

MODULE CODE(S): M2X9623
TITLE(S): Environmental Monitoring & Remediation

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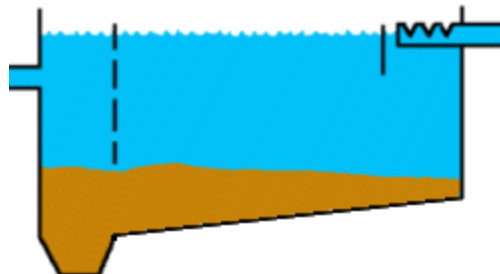
Date: 12.02.2020

Sources: Sergio Garate & Various

Sedimentation Tank Design

Specifications for the Sedimentation Tank (Given)

- Flow = 6900 m³/day
- Rectangular basin
- Depth 2m to 5m
- Width 3m to 15m
- Length = 4 x Width
- Influent baffle to reduce the flow momentum
- Slope of bottom toward sludge hopper > 1%
- Continuous sludge removal with a scraper velocity < 4.5 m/min
- Detention time 4hrs to 8hrs
- Flow through velocity < 0.15 m/min (= 0.5 ft. /min)
- Overflow rate 25.5 to 50 m³/day-m²



Step 1: Divide the flow in to at least 2 tanks

The flow should be divided in to at least 2 tanks and the flow through each tank should be considered as follows;

$$Q_{tank} = \frac{Q}{n}$$

Q_{tank} = the flow in each tank (m³/day)

Q = the total daily flow (m³/day)

n = number of tanks

$$Q_{tank} = \frac{Q}{n}$$

Where;

$Q = 6900$ (m³/day) – given

$n = 3$ (three tanks) – we assumed

$$Q_{tank} = \frac{6900}{3} = 2300$$

$Q_{tank} = 2300$ (m³/day)

Step 2: Calculate the surface (plan) area of the tank

To calculate the surface area use the overflow rate given as follows;

$$A_{tank} = \frac{Q_{tank}}{OR}$$

A_{tank} = Surface area of each tank (m²)

OR = Overflow rate (m³/day-m²)

$$A_{tank} = \frac{Q_{tank}}{OR}$$

Where;

$Q_{tank} = 2300$ (m³/day) – from step 1

$OR = 25.5$ (m³/day-m²) – given

$$A_{tank} = \frac{2300}{25.5} = 90.2$$

$A_{tank} = 90.2$ (m²)

Step 3: Calculate the volume of the tank

Volume of the tank is calculated by multiplying the tank flow by the detention time as follows;

$$V_{tank} = Q_{tank} \times t$$

V_{tank} = Volume of each tank (m³)
 t = detention time (hrs/day)

$$V_{tank} = Q_{tank} \times t$$

Where;

$Q_{tank} = 2300$ (m³/day) – from step 1
 $t = \frac{4}{24}$ (hrs/day) – given (assuming 4 hrs)

$$V_{tank} = 2300 \times \frac{4}{24} = 383.4$$

$$V_{tank} = 383.4 \text{ (m}^3\text{)}$$

Step 4: Calculate the depth of the tank

Depth of the tank is calculated by dividing the volume by the surface area as follows;

$$d_{tank} = \frac{V_{tank}}{A_{tank}}$$

d_{tank} = Depth of each tank (m)

$$d_{tank} = \frac{V_{tank}}{A_{tank}}$$

Where;

$V_{tank} = 383.4$ (m³) – from step 3
 $A_{tank} = 90.2$ (m²) – from step 2

$$d_{tank} = \frac{383.4}{90.2} = 4.25$$

$d_{tank} = 4.25$ (m) – which is below the specified 5m. Acceptable.

Step 5: Calculate the width and length of the tank

Given that the Length = 4 x Width, we could use the information on the surface area to calculate the width and the length as follows;

$$L_{tank} \times W_{tank} = A_{tank}$$

L_{tank} = Length of each tank (m)

W_{tank} = Width of each tank (m)

$L_{tank} \times W_{tank} = A_{tank}$

Where;

$L_{tank} = 4 \times W_{tank}$ – given

$A_{tank} = 90.2 \text{ (m}^2\text{)}$ – from step 2

$$4 \times W_{tank} \times W_{tank} = 90.2$$

$$W_{tank}^2 = \frac{90.2}{4} = 22.55$$

$$W_{tank} = \sqrt{22.55} = 4.75$$

$$L_{tank} = 4 \times W_{tank} = 4 \times 4.75 = 19$$

$W_{tank} = 4.75 \text{ (m)}$ and $L_{tank} = 19 \text{ (m)}$

Step 6: Calculate the flow through velocity

Given that the Length and the Depth of the tank, the flow through velocity is calculated using the vertical cross-sectional area of the tank as follows;

$$Velocity_{flow} = \frac{Q_{tank}}{W_{tank} \times d_{tank}}$$

$Velocity_{flow}$ = Flow through velocity (m/day)

$$Velocity_{flow} = \frac{Q_{tank}}{W_{tank} \times d_{tank}}$$

Where;

$Q_{tank} = 2300 \text{ (m}^3\text{/day)}$ – from step 1

$d_{tank} = 4.25 \text{ (m)}$ – from step 4

$W_{tank} = 4.75 \text{ (m)}$ – from step 5

$$Velocity_{flow} = \frac{2300}{4.75 \times 4.25} = 113.9$$

$Velocity_{flow} = 113.9 \text{ (m/day)}$

1. Converting to feet per minute (ft. /min)

1m = 3.28 ft.

1day = 24hrs = 24 x 60 minutes = 1440 minutes

$$Velocity_{flow} = \frac{113.9 \times 3.28}{1440} = 0.26$$

$Velocity_{flow} = 0.26 \text{ (ft. /min)}$ – less than 0.5, this is acceptable

2. Or, converting to metres per minute (m/min)

1day = 24hrs = 24 x 60 minutes = 1440 minutes

$$Velocity_{flow} = \frac{113.9}{1440} = 0.08$$

$Velocity_{flow} = 0.08 \text{ (m/min)}$ – less than 0.15, this is acceptable