# Primary Sedimentation tank

**Purpose:**

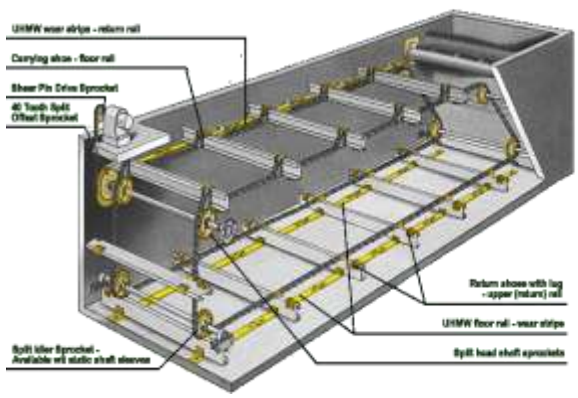
1- Removal of 40 - 60 % of suspended solids
2- Removal of 25 - 35 % of B.O.D.
3- Sediment the organic and inorganic matters to improve the properties of the sewage and prepare it for the biological treatment.

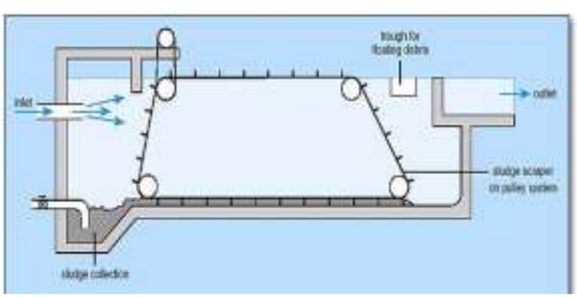
**Types of primary sedimentation tanks:**

1- Rectangular tank.
2- Circular tank.

**Factors affecting sedimentation efficiency:**

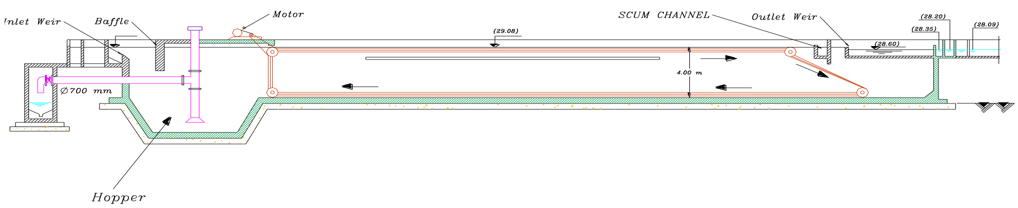
1- Viscosity
2- Concentration of suspended solids
3- Retention period
4- Horizontal velocity
5- Temperature
6- Surface loading rate = 24 - 48 $m^3/m^2/day$

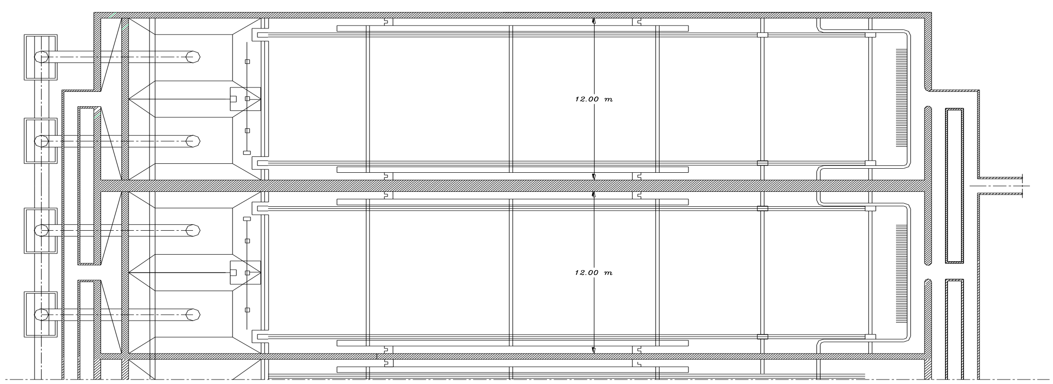


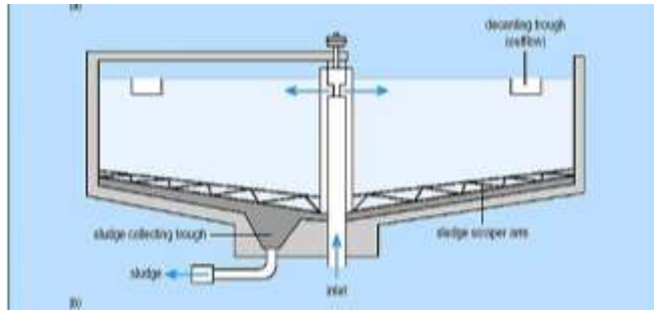

Primary sedimentation tank
(horizontal flow)


Effluent weir of rectangular sedimentation tank

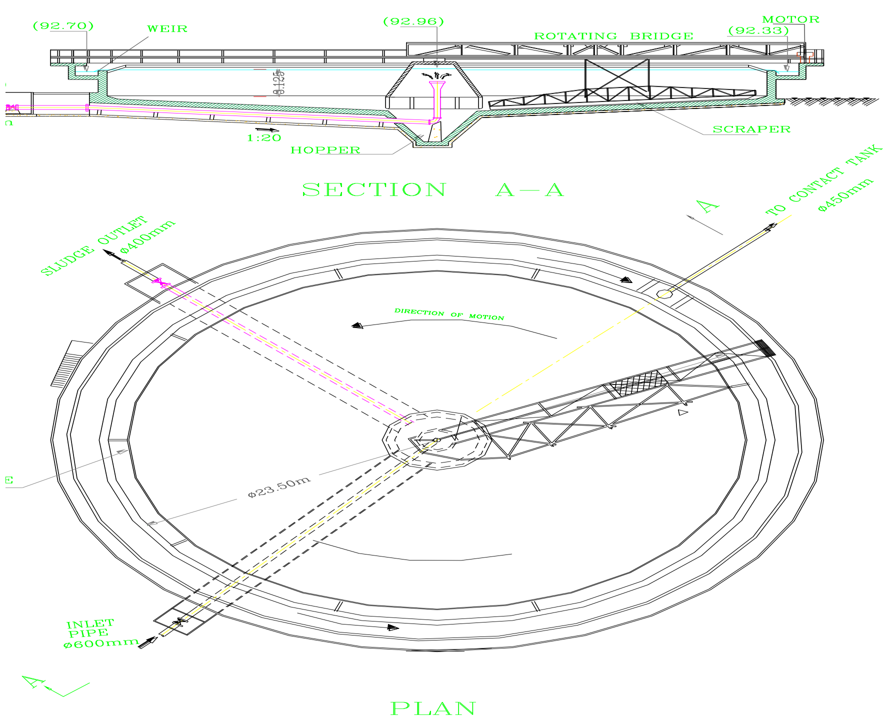



Rectangular primary sedimentation tank




Primary sedimentation tank
(Radial flow)




Circular primary sedimentation tank

7- Dimension of tank
8- Dead zones.

**Design criteria:**

1- Retention period = T = 2 - 3 hrs
2- Surface loading rate (S.L.R.) = 24 - 48 $m^3/m^2/day$
3- Horizontal velocity ≤ 0.3 m/min
4- Effluent weir loading (E.W.L.) ≤ 600 $m^3/m/day$ (≤ 25 $m^3/m/hr$)
5- L = 3 – 5 B
L ≤ 40 m
6- d = 3 - 5 m
7- B = 2 – 3 d
8- Φ ≤ 40 m
9- Bottom slope for circular tank = 4 - 10 %
for rectangular tank = 1 - 2 %

V = Qd x T
S.L.R = Qd / S.A

**Example:**

For a sewage treatment plant, the following data are given:
- Qave summer = 18000 m3/d
- S.L.R = 30 m3/m2/d

It is required to design primary sedimentation tanks.

Solution:

Qd = 1.5 x 18000 = 27000 m3/d

**For rectangular tank:**

Assume T = 2.5 hr

$$V = Q_d \times T$$

$$= 27000 \times \frac{2.5}{24} = 2812.5 \quad m^3$$

$$S.L.R = \frac{Q_d}{S.A}$$

$$S.A = \frac{27000}{30} = 900 \quad m^2$$

$$d = \frac{V}{S.A}$$

$$= \frac{2812.5}{900} = 3.1 \quad m$$

$Take\ n = 2$

$$\therefore S.A\ of\ one\ tank = \frac{900}{2} = 450 \quad m^2$$

$Assume\ length = 40\ m$

$$b = \frac{S.A}{L} = \frac{450}{40} = 11.25 \quad m$$

$Check:$

$$1 - V_h = \frac{Q_d}{cross\ sectional\ area} = \frac{Q_d}{n \times b \times d}$$

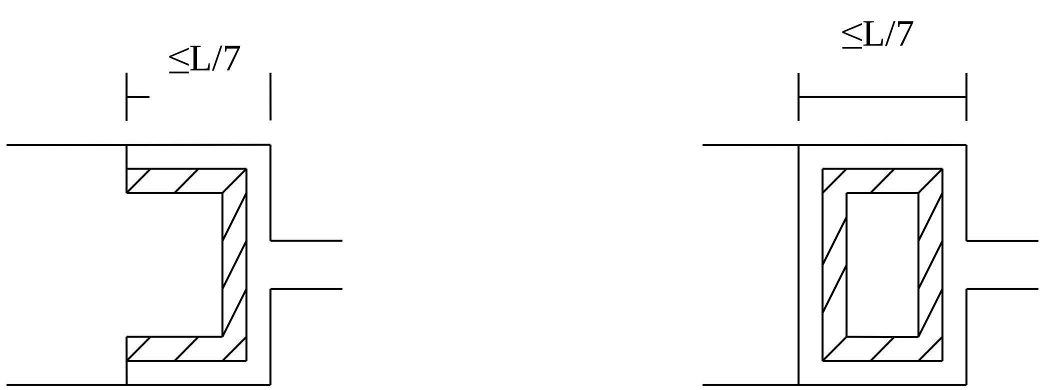
$$= \frac{27000}{(2 \times 11.25 \times 3.1) \times 24 \times 60} = 0.269 \prec 0.3\ m/\min\ safe$$

$$2 - E.W.L = \frac{Q_d}{n \times b}$$

$$= \frac{27000}{2 \times 11.25} = 1200 \quad m^3/m/d \quad \succ 600\ unsafe$$

$\therefore take\ weir\ loading = 600\ m^3/m/d$

$$Length\ of\ weir = \frac{Q_d}{weir\ loading} = \frac{27000}{2 \times 600} = 22.5\ m$$



**Circular primary sedimentation tank:**

$$V = Q_d \times T$$

$$= 27000 \times \frac{2.5}{24} = 2812.5 \quad m^3$$

$$S.L.R = \frac{Q_d}{S.A}$$

$$S.A = \frac{2700}{30} = 900 \quad m^2$$

$$d = \frac{V}{S.A}$$

$$= \frac{2700}{900} = 3.1 \quad m$$

$$Take\, n = 2$$

$$\therefore S.A\, of\;\, one\, \tan k = \frac{900}{2} = 450\, m^2$$

$$= \frac{\pi \phi^2}{4}$$

$$\therefore \phi = 24\, m$$

$$Chick:$$

$$1 - v_h = \frac{Q_d}{n \times \pi \times \phi \times d}$$

$$= \frac{27000}{2 \times \pi \times 24 \times 3.1 \times (24 \times 60)} = 0.04\, m/\min \prec 0.3\, m/\min\, safe$$

$$2 - E.W.L = \frac{Q_d}{n \times \pi \times \phi}$$

$$= \frac{27000}{n \times \pi \times 24} = 179\, m^3/m/d \prec 600\, safe$$

**Example:**

Estimate the volume of sludge produced per 27000 m3/d if the influent S.S 300 mg/l. The removal efficiency is 60%.

**Solution:**

$$Weight\,of\ dry\,solids = \frac{60}{100} \times 300 \times 27000 \times 10^{-6} = 4.86\,t/d$$

$$Specific\,gravity\,of\ sludge = 1.03\,t/m^3$$

$$Volume\,of\ dry\,solids = \frac{weight}{S.G} = \frac{4.86}{1.03} = 4.718\,m^3/d$$

$$Moisture\,content\,of\ sludge = 95\%\ (5\%\ solids)$$

$$Volume\,of\ sludge = \frac{4.718}{0.05} = 94.37\,m^3/d$$

$$Design\,of\ hopper:$$

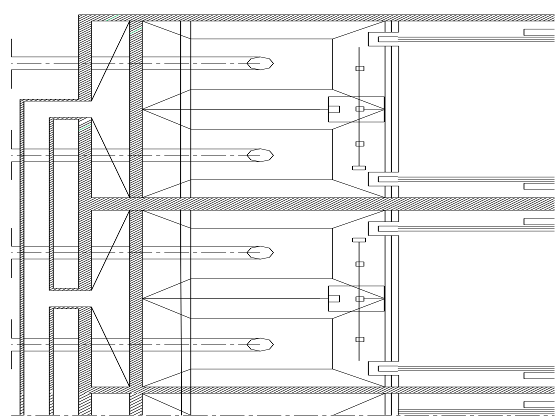
$$Volume\,of\ sludge\ per\ \tan k = \frac{94.37}{2} = 47.18\,m^3/d$$

$$Volume\,of\ sludge\ per\ hopper = \frac{47.18}{2} = 23.59\,m^3/d$$

$$Assu\min g\ sludge\,withdrawal\,every\,12\,hours$$

$$Volume\,of\ sludge\ per\ hopper = \frac{23.59}{2} = 11.796\,m^3/d$$

$$V = \frac{h}{3}(a_1 + a_2 + \sqrt{a_1 + a_2})$$



$$a_1 = 1m \times 1m$$

$$a_2 = \frac{B}{2} \times \frac{B}{2}$$

$$= \frac{11.25}{2} \times \frac{11.25}{2} = 31.64\,m^2$$

$$11.796 = \frac{h}{3}(1 + 31.64 + \sqrt{1 + 31.64})$$

$$h = \frac{11.796 \times 3}{38.265} = 0.925\,m \quad (h = 1 - 2)$$

**For circular tank:**

$$V = \frac{\pi}{4}\left(\frac{\phi_b^2 + \phi_s^2}{2}\right) h$$

$$\phi_s \geq 1m$$

$$h = 1 - 2m$$

$$\theta = 45^o - 60^o$$

$$Design\ of\ sludge\ withdrawal\ pipe:$$

$$Assume\ time\ of\ withdrawal\ 5\ \text{min}utes\ (5-20\ \text{min}utes)$$

$$Q_{sludge} = \frac{11.796}{5\times 60} = 0.039\,m^3/s$$

$$Q_{sludge} = A\times v \qquad\qquad v\ in\ sludge\ pipe = 1-1.5m/s$$

$$0.039 = \frac{\pi\phi^2}{4}\times 1$$

$$\therefore \phi = 0.22\,m \approx 200\,mm \qquad\qquad (\phi \geq 150\,mm)$$

$$v_{act} = 1.24\,m/s \quad safe$$