boldsymbol{\phi}$$

WHERE ,

Dia= 1.11 m2

So, P=3.14 * 1.11

= 3.50 m

Slope =

Formula :

$$\mathbf{V} = \mathbf{0.85} * \mathbf{C} * \mathbf{R}^{\mathbf{0.63}} * \mathbf{S}^{\mathbf{0.54}}$$

WHERE ,

C=Coefficient of pipe material (C)= 100

R=Hydraulic Radius (R)

S=Slope of Energy line

V=Velocity of Flow

Hydraulic Radius (R) =

Formula :

$$\mathbf{R} = \frac{\mathbf{A}}{\mathbf{P}}$$

WHERE ,

A= 0.975 m2

P=3.50 m2

So, R= 0.975 / 3.50

R= 0.27 m

No of pipes = (((Pi*D 2)/4)*Q*V

= 4.9681 = 4.9681_roundoff

Slope of energy line (S)=

Formula :

$$\mathbf{S} = \left(\frac{\mathbf{V}}{0.85 * \mathbf{C} * \mathbf{R}^{0.63}}\right)^{1.85}$$

WHERE ,

V= 0.4 m/sec

C= 100

R= 0.27 m

So, S=(0.4 / (0.85* 100 * 0.27 ^0.63))^1.85

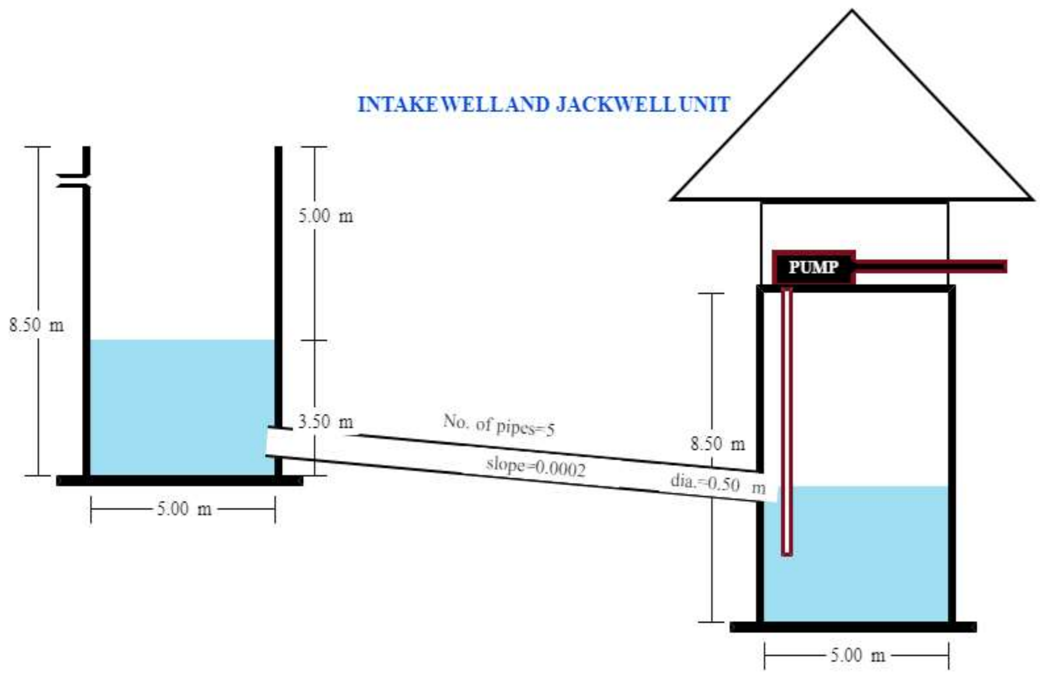
S= 0.0002

JackWell

Diameter of jackwell=   5.00 m

Depth of jackwell below gravity main = 3.50 m

Depth of jackwell above gravity main to pump deck depends on topography and power of pump = 5.00 m


INTAKEWELL AND JACKWELL UNIT
8.50 m
5.00 m
3.50 m
5.00 m
No. of pipes=5
slope=0.0002
8.50 m
dia.=0.50 m
PUMP
5.00 m

Pump design

Input :

Required Discharge (Q)= 0.39 MLD

Discharge range of pump (q)= 0.5 m3/sec

Assume velocity of flow in pipe (V)= 0.4 m/sec

Provide Number of stand by pump (n)= 2 Units

Required static suction head (H)= 5 m

Output :

Diameter of pipe (d):

Formula :

$$\mathbf{d} = \sqrt{\frac{\mathbf{q} + \mathbf{4}}{\pi * \mathbf{V}}}$$

WHERE ,

q = 0.5 m3/sec

V = 0.4 m/sec

So, d = SQRT ((0.5 * 4) / (3.14 * 0.4))

d = 1.26 m

Number of pumps (Np):

Formula :

$$\mathbf{N_p} = \frac{\mathbf{q}}{\mathbf{Q}}$$

WHERE ,

q = 0.5 m3/sec

Q = 0.39 MLD

So, Np = 0.39 / 0.5

Np = 1 Pumps

Total Number of pumps (Nt):

Formula :

$$\mathbf{N_t = n + N_p}$$

WHERE ,

n = 2 Pumps

Np = 1 Pumps

So, Nt = 2 + 1

Nt = 3 Pumps

Minimum clearance between two pumps foot valve (S):

Formula :

$$\mathbf{S = 2 * d}$$

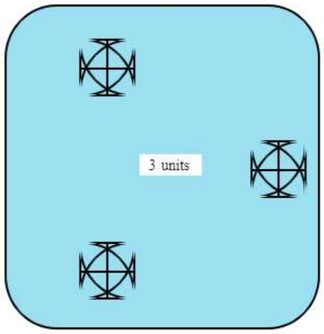
WHERE ,

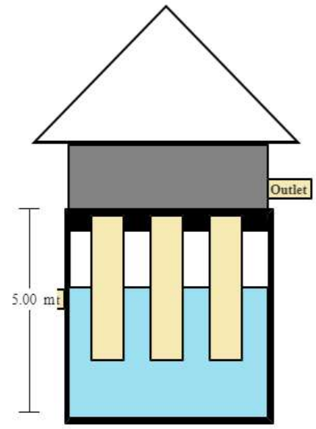
d = 1.26 m

So, S = 2 * 1.26

S = 2.52 m

DESIGN OF PUMP UNIT





Presedementation Tank

General :

Overaflow rate (Q)= 50 m3/m2/d

Minimum side water depth (h)= 2.5 m

Hydraulic Design

Input :

Discharge (Q)= 34.00 MLD

Duration of pumping per day (t)= 23 hrs

Detention period (T)= 3 hrs

Effective depth (H')= 3.5 m

Free board (h)= 0.5 m

Ratio of length and width is 3:1 to 5:1 (H)= 1.5 : 1

Provide width of tank (W)= 11 m

Output :

Total inflow in pre-sedimentation tank is (Q'):

Formula :

$$\mathbf{Q}' = \mathbf{Q}$$

WHERE ,

Q = 34.00 MLD

So, Q'= 34.00

Q'= 34.00 MLD

Discharge coming into the tank per hour (q):

Formula :

$$\mathbf{q = \frac{Q'}{T} * 1000}$$

WHERE ,

Q'= 34.00 MLD

T = 23 hrs

So, q = (34.00 / 23) * 1000

q = 1478.26 MLD

Total Volume required (V):

Formula :

$$\mathbf{V = T * q}$$

WHERE ,

T = 23 hrs

q = 1478.26 MLD

So, V = 1478.26 * 23

V = 4434.78 m3

Length of tank is given by considering length to width ratio (L):

Formula :

$$\mathbf{L = W * H}$$

WHERE ,

W = 11 m

H = 1.5

So, L = 11 * 1.5

L = 16.5 m

Volume of one tank is (v):

Formula :

$$\mathbf{v} = \mathbf{W} * \mathbf{L} * (\mathbf{H}' + \mathbf{h})$$

WHERE ,

W = 11 m

L = 16.5 m

H'= 3.5 m

h = 0.5 m

So, v = 11 * 16.5 * (3.5 + 0.5)

v = 726 m3

Area of one tank (A):

Formula :

$$\mathbf{A} = \mathbf{W} * \mathbf{L}$$

WHERE ,

W = 11 m

L = 16.5 m

So, A = 11 * 16.5

A = 181.5 m2

Number of tanks required (No):

Formula :

$$N_o = \frac{V}{v}$$

WHERE ,

v = 726 m3

v = 726 m3

No= 4434.78 / 726

No= 7 Tanks

Influent Structure

Input :

Width of influent structure (w)=   0.6 m

Depth of influent structure (d)=   0.6 m

Width of tank (W)= 11 m

Spacing of influent structure (S)=   1 m

Width of orifice (w')=   0.2 m

Depth of orifice (d')=   0.2 m

Output :

Number of influent structures (no):

Formula :

$$N_o = \frac{W}{(S + W)}$$

WHERE ,

W = 11 m

S = 1 m

w = 0.6 m

So, no = 11 / (1 + 0.6)

no = 7 Units

Spacing of orifices (S'):

Formula :

$$\mathbf{S}' = \frac{\mathbf{W}}{\mathbf{4 + W'}}$$

WHERE ,

w' = 0.2 m

So, S' = 11 / (4 + 0.2)

S' = 2.62 m

<u>Effluent Structure</u>

Input :

Assume weir loading (w)= 218.92 m3/day/m

Number of launder troughs provided (no) = 8 Unit

Width of central launder trough (Wc) = 0.3 m

Output :

Net outflow (Q'):

Formula :

$$\mathbf{Q}^{'} = \frac{\mathbf{q}}{\mathbf{N_o}}$$

WHERE ,

q = 1478.26 MLD --From Hydraulic Design

No = 7 Tanks --From Hydraulic Design

So, Q' = 1478.26 / 7

Q' = 184.78 m3

Length of weir (L):

Formula :

$$\mathbf{L} = \frac{\mathbf{24 * Q^{'}}}{\mathbf{W}}$$

WHERE ,

Q' = 184.78 m3

w = 218.92 m3/day/m

So, L = (184.78 * 24) / 218.92

L = 20.26 m

Spacing of launder trough (S"):

Formula :

$$\mathbf{S}^{"} = \frac{\mathbf{W}}{(\mathbf{W}^{"} + \mathbf{no})}$$

WHERE ,

W = 11 m

W"= 0.3

no = 8

So, S"= 11 / (0.3 + 8)

S"= 1.33 m

Length of Launder (LL):

Formula :

$$LL = \frac{L}{no}$$

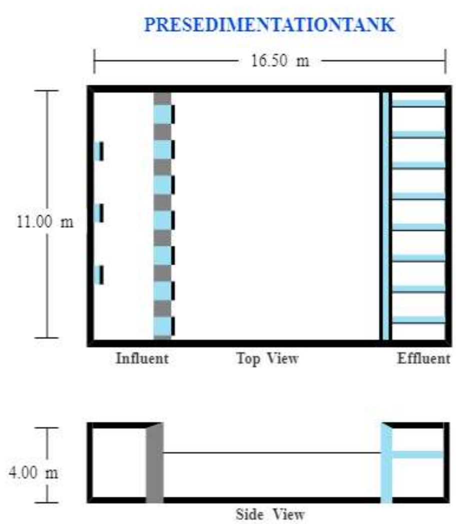
WHERE ,

L = 20.26 m

no = 8

So, LL = 20.26 / 8

LL = 2.53 m3/hr



Aeration Unit

Input :

Required Discharge for Aerator (Q)= 34.00 MLD

Velocity (V): 0.40 m/Sec

Head Requirement (h)= 3 m

Number of Trays (n)=   5 Units

Rise of Tray (r)=   .2 m

Space Requirement (S)= .03 m2/m3/hrs

Output :

Required Discharge per Hour (Q'):

Formula :

$$\mathbf{Q}' = \frac{\mathbf{Q} * \mathbf{1000}}{\mathbf{24}}$$

WHERE ,

Q = 34.00 MLD

So, Q'= 34.00 * 1000 / 24

Q'= 1416.67 m3/hrs

Diameter of inner pipe (Di):

Formula :

$$\mathbf{D_i} = \sqrt{\frac{\mathbf{Q}' * \mathbf{4}}{\mathbf{V} * \pi * \mathbf{60} * \mathbf{60}}}$$

WHERE ,

Q' = 1416.67 m3/hrs

V = 0.40 m/Sec

So, Di = SQRT ((1416.67 * 4) / (0.40 * 3.14 * 60 * 60))

Di = 1.25 m

Provide Area at Tray (A):

Formula :

$$\mathbf{A} = \mathbf{Q}' * \mathbf{S}$$

WHERE ,

Q' = 1416.67 m3/hrs

S = .03 m2/m3/hrs

So, A = 1416.67 * .03

A = 42.50 m2/m3/hrs

Diameter of bottom tray (Db):

Formula :

$$\mathbf{D_b} = \sqrt{\frac{\mathbf{D_i} * \mathbf{4}}{\pi} + \mathbf{A}}$$

WHERE ,

Di = 1.25 m

A = 42.50 m2/m3/hrs

So, Db = SQRT { (42.50 * 4)/3.14 } + 42.50

Db = 8.61 m

Tread of Tray (t):

Formula :

$$\mathbf{t} = \frac{\mathbf{D_b} - \mathbf{D_i}}{\mathbf{2} * \mathbf{n}}$$

WHERE ,

Db = 8.61 m

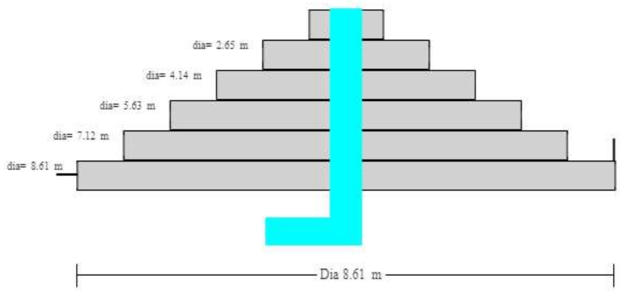
Di = 1.25 m

n = 5

So, t = (8.61 - 1.25)/(2 * 5)

t = 0.74 m

AERATION UNIT



Alum Dose

Input :

Volume of water (Vw): 34.00 MLD

Alum applied (ppm): 52 mg/lit

Height of platform from top level rapid mix unit (h): 2 m

Required for months (n): 6 Months

Height of tank H: 1 m

Density of alum d: 2672 kg/m3

Output :

Alum required per hour (R):

Formula :

$$\mathbf{R} = \frac{\mathbf{ppm} * \mathbf{V_w} * \mathbf{10^6}}{\mathbf{24} * \mathbf{10^6}}$$

WHERE ,

ppm = 52 mg/lit

Vw = 34.00 MLD

So, R = 52 * 34.00 / 24

R = 73.67 kg/hr

Alum required per day (W):

Formula :

$$\mathbf{W} = \frac{\mathbf{ppm} * \mathbf{V_w} * \mathbf{10^6}}{\mathbf{10^6}}$$

WHERE ,

ppm = 52 mg/lit

Vw = 34.00 MLD

So, W = 52 * 34.00

W = 1768.00 kg

Total Alum required for n months (Wt):

Formula :

$$\mathbf{W_t = 30 * W * n}$$

WHERE ,

W = 1768.00 kg

n = 6 Months

So, Wt= 30 * 1768.00 * 6

Wt= 318240.00 kg

volume of tank (V1):

Formula :

$$\mathbf{V_1 = \frac{W_t}{d}}$$

WHERE ,

Wt = 318240.00 kg

d = 2672 kg/m3

So, V1 = 318240.00 / 2672

V1 = 119.10 m3

Volume for Provision of drainage, mixing, and stirring is 10% (V2):

Formula :

$$\mathbf{V_2 = (\frac{10}{100} * V_1)}$$

WHERE ,

V1 = 119.10 m3

So, V2 = 0.1 * 119.10

V2 = 11.91 m3

Total volume (V):

Formula :

$$\mathbf{V = V_1 + V_2}$$

WHERE ,

V1 = 119.10 m3

V2 = 11.91 m3

So, V = 119.10 + 11.91

V = 131.01 m3

Diameter of tank (dia):

Formula :

$$\mathbf{dia} = \sqrt{\frac{\mathbf{4 * V_w}}{\pi * \mathbf{H}}}$$

WHERE ,

Vw = 34.00 MLD

H = 1 m

So, dia = SQRT ((4 * 34.00) / (3.14 * 1))

dia = 6.58 m

Square Platform with one side (l):

Formula :

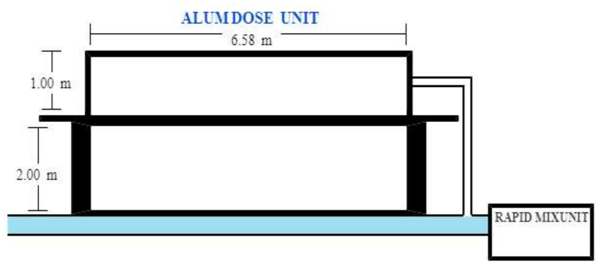
$$\mathbf{l = dia + 0.75}$$

WHERE ,

dia = 6.58 m

So, l = 0.75 + 6.58

l = 7.33 m



<u>Rapid Mix Unit</u>

Input :

Discharge (Q): 34.00 MLD

Detention time (t): 40 hrs

Assume height of tank considering free board (H): 2.5 m

Ratio of tank height to diameter 1.5:1 : 1.5:1

Ratio of impeller diameter to tank diameter 0.4:1 : 0.4

Rotational speed of impeller (n): 125 rpm

Power rate (p): 2 watts/m3/hrs

Motor of 1HP is required for treating water 6.31 MLD : 2 HP

Output :

Design flow (Q'):

Formula :

$$\mathbf{Q}^{'} = \frac{\mathbf{Q} * \mathbf{1000}}{\mathbf{24} * \mathbf{60} * \mathbf{60}}$$

WHERE ,

Q = 34.00 MLD

So, Q'= (34.00 * 1000) /(24 * 60 * 60)

Q'= 0.39 m3/s

Capacity of tank (C):

Formula :

$$\mathbf{C} = \mathbf{Q}^{'} * \mathbf{t}$$

WHERE ,

Q' = 0.39 m3/s

t = 40 sec

So, C = 0.39 * 40

C = 15.74 m3

Diameter of tank (D):

Formula :

$$\mathbf{D = \frac{H}{0.4}}$$

WHERE ,

H = 2.5 m

So, D = 2.5 / 0.4

D = 6.25 m

Volume of tank (V):

Formula :

$$\mathbf{V = \frac{\pi}{4} D^2 H}$$

WHERE ,

D = 6.25 m

H = 2.5 m

So, V = 3.14 * 6.25 * 6.25 * 2.5 / 4

V = 76.73 m3

Number of rapid mix units (no):

Formula :

$$\mathbf{no = \frac{C}{V}}$$

WHERE ,

C = 15.74 m3

V = 76.73 m3

So, no= 15.74 / 76.73

no= 0.21   Units

Hence to treat volume of tank required motor power (HP):

Formula :

$$\mathbf{HP} = \frac{\mathbf{Q}}{\mathbf{6.31}}$$

WHERE ,

Q = 34.00 MLD

So, HP = 34.00 / 6.31

HP = 5.39   HP

Diameter of impeller (d):

Formula :

$$\mathbf{d} = \mathbf{0.4} * \mathbf{D}$$

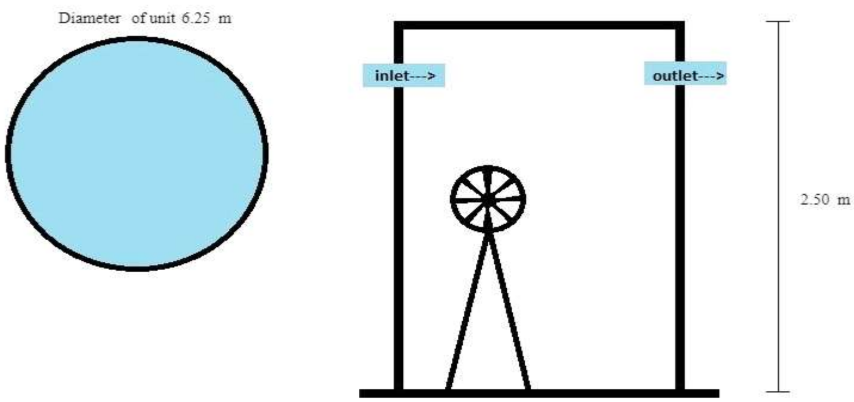
WHERE ,

D = 6.25 m

So, d = 0.4 * 6.25

d = 2.50   m

RAPID MIXUNIT



Flocculator Design

Input :

Detention Period (t): 40 min

Velocity Gradient (G): 50 S^-1

Provide a water depth (H): 4.5 m

Diameter of inlet pipe (d): 0.5 m

Number of Tanks (n): 1 m

Output :

Design average outflow (Q):

Formula :

$$Q = \frac{q_2 * 1000}{24 * 60}$$

WHERE ,

q2 = 34.00 MLD

So, Q = 34.00 * 1000 /(24*60)

Q = 23.61 m3/min

Volume of circular Flocculator (V):

Formula :

$$V = Q * t$$

WHERE ,

Q = 23.61 m3/min

t = 40 min

So, V = 23.61 * 40

V = 7.33 m3

Plan area for flocculator (A):

Formula :

$$\mathbf{A = \frac{V}{H}}$$

WHERE ,

V = 7.33 m3

H = 4.5 m

So, A = 7.33 / 4.5

A = 209.88 m2

Diameter of flocculator (D):

Formula :

$$\mathbf{D = \sqrt{\frac{4A}{\pi} + d^2}}$$

WHERE ,

A = 209.88 m2

d = 0.5 m

So, D = SQRT((4 * 209.88 / 3.14) +(0.5 * 0.5))

D = 16.35 m

Dimensions of paddles

Input :

For volume, Total power input to flocculator (V'): 87 m3

Newton's co-efficient of drag : 1.8

Density of water at 25degree C : 997 kg/m3

Velocity of tip of blades: 0.4 m/s

Using above formula area of paddle is (Ap'): m2

Number of shafts provided (Ns): 2 Units

Each shaft supports n no of paddles (Nes): 4 Unit

Provide length of each paddle (l): 1 m

Width of each paddle (w): 0.4 m

Output :

Area of paddle for volume 1459.167 is (Ap):

Formula :

$$\mathbf{A_p} = \frac{\mathbf{V}}{\mathbf{V'}} * \mathbf{A_p'}$$

WHERE ,

V = 7.33 m3

V' = 87

Ap'=

So, Ap = 7.33 * /

Ap = NaN m2

Paddle area (a):

Formula :

$$\mathbf{a} = \mathbf{l} * \mathbf{w}$$

WHERE ,

l = 1 m

w = 0.4 m

So, a = 1 * 0.4

a = _1 m2

Shaft distance from central line of clariflocculator (s):

Formula :

$$\mathbf{S} = \frac{\mathbf{d}}{\mathbf{2}} + \mathbf{1.5}$$

WHERE ,

d = 0.5 m

So, s = (0.5 / 2) + 1.5

s = 9.68 m

total no of paddles (Tno):

Formula :

$$\mathbf{T_{no} = N_s + N_{es}}$$

WHERE ,

(Ns) = 2 Units

(Nes)= 4 Unit

So, Tno = 2 * 4

Tno = 8 Units

Clarifier

Input :

Assume surface overflow rate (R): 20 m3/m2/d

Assume detention period (t): 2 hrs

Assume free board (b): 2 m

Output :

Surface area of clarifier (Ac):

Formula :

$$\mathbf{A_c = \frac{Q * 24 * 60}{R}}$$

WHERE ,

Q = 23.61 m3/min

R = 20 m3/m2/d

So, Ac= (23.61 * 60 * 24) / 20

Ac= 1700.00 m2

Diameter of clariflocculator (D'):

Formula :

$$\mathbf{D^{'} = \sqrt{\frac{4A_c}{\pi} + D^2}}$$

WHERE ,

Ac= 1700.00 m2

D = 16.35 m

So, D'= SQRT ((4 * 1700.00 / 3.14) + (16.35 * 16.35))

D'= 49.31 m

Length of weir (L):

Formula :

$$\mathbf{L = 3.15 * D^{'}}$$

WHERE ,

D'= 49.31 m

So, L = 3.15 *49.31

L = 155.31 m

Weir loading (F):

Formula :

$$\mathbf{F = \frac{Q * 60 * 24}{L}}$$

WHERE ,

Q = 23.61 m3/min

L = 155.31 m

So, F = (23.61 * 60 *24) / 155.31

F = 218.92 m3/m/d

Depth of tank (d):

Formula :

$$\mathbf{d = \frac{Q * 60 * t}{A_c}}$$

WHERE ,

Q = 23.61 m3/min

Ac= 1700.00 m2

t = 2 hrs

So, d = (23.61 * 60 * 2) / 1700.00

d = 1.67 m

Depth for sludge accumulation (d1):

Formula :

$$\mathbf{d_1 = \frac{25}{100} d}$$

WHERE ,

d = 1.67 m

So, d1 = 25 % of 1.67

So, d1 = 0.25 * 1.67

d1 = 0.42 m

Total depth at centre of tank (d'):

Formula :

$$\mathbf{d' = b + d_1 + d}$$

WHERE ,

b = 2 m

d1= 0.42 m

d = 1.67 m

So, d' = 2 + 0.42 + 1.67

d' = 4.08 m

Launder/Collecting channel(RCC)

Input :

Provide n number of Launders (Nl): 2 Units

Velocity of flow through launder (V'): 1 m/s

Output :

Discharge flow for 1 unit (q):

Formula :

$$\mathbf{q = \frac{Q * 24 * 60}{Nl * 1000}}$$

WHERE ,

Nl = 2 Units

Q = 17.00 m3/min

So, q = (17.00 * 24 * 60) / (1000 * 2) q = 17.00 MLD

Cross sectional area of each launder (a'):

Formula :

$$\mathbf{a'} = \frac{\left(\frac{\mathbf{q*1000}}{\mathbf{24*60*60}}\right)}{\mathbf{V'}}$$

WHERE ,

q = 17.00 MLD

V'=1 m/s

So, a'= (17.00 * 1000 / (24 * 60 * 60)) / 1

a'= 0.20 m2

Perimeter of launder (P):

Formula :

$$\mathbf{P} = \pi\sqrt{\frac{\mathbf{4a'}}{\pi}}$$

WHERE ,

a' = 0.20 m2

So, P = 3.14 * SQRT (4* 0.20 /4)

P = 1.57 m

Hydraulic mean radius (R):

Formula :

$$\mathbf{R} = \frac{\mathbf{a'}}{\mathbf{P}}$$

WHERE ,

P = 1.57 m

a' = 0.20 m2

So, R = 0.20 / 1.57

R = 0.13 m

Slope of channel (S): 0.002736

Formula :

$$\mathbf{S} = \left(\frac{\mathbf{0.013 * V'}}{\mathbf{R^{0.67}}}\right)^{\mathbf{2}}$$

WHERE ,

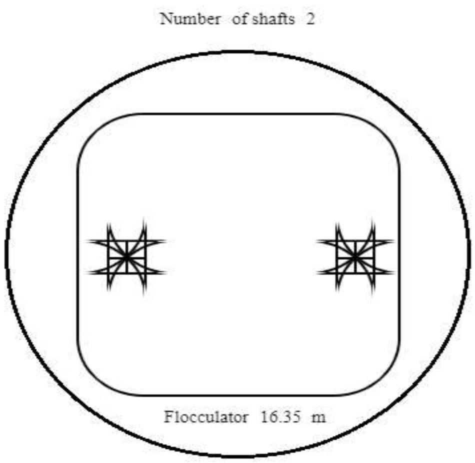
V'= 1 m/s

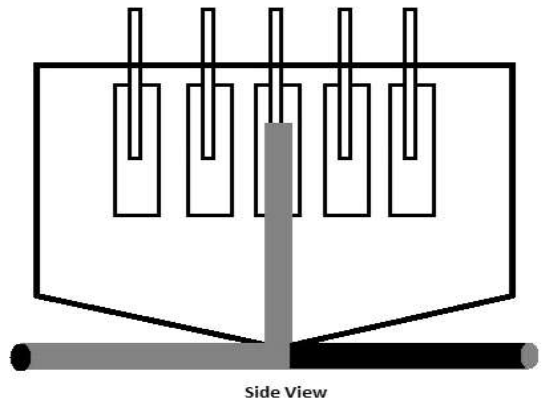
R = 0.13 m

So, S = ((0.013 * 1) / (0.13 ^0.67))^ 2

S = 0.002736

CLARIFLOCCULATORUNIT





Rapid sand Gravity Filter

General provision :

Input :

required inflow (Q): 34.00 MLD

Time lost during backwashing (t'): 30 min

Working hours of filter per day (T): 23 hrs

Rate of filtration (r): 4 m3/m2/hrs

Length:Width ratio : 1.25

Size of perforation (Qp): 10 mm

Filter bed dimension

Input :

Provide width of filter bed (w): 8 m

Provide length of filter bed (l): 10 m

Q1 = 47.54 MLD

Design flow for filter after accounting for backwash water and time lost (Q1):

Formula :

$$\mathbf{Q_1} = \frac{\left(\frac{\mathbf{Q} * \mathbf{q}}{\mathbf{100}} + \mathbf{Q}\right) * \mathbf{24}}{\mathbf{T}}$$

WHERE ,

Q = 34.00 MLD

q = 34.00 MLD

T = 23 hrs

So, Q1 =((((34.00 * 34.00) / 100) +34.00) * 24) / 23

Q1 = 47.54 MLD

Area of filter required (A):

Formula :

$$\mathbf{A} = \frac{\mathbf{Q_1} * \mathbf{1000}}{\mathbf{r} * \mathbf{24}}$$

WHERE ,

Q1 = 47.54 MLD

r = 4 m3/m2/hrs

So, A = ((47.54 * 1000) / (4 * 24))

A = 495.22 m2

The number filter beds (morell and wallace) (no):

Formula :

$$\mathbf{no = 1.22\sqrt{Q}}$$

WHERE ,

Q1 = 47.54 MLD

So, no = 1.22* SQRT (47.54)

no = 9 Unit

Area of each filter (A'):

Formula :

$$\mathbf{A' = \frac{A}{no}}$$

WHERE ,

A = 495.22 m2

no = 9 Unit

So, A'= 495.22 / 9

A'= 55.02 m2

Design of under-drainage system

Input :

Diameter of perforator (Qp): 10 mm

Assume Spacing for laterals (Sl): 0.15 m

Assume diameter of lateral (Ql): 0.08 m

Output :

Total area of perforation (a):

Formula :

$$\mathbf{a = \frac{3}{1000} * l * w}$$

WHERE ,

l = 10 m

W = 8 m

So, a = (3/1000)* 10 * 8

a = 0.24 m2

Total number of perforations (num):

Formula :

$$\mathbf{num = \frac{4a * 10^6}{\pi(Q_p)^2}}$$

WHERE ,

a = 0.24 m2

Qp = 10 mm

So,num = (4 *0.24 *100000)/ (3.14 * 10 * 10)

num = 3055 Unit

Total c/s area of laterals (a'):

Formula :

$$\mathbf{a' = 3 * a}$$

WHERE ,

a = 0.24 m2

So, a'= 3 * 0.24

a'= 0.72 m2

Area of central manifold (Am):

Formula :

$$\mathbf{A_m = 2 * a'}$$

WHERE ,

a' = 0.72 m2

So, Am = 2 * 0.72

Am = 1.44 m2

Diameter of manifold (Qm):

Formula :

$$\mathbf{Q_m} = \sqrt{\frac{\mathbf{4A_m}}{\pi}}$$

WHERE ,

Am = 1.44 m2

So, Qm = SQRT(4 * 1.44 / 3.14)

Qm = 1.35 m

Number of laterals on one side considering spacing (Nl):

Formula :

$$\mathbf{N_l} = \frac{\mathbf{l}}{\mathbf{S_l * Q_l}}$$

WHERE ,

l = 10 m

Sl = 0.15 m

Ql = 0.08 m

So, Nl = 10 / (0.15 + 0.08)

Nl = 44 Unit

Laterals on both sides on one manifold (Nbl):

Formula :

$$\mathbf{N_{bl} = 2 * N_l}$$

WHERE ,

Nl = 44

So Nbl = 2 * +rsg.uds11

Nbl = 87 Unit

Total Number of required laterals (Tnl):

Formula :

$$\mathbf{T_{nl} = \frac{4a'}{\pi(Q_l)^2}}$$

WHERE ,

a' = 0.72 m2

Ql = 0.08 m

So, Tnl= (4 * 0.72) / (3.14 * 0.08 * 0.08)

Tnl= 144 Unit

Total Number required manifold in one filter (Tm):

Formula :

$$\mathbf{T_m = \frac{N_{bl}}{T_{nl}}}$$

WHERE ,

Nbl = 87 Unit

Tnl = 144 Unit

So, Tm = 87 / 144

Tm = 2 Unit

Spacing of manifold along width of filter (Sm):

Formula :

$$\mathbf{S_m = \frac{w}{T_m + Q_m}}$$

WHERE ,

W = 8 m

Tm = 2 Unit

Qm = 1.35 m

So, Sm = 8 / (2 + 1.35)

Sm = 2.38 m

Length of each lateral (Ll):

Formula :

$$\mathbf{Ll = \frac{\left(\frac{w}{T_m} - Q_m\right)}{2}}$$

WHERE ,

Tm = 2 Unit

W = 8 m

Qm = 1.35 m

So, Ll = ((8 /2.00) - 1.35) * 0.5

Ll = 1.32 m

Number of perforations per lateral (Np):

Formula :

$$\mathbf{N_p = \frac{num}{T_{nl}}}$$

WHERE ,

num = 3055 Unit

Tnl = 144 Unit

So, Np = 3055 / 144

Np = 22 Unit

spacing of perforators along width of filter (Sp):

Formula :

$$\mathbf{S_p} = \frac{\mathbf{Ll}}{\left(\mathbf{N_p} + \frac{\mathbf{Q_p}}{\mathbf{100}}\right)}$$

WHERE ,

Ll = 1.32 m

Qp = 10 mm

Np = 22 Unit

So, Sp = 1.32 / (22 + (10 / 100))

Sp = 0.06 m

Design of wash water trough

Input :

Assume Wash water rate (Rw): 20 m3/m2/hr

Assume spacing for wash water trough along width of filter (St): 1.4 m

Assume width of trough (Wt): 0.40 m

Assume free board for trough (bt): 0.1 m

Bottom of trough from sand bed is given as: 0.5 m

Output :

Wash water discharge for 1 filter (Qw):

Formula :

$$\mathbf{Q_w = \frac{R_w * l * w}{60 * 60}}$$

WHERE ,

Rw = 20 m3/m2/hr

l = 10 m

W = 8 m

So,Qw = (20 * 10 * 8) / (60 * 60)

Qw = 0.44 m3/sec

Total number of trough (Nt):

Formula :

$$\mathbf{N_t = \frac{w}{S_t + W_t}}$$

WHERE ,

W = 8 m

St = 1.4 m

Wt = 0.40 m

So,Nt = 8 / (1.4 +0.40)

Nt = 5 Unit

Discharge per unit trouhg (Qt): 0.10 m3/sec

Formula :

$$\mathbf{Q_t = \frac{Q_w}{N_t}}$$

WHERE ,

Qw = 0.44 m3/sec

Nt = 5 Unit

So,Qt = 0.44 / 5

Qt = 0.10 m3/sec

Trough depth is given by formula Q= 1.376 bh ^(3/2) (Dt):

Formula :

$$\mathbf{D_t} = \left(\frac{\mathbf{Q_t}}{\mathbf{1.376W_t}}\right)^{\mathbf{0.67}}$$

WHERE ,

Q = Qt = 0.10 m3/sec

b = Wt = 0.40 m

So,h = Dt = (0.10 / (1.376 * 0.40)) ^ 0.67

Dt = 0.32 m

Water depth at upper end in the trough considering free board (dut):

Formula :

$$\mathbf{d_{ut}} = \mathbf{D_t} + \mathbf{b_t}$$

WHERE ,

Dt = 0.32 m

bt = 0.1 m

So dut = 0.32 + 0.1

dut = 0.42 m

Computing of total depth of filter box

Input :

Minimum depth required for sand is given by Hudson's formula in metric unit (d1): 0.7 m

Depth of water while filtering (d2): 1 m

Depth of water while backwashing (d3): 0.6 m

Depth of gravel at bottom (d4): 0.6 m

Free board for rapid gravity filter (d6): 0.6 m

Output :

Depth of underdrainage system (d5):

Formula :

$$\mathbf{d_5 = Q_m}$$

WHERE ,

Qm = 1.35 m

So, d5 = 1.35 m

d5 = 1.35 m

Total depth of rapid gravity filter (D):

Formula :

$$\mathbf{D = d_1 + d_2 + d_4 + d_5 + d_6}$$

WHERE ,

d1 = 0.7 m

d2 = 1 m

d4 = 0.6 m

d5 = 1.35 m

d6 = 0.6 m

So,D = 0.7 + 1 + 0.6 + 1.35 + 0.6

D = 4.25 m

Main Gutter

Input :

Assume rise/min backwash rate (h): 60 m/min

Flow per filter bed considering wash water rate (q): 2 m3/sec

Width of main gutter is found by using formula Q= 1.376bh^(3/2) (b): 0.32 m

Wash water Tank

Input :

Required flow for backwash (Qb): 1 m3/m2/min

Duration of backwash for 2 filter bed (Tb): 30 min

Output :

Volume of tank (V):

Formula :

$$\mathbf{V = 2 * Q_b * T_b * l * w}$$

WHERE ,

Qb = 1 m3/m2/min

Tb = 30 min

l = 10 m

W = 8 m

So, V = 2 * 1 * 30 * 10 * 8

V = 4800.00 m3

Total no of tanks (No_Tank):

Formula :

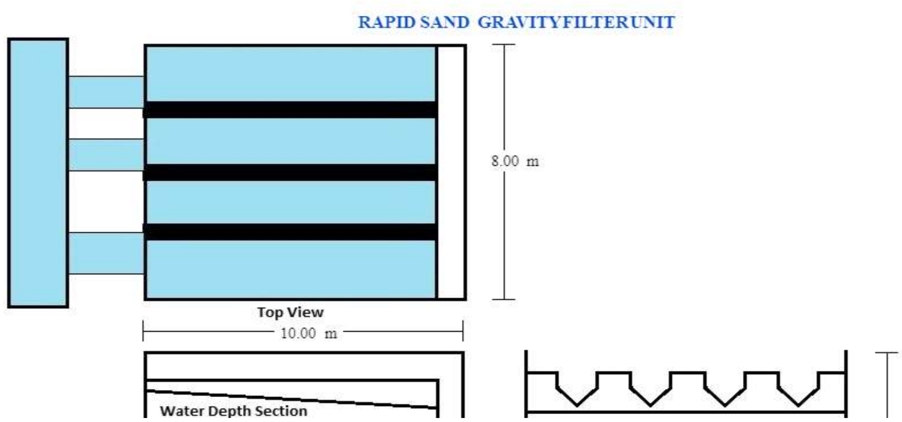
$$\mathbf{NoTank} = \frac{\mathbf{no}}{\mathbf{2}}$$

WHERE ,

no= 9 Unit

So, No_Tank = 9 / 2

No_Tank = 5 Unit



Chlorinator

Input :

Volume of water : 34.00 MLD

Liquid Chlorine applied (pre_chl) : 1.2 mg/lit

Residual liquid chlorine (post_chl) : 0.15 mg/lit

Required for months (n): 6 Unit

Height of tank (H): 1 m

Height of platform from top level of rapid sand gravity filter: 2 m

Density of liquid chlorine (d): 1562.5 kg/m3

Output :

Total Liquid Chlorine applied (ppm):

Formula :

$$\mathbf{ppm = prechl + postchl}$$

WHERE ,

pre_chl= 1.2 mg/lit

post_chl= 0.15 mg/lit

So, ppm= 1.2 + 0.15

ppm= 1.35 mg/lit

Liquid chlorine required per hour (R):

Formula :

$$\mathbf{R = \frac{ppm * V}{24}}$$

WHERE ,

ppm= 1.35 mg/lit

V= 34.00 MLD

So, R= (1.35 * 34.00) / 24

R= 1.91 kg/hr

Chlorine per day (W):

Formula :

$$\mathbf{W} = \frac{\mathbf{ppm} * \mathbf{V} * \mathbf{10^6}}{\mathbf{10^6}}$$

WHERE ,

ppm= 1.35 mg/lit

V= 34.00 MLD

So, W= (1.35 * 34.00

W= 45.90 kg

Total Chlorine required for n months (Wt):

Formula :

$$\mathbf{W_t} = \mathbf{30} * \mathbf{W} * \mathbf{n}$$

WHERE ,

n = 6 Months

W = 45.90 kg

So, Wt = 6 * 30 * 45.90

Wt = 8262.00 kg

Volume of tank :(V1)

Formula :

$$\mathbf{V_1} = \frac{\mathbf{W_t}}{\mathbf{d}}$$

WHERE ,

Wt = 8262.00 kg

d = 1562.5 kg/m3

So, V1 = 8262.00 / 1562.5

V1 = 5.29 m3

Volume for Provision of drainage, mixing, and stirring is 10% (V2):

Formula :

$$\mathbf{V_2 = \frac{10}{100} V_1}$$

WHERE ,

V1 = 5.29 m3

So, V2 = 10 % * (5.29)

V2 = 0.53 m3

Total volume (V):

Formula :

$$\mathbf{V = V_1 + V_2}$$

WHERE ,

V1 = 5.29 m3

V2 = 0.53 m3

So, V = 5.29 + 0.53

V = 5.82 m3

Diameter of tank (Dia):

Formula :

$$\mathbf{Dia = \sqrt{\frac{4V}{\pi H}}}$$

WHERE ,

V = 5.82 m3

H = 1 m

So, Dia = SQRT((4 * 5.82) / (3.14 * 1.00))

Dia = 2.72 m

Square Platform with one side (l):

Formula :

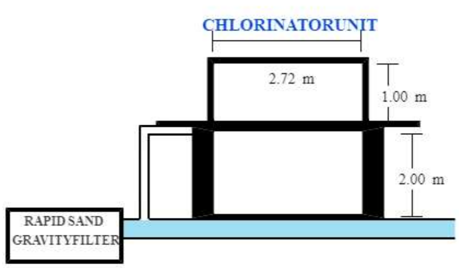
$$\mathbf{l = Dia + 0.75}$$

WHERE ,

Dia = 2.72 m

So, l = 2.72 + 0.75

l = 3.47 m



Clear Water Tank

Input :

Voiume of tank : 34.00 MLD ---------From Water Demand

Depth of tank: 6 m

Output :

C/S area of tank (A):

Formula :

$$\mathbf{A} = \frac{\mathbf{V}}{\mathbf{D}}$$

WHERE ,

V= 34.00 MLD

D= 6 m

So, A= 34.00 / 6

A= 5.67 m2

Diameter of tank (d):

Formula :

$$\mathbf{d} = \sqrt{\frac{\mathbf{4A}}{\pi}}$$

WHERE ,

A= 5.67 m2

So, d = SQRT(4* 5.67 / 3.14)

$d = 2.69$ m