Grit removal chamber

Grit consists of:

Gravel, sand, silt or other material having a specific gravity greater than of organic matter. (particle size ≥ 0.2 mm)

purpose :

It is a sedimentation tank , the velocity through which is so controlled to allow settlement of sand & silt of 0.2 mm diameter without allowing settlement of organic matter.

The sedimentation tank is not used for the removal of particles ≥ 0.2 mm:

1- To improve the quality of sludge.

2- Decrease the quantity of sludge.

3- Decrease the load on the sedimentation tank to decrease the construction cost.

Types of grit removal chamber:

1- Rectangular (conventional type (horizontal flow)).

2- Aerated grit chamber.

3- Vortex.

1- Conventional type (horizontal flow) grit removal chamber:

Design criteria:

1- Velocity of flow 0.25 – 0.35 m/s taken 0.3 m/sec

2- Retention period T = 1 min

3- Length (L) = 18 - 20 m

4- Surface loading rate ⩽ 1200 m^3/m^2/day

5- No. of grit chamber n ⩾ 2

6- Depth (d) = 0.6 – 1 m.

7- width (b) = 1 - 2 d

8- Amount of grit removed = 100 – 250 l / 1000 m^3 of Qd /day.

Inorder to keep the velocity constant we either use:

1- Rectangular section + proportional weir.

proportional weir:

Purpose:

Keep the velocity constant at different discharge rates (Q).

$$Q_d = 4BH^{\frac{3}{2}}$$

$$BH^{\frac{1}{2}} = Constant$$

H = depth of wastewater in grit chamber (d) – 0.1

B = width of water in proportional weir at height H.

2- Parabolic section.

$$V = \frac{1}{n} R^{\frac{3}{2}} S^{\frac{1}{2}} \qquad R = \frac{A}{P}$$

To get constant velocity the hydraulic radius must be constant at different flow rates.
The ratio of A/p remains constant in case of parabolic section at different flow rates.

Grit removal chamber

2- Aerated grit removal chamber:

Purpose:

1- Removal of oil and grease.
2- Removal of particles of size ≥ 0.2 mm.

Design criteria:

1- Velocity of flow 0.25 – 0.3 m/s
2- Helical velocity 0.1 – 0.2 m/s
3- Retention period T = 2 - 5 min

4- Length (L) = 7.5 - 20 m

5- Surface loading rate ⩽ 1000 m^3/m^2/day

6- No. of grit chamber n ⩾ 2

7- Depth (d) = 3 – 5 m.

7- width (b) ⩽ 2 m

8- Rate of aeration = 0.3 – 0.7m^3/minute/m of chamber length (average 10 m^3/hour/ m^3 of the chamber)

9- Amount of grit removed = 100 – 250 l / 1000 m^3 of Qd /day.

Example:

A city of population 200000 capita and average sewage flow of 200 l/c/d. Design conventional grit removal chamber.

Solution:

$$Q_{ave} = \frac{average sewage\ flow \times population}{1000 \times 24 \times 60 \times 60}$$

$$= \frac{200 \times 200000}{1000 \times 24 \times 60 \times 60} = 0.46 \quad m^3/s$$

$$Q_d = 1.5 \times (1.2 \times Q_{ave})$$

$$= 1.5 \times 1.2 \times 0.46 = 0.83 \quad m^3/s$$

Assume T = 1 min = 60 sec

V = Qd x T

= 0.83 x 60 = 49.68 m3

V = n x L x b x d

Horizontal velocity = 0.3 m/s

Qd = A (cross sectional area) x v

$$A = \frac{Q_d}{v} = \frac{0.83}{0.3} = 2.77 \quad m^2$$

$$L = \frac{V}{A} = \frac{49.68}{2.77} = 17.93 \approx 18 \quad m$$

$$Assume\ S.L.R = 1200\, m^3/m^2/d$$

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

$$S.A = \frac{Q_d}{S.L.R} = \frac{0.83 \times 24 \times 60 \times 60}{1200} = 59.76 \quad m^2$$

$$d = \frac{V}{S.A} = \frac{49.68}{59.76} = 0.83 \quad m$$

$$Assume\, b = d$$

$$S.A = n \times b \times L$$

$$n = \frac{59.76}{0.83 \times 18} = 4$$

$$\therefore b = \frac{59.76}{4 \times 18} = 0.83 \quad m$$

$$n = 4 \quad L = 18 \quad b = 0.83 \quad d = 0.83$$

Design of proportional weir:

$$H_{max} = d - 0.1$$

$$= 0.83 - 0.1 = 0.73 \quad m$$

$$Q_{for\ one\ chamber} = 4BH^{\frac{3}{2}}$$

$$Q_{for\ one\ chamber} = 4 \times B_{min} \times (H_{max})^{\frac{3}{2}}$$

$$\frac{0.83}{4} = 4 \times B_{min} \times (0.73)^{\frac{3}{2}}$$

$$B_{min} = 0.08 \quad m$$

$$BH^{\frac{1}{2}} = Cons\tan t$$

$$B_{min} H_{max}^{\frac{1}{2}} = 0.08 \times (0.73)^{\frac{3}{2}} = 0.05$$

$$Equation\, of \ weir:$$

$$B = \frac{0.05}{H^{\frac{1}{2}}}$$

H	0.39	0.34	0.29	0.24	0.19	0.14	0.1
B	0.08	0.086	0.09	0.1	0.11	0.13	0.16