WATER TREATMENT METHOD

- The available water must be treated and Purified before they can be Supplied to the public for their domestic industrial or any other uses. the extend of treatment required to be given to the particular water depends upon characteristics and quality of the avaible water.

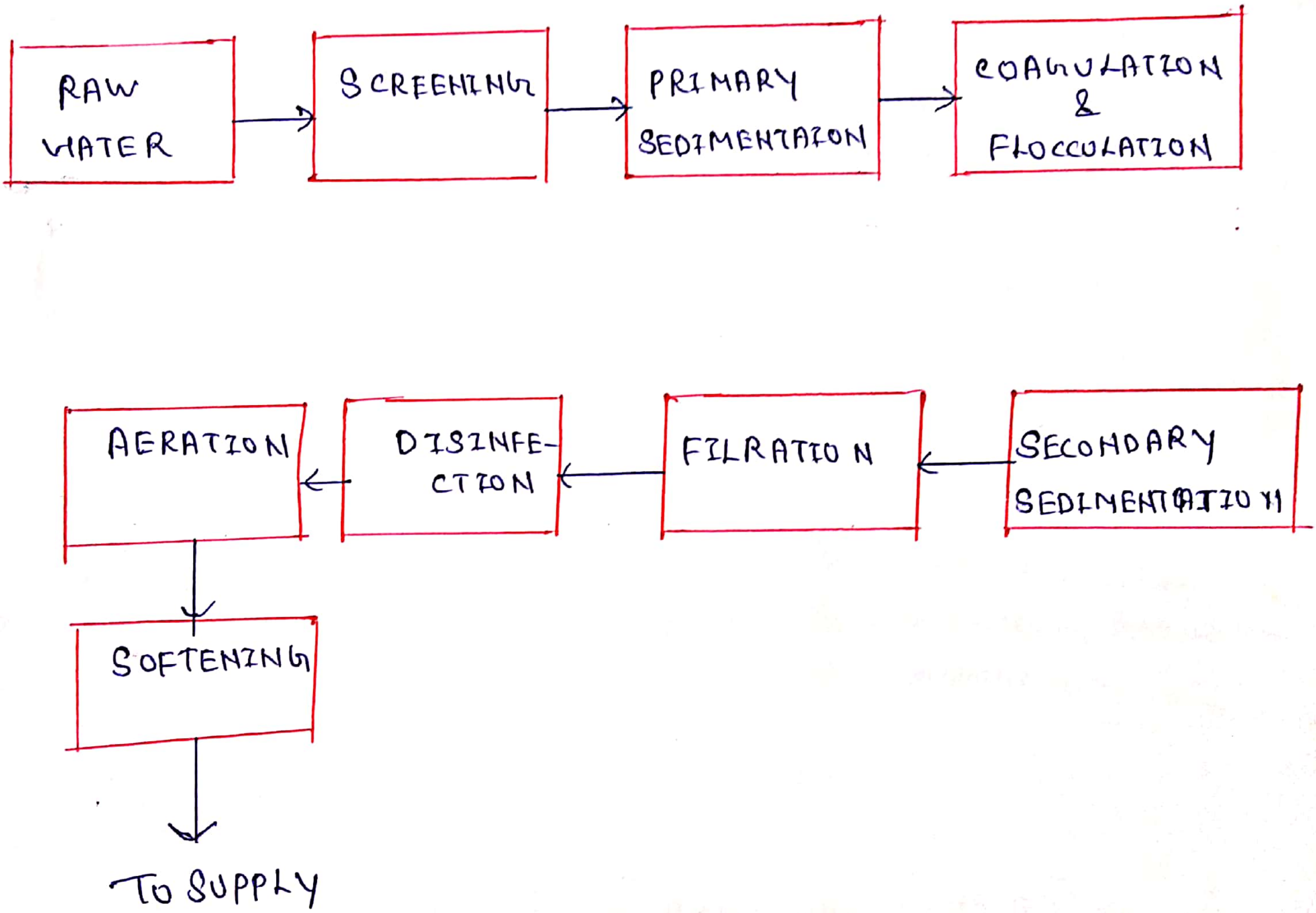

fig: Conventional water treatment plant.

Purification of water →

Screening → Plain Sedimentation → Sedimentation with Coagulation → Filtration → disinfection → aeration → Softening

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① Screening →

inclination 45° to 60° with horizontal (to increase opening area so as to reduce velocity)

Velocity ≯ 0.8 to 1 m/s

① Bar Screens → Space 5 cm or above

Fine Screen → 2 cm to 5 cm.

Communitors → cutting tools

Sedimentation is of two types

① intermittent (Quiescent) (ii) Continuous

Principle based on Stokes law →

$$V_s = \frac{g}{18} \frac{(S_s - 1)d^2}{\nu}$$

V_s = Terminal velocity
S_s = Sp. gravity of sediments
ν = Kinematic viscosity of liquid

① Stoke's equation

$$V_s = 418 (S_s - 1) d^2 \frac{(3T+70)}{100}$$ for Streamline $(d < 0.1)$ mm

② Hazen equation

$$V_s = 418 (S_s - 1) d \frac{(3T+70)}{100}$$ for transition zone (d b/w 0.1 to 1 mm)

③ Newton's equation

$$V_s = 1.8 \sqrt{g d (S_s - 1)}$$ for turbulent settling $(d > 1$ mm$)$

- 70% of the suspended impurities present in water remove.
- Flow velocity $= \frac{Q}{B.H.}$
- Settling velocity $V_s = \frac{Q}{B.L.}$

MN

<Design criteria>

① over flow rate $= \frac{Q}{BL}$ (discharge per unit flow surface area or plan area)

= overflow rate or surface loading

= 500-750 lit/hr/m² (plain sedimentation)

= 1000-1250 lit/hr/m² (Coagulation sedimentation)

② Depth

= 3 to 4.5 m, (≮ 1.8m and ≯ 6.0m)

= L ≯ 4B

③ Detention Period (time required to fill the tank)

(A) if there is no outflow, then time required to flow through the tank, t is

(a) $t = \frac{\text{Volume}}{\text{discharge}} = \frac{B.L.H}{Q}$ ------- (for rectangular tank)

(b) $t = \frac{d^2(0.011d + 0.785H)}{Q}$ (for circular tank, cone shaped bottom with 1:1 slope)

| L ≯ 4B |

| B = 10m
≯ 12m |

| Depth = 3 to 4.5m
⇒ (1.8m and ≯ 6.0m) |

t = 4 to 8 hr (plain sedimentation)

= 2 to 4 hr (Coagulation sedimentation)

| Velocity $= \frac{L}{T}$ |

- Displacement efficiency:-

Displacement $\eta_{cy} = \frac{\text{flowing through Pd.}}{\text{detention Pd}} \approx$ 0.28 to 5

Q. Water supply project, Population of town 50,000, with per capita demand = 150 lit/day

Solution

Assume

detention period = 4 hours.   depth = 3 m.

Velocity flow = 0.3 m/min

Per capita demand = 150 lit/day

daily average demand of water = 150 × 50,000 = 7500000 lit/day

Peak demand = 1.5 × 7500000 = 11250000 lit/day

quantity of water to be detained = $\frac{11250000 \times 4}{24}$ lit/day

= 1875 m^3

Capacity of tank = 1875 m^3

Velocity = $\frac{L}{T}$

Length of tank = Velocity × detention time

= 0.3 × 4 × 60

= 72 m

Volume = L × B × H

Volume = L × H × B = L × A

$\frac{\text{Volume}}{L}$ = A ⇒ $\frac{1875}{72}$ = 26.04 m^2

width of tank = $\frac{26.04}{3}$ = 8.6 m

assuming free board as 0.5 m

Actual depth = ~~8.6 + 0.5~~ = 3 + 0.5 = 3.5 m

Considering 20% extra length for inlet and outlet work

extra length = 72 × 0.2 = 14.4 m = 14.5 m

total length = 72 + 14.5 = 86.5 m

therefore

dimension = 86.5 m × 8.6 × 3.5 m

Q. in a Continuous flow settling tank 3.5 m deep and 65 m long. if the flow velocity of water observed is 1.22 cm/s. what size of the particle of specific gravity 2.65 may be effectively removed? Assume temp 25°C and kinematic viscosity of water as 0.01 cm²/s

Solutions

Depth of tank = 3.5 m (given)
out of this depth, 0.5 m can be assumed as free-board
Thus,
effective depth of tank or water depth $= H = 3.5 - 0.5$
$= 3m$

Flow velocity $V = 1.22 \ cm/sec$

Length of tank $L = 65 \ m$

Specific gr. of particles $= 2.65$

Temp $T = 25°C$

Kinematic viscosity $\nu = 0.01 \ cm^2/s$

Let the particle size be 'd' and the settling velocity be V_s
we know that for a particle to be removed in the settling tank it must satisfy the relation

$$\frac{V}{V_s} = \frac{L}{H}$$

$$V_s = \frac{VH}{L} = \frac{1.22 \times 3}{65} = 0.0563 \ cm/s$$

But settling velocity V_s as per Stoke's equation

$$V_s = \frac{g}{18}(S_s - 1)\frac{d^2}{\nu} \quad \text{for } d < 0.1 \ mm$$

$$V_s = 418 (S_s - 1) d^2 \left(\frac{3T + 70}{100}\right) \quad \text{for } d < 0.1 \ mm$$

$$V_s = \frac{981}{18}(2.65 - 1)\frac{d^2}{0.01}$$

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$0.0563 \times 18 \times 0.01 = 1.65 \times 981 \times d^2$

$\boxed{d = 0.002502}$ cm

$d = 0.025$ mm $(< 0.1$ mm$)$ Hence ok

$$V_s = 418(2.65 - 1) \times d^2 \times \left(\frac{3 \times 25 + 70}{100}\right)$$

$$0.0563 \times 10 = 418 \times 1.65 \times d^2 \times \frac{145}{100}$$

$\boxed{d = 0.024 \text{ mm}}$ < 0.1 mm Hence ok

Thus, the particles of size 0.024mm and above shall be effectively removed.