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CMR INSTITUTE OF TECHNOLOGY

Department of Civil Engineering

18CV46 – WATER SUPPLY AND TREATMENT ENGINEERING

Scheme and Evaluation

Subject	Water supply and Engineering treatment Engineering	Branch	CIVIL
Sub Code	18CV46	Date	24/06 / 2021
Duration	90 min’s	Sem	VI
IAT-1; Max Marks: 50			

Sl. No.	Question	Marks	Scheme
1	Discuss on surface and subsurface water sources with regard to their quality and quantity	6	(3 * 2)
2	What is sampling of water? Discuss the objectives of sampling and preservation techniques	6	Definition -1M Description -5M
3	a. Explain briefly Physical, Chemical and biological water quality characteristics	6	(3 * 2)
	b. Write the desirable limits of following parameters as per BIS 10500-2012. a) Color b) pH c) Total hardness d) Nitrate e) Iron f) Total dissolved solids h) Chlorides.	7	(7 * 1)
4	a. What is sedimentation process? With the help of sketch of an ideal settling tank, show that the efficiency of the settling tank is independent of its depth	5	Definition -1M Proof -4M
	b. Design a set of three circular settling tanks to handle 6 million litres of water per day. Take detention time as 4 hours and side water depth as 3m. Check for the design and sketch the designed tank	7	(7 M)
5	a. A rectangular settling tank without mechanical equipment is to treat 1.8 million litres per day of raw water. The sedimentation period is to be 4 hours, the velocity of flow 8cm/min and the depth of water and sediment 4.2m. If an allowance of 1.2m for sediment is made. Design the dimension of the tank	7	(7 M)
	b. Describe briefly the various constituents of coagulation sedimentation tank	6	6M

1. Solution

Surface water sources	subsurface water sources
Ponds and lakes,	Springs,
Rivers and Streams;	infiltration galleries,
Reservoirs;	infiltration wells, including tube wells

Surface water sources:

i) Ponds and Lakes:

- The quantity of water from such sources depends on catchment area, rainfall and geological formation. Such source of water is useful for small community like villages or town.
- The Quality of such source is generally good and does not need proper purification. Natural purification of water due to sedimentation of suspended matter, removal of bacteria and bleaching of color further purify water. The problem of algae, weed and vegetable growth take place, imparting bad smells, taste and colors to their waters.

ii) Streams and Rivers:

- Small streams channels feed the water to lakes or rivers. Such source of water is not reliable for water supply as of less quantity of water available in them and they may even sometimes go dry. They are useful for small community.
- Rivers are the important source of water for public water supply schemes.

- The quality of water obtained from rivers is generally not-reliable, as it contains large amounts of silt, sand and a lot of suspended matter.
- The disposal of the untreated or treated sewage into the rivers is further liable to contaminate their waters.
- The river waters must, therefore, be properly analyzed and well treated before supplying to the public.

iii) Storage Reservoirs:

- A barrier in the form of dam may therefore sometimes be constructed across the river, so as to form a pool of water on the upstream side of the barrier. This pool or artificial lake formed on the upstream side of the dam is known as the storage reservoir.
- The quality of this reservoir water is not much different from that of natural lake. The water stored in the reservoir can be used throughout the year. And continuous supply

of the water is possible by storage of excess water during monsoon season and supplying the same during non-monsoon period.

Subsurface water sources: The water which store in the ground water reservoir through infiltration is under ground water. This water is generally uncontaminated but may contain aesthetically or economically undesirable impurities. Such water is rich in dissolved salts, minerals and various gasses

2. Solution

The process of collecting a representative portion of water, as from the natural environment for the purpose of analyzing and testing its quality.

Objective of sampling is

- To collect a portion of material small enough in volume to be transported comfortably and yet large enough for analytical purposes while still representing the material being sampled.
- To obtain reliable and useful data
- To assess the impact of human activities on Water quality and its suitability
- To determine the quality of water in its natural state
- To keep under observation the sources and pathways of pollutants/contamination

Prevention:

Contamination may occur from: sampling equipment, sample bottle, preservatives, ambient atmosphere, personnel taking the sample etc.

Utmost care should be maintained during sampling in order to prevent contamination.

• Often sampling bottles need to be cleaned in a special way, depending on the parameter. To avoid cross-contamination, the same bottles should be used only for identical selected parameters.

• Separate sets of bottles should be used for natural waters and for effluents.

• To prevent contamination by the hands, plastic (PE) gloves are needed.

3.a. Solution

a) **Physical Parameter of water quality**, following are the physical parameters

1. Color ; 2. Taste & Odor ; 3. Turbidity ; 4. Temperature

Chemical Parameter of water quality

Ph ; Acidity ; Alkalinity ; Hardness ; Chlorides ; Sulfates; Iron ; Solids ; Nitrates

Biological Characteristics:

Standard Plate Count Test; Most Probable Number; Membrane Filter Technique

3.b) BIS 10500-2012 Table

parameter	Acceptable range
a) Color	5 to 50
b) pH	6.5 to 8.5
c) Total hardness	300 to 600
d) Nitrate	45
e) Iron	0.3 to 1
f) Total dissolved solids	10 to 25
h) Chlorides.	250 to 1000

4.a Solution

Sedimentation is a process of settling of suspended particles present in raw water in a basin

When a solid particle settles down in water, the downward settlement is opposed by the drag force offered by the water (F_D) and Buoyancy (F_B) due to its fluid displacement.

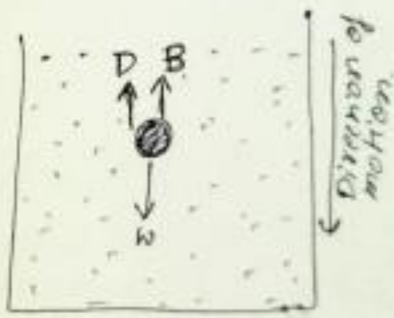
These opposite forces start retarding the downward motion of the particle until it reaches equilibrium condition

ie., $\boxed{F_W = F_D + F_B} \rightarrow (1)$ where F_W is downward force of solid particle.

After achieving this state, the soil particle falls down with the constant velocity, called settling velocity (V_s).

F_D is given by Newton's law as

$$F_D = C_D A \rho_w \frac{V_s^2}{2} \rightarrow (a)$$



where $C_D \leftarrow$ co-efficient of drag
$A \leftarrow$ Area of particle
$\rho_w \leftarrow$ Density of water
$V_s \leftarrow$ velocity of fall. (settling velocity)

$$F_W = \frac{4}{3}\pi r^3 \gamma_s \rightarrow (b)$$ where $r \leftarrow$ radius of particle
$\gamma_s \leftarrow$ unit weight of particle

$$F_B = \frac{4}{3}\pi r^3 \gamma_w \rightarrow (c)$$ $\gamma_w \leftarrow$ unit weight of water.

Substituting eqn a, b & c in eqn (1)

$$\therefore \frac{4}{3}\pi r^3 \gamma_s = C_D A \rho_w \frac{V_s^2}{2} + \frac{4}{3}\pi r^3 \gamma_w$$

$$\Rightarrow C_D A \rho_w \frac{V_s^2}{2} = \frac{4}{3}\pi r^3 (\gamma_s - \gamma_w)$$

For laminar flow $Re < 1.0$, It is given as

$$C_D = \frac{24}{Re}$$

on substituting value of C_D in eq^n ⑥, we get

$$V_s = \left[\frac{\frac{4}{3} g (G-1) d}{\frac{24}{Re}}\right]^{1/2}$$

or

$$V_s^2 = \frac{4}{3} g (G-1) d \times \frac{Re}{24}$$

$$= \frac{1}{18} g (G-1) d \cdot Re$$

since ~~Reynold~~ Reynold number for sperical particle is

$$Re = \frac{V d}{\nu}$$; where V ← velocity of the sphere in m/s
ν ← kinematic viscosity of liquid m^2/s
d ← diameter of sphere in m

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

$$\boxed{V_s = \frac{g}{18} \frac{(G-1) d^2}{\nu}}$$ ← which shows that "Particle settling velocity is independent of the depth of the sedimentation tank"

← Also, Stoke's law for settling velocity.

4.b solution

Solution:- Given Data.

Capacity of a circular settling tanks = 6×10^6 l/day.

Detension time = 4 hours.

Depth of tank = 3 m.

∴ capacity of each circular settling tank = $\frac{6}{3} \times 10^6$ l/day

$= 2 \times 10^6$ l/day.

Quantity of raw water to be treated during DT = 4 hours.

$= \frac{2 \times 10^6}{24} \times 4 \simeq 334 \times 10^3$ l

$\simeq 334\ m^3$.

depth of tank = 3 m ← H (Given)

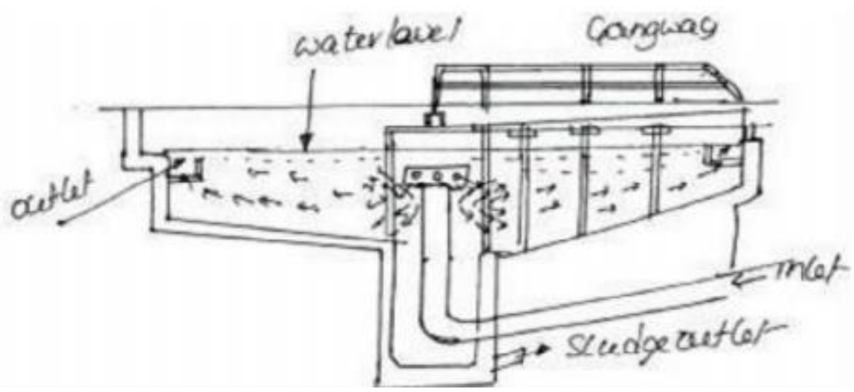
The capacity of a circular tank of depth H and diameter d is given by

volume = $d^2(0.011d + 0.785H)$

$334 = d^2(0.011d + 0.785 \times 3)$

$d = 11.8$ m

The dimension of each 0^{lar} tank is 11.8m diameter & 3m depth.



5.a Solution

Solution:- Given data:

water to be treated 1.8×10^6 l/day

Detention period t = 4 hours.

flow velocity 8 cm/minute

Depth of water + sediment = 4.2 m.

depth of sediment = 1.2 m

∴ Depth of water = 4.2 − 1.2

D = 3.m

Design the dimension of the tank = ? (L×B)

Quantity of water to be treated during the detention period of 4 hours

$$= \frac{1.8 \times 10^6}{24} \times 4 = 0.3 \times 10^6 \text{ litres}$$

$= 300\ m^3$

Length of the tank = flow velocity × Detention time

= 8 × (4×60) = 1920 cm

L = 19.2 m

The cross-sectional area of the tank

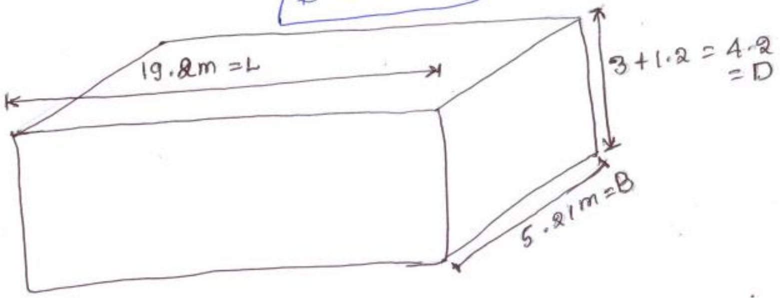
$$= \frac{\text{Capacity of the tank}}{\text{length of the tank}} = \frac{300}{19.2}$$

$A = 15.63\ m^2$

$$\text{The width of the tank} = \frac{\text{C/s Area}}{\text{Water depth}}$$

$$= \frac{15.63}{3}$$

B = 5.21 m

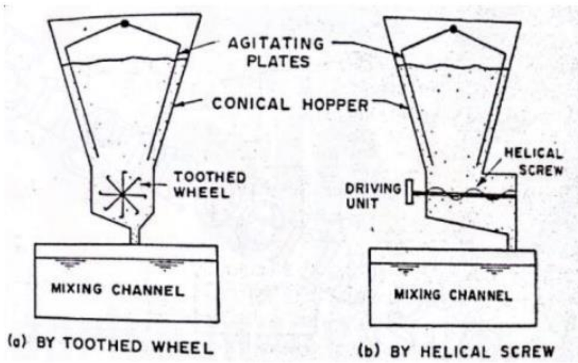


5.b Solution

The coagulation sedimentation tank is also called as clari-flocculator contains following four units;

1) Feeding Devices

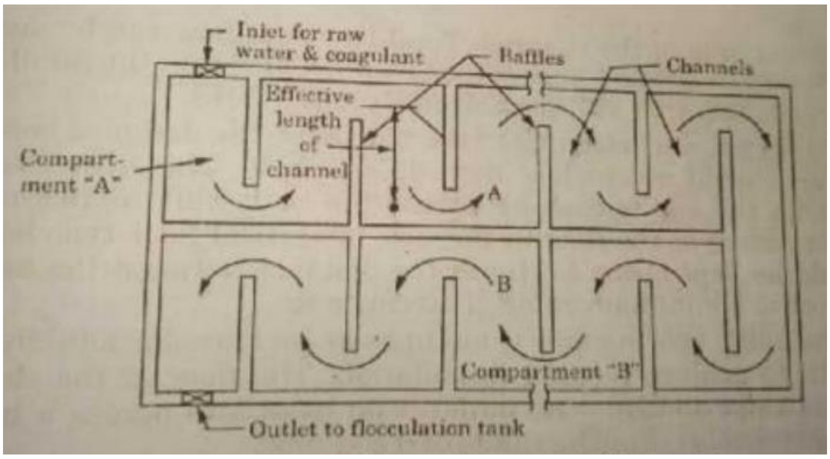
a) Dry Feeding Device



These are the tanks with a hopper bottom and agitating plates are placed inside a tank so as to prevent the arching or bridging of the coagulants. The powdered coagulant is then filled into the tank and is then allowed to fall into the mixing basin. The dosage of the coagulant added is regulated by toothed wheel or a helical screw. The speed of the toothed wheel or helical screw is turn controlled by connecting it to a venture device installed in the raw water pipes bringing water to the mixing basin. The quantity of the coagulant released is, thus controlled in proportion to the quantity of raw water entering the mixing tank.

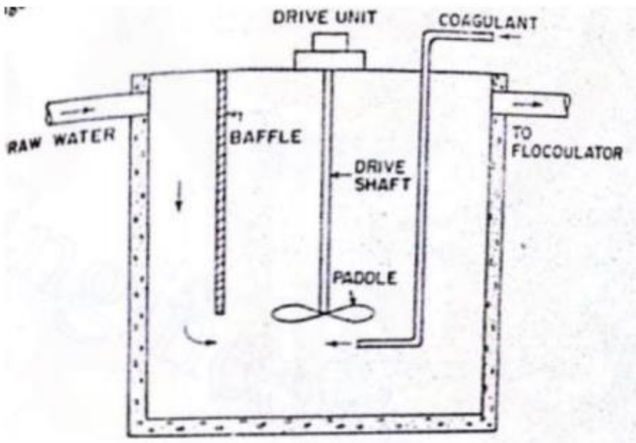
2) Mixing Basin

After addition of coagulant, the mixture is thoroughly mixed, so that the coagulant gets fully dispersed into the entire mass of water. This agitation of water gets achieved by thorough mixing. There are two types of mixing basins.



The baffle type mixing basins are rectangular tanks which are divided by baffle walls. The baffles may either be provided in such a way that the water flows horizontally around their ends or they may be provided as to make the water move vertically over and under the baffles. The hinderness and disturbances created by the provision of baffles in the path of flow, give it sufficient agitation, as to cause necessary mixing to develop the floc. 2) Mixing Basin Equipped with Mechanical Devices: most of the modern water treatment plants now have mixing basins with mechanical devices. The figure shows a typical "flash mixer" in which the raw water and the coagulant is agitated vigorously by a paddle operated by a variable speed motor.

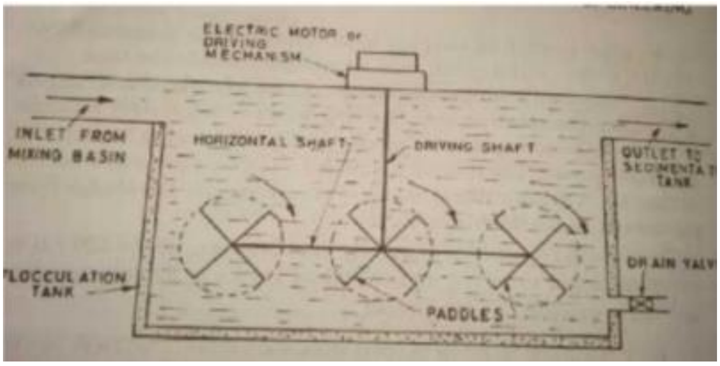
The mechanically agitated mixing basins provide the best type of mixing as also the flocculating devices. The chemical added to raw water is vigorously mixed and agitated by a flash mixer for its rapid dispersion in water and the water is then transferred to a flocculation tank provided with a slow mixer. Mixing involves high degree of turbulence and power dissipation. A typical flash mixer consists of rectangular tank provided with an



impeller fixed to an impeller shaft. The impeller is driven by an electric motor and it revolves at a high speed inside the tank. The coagulant brought by the coagulant pipe and is discharged just under the rotating fan. The raw water is separately brought from the inlet end and is deflected towards the moving impeller by a deflection wall. The thoroughly mixed water is taken out from the outlet end. A drain valve is also provided to remove the sludge from the bottom of the flash mixer.

3) Flocculation Tank or flocculator

The best floc will form when the mixture of water and coagulant are violently agitated followed by a relatively slow and gentle stirring to permit build up and agglomeration of



the floc particles. Therefore, from the mixing basin the water is taken to a flocculation tank called a flocculator, where it is given a slow stirring motion. Rectangular tanks fitted with paddles operated by electric motors can best serve this purpose.