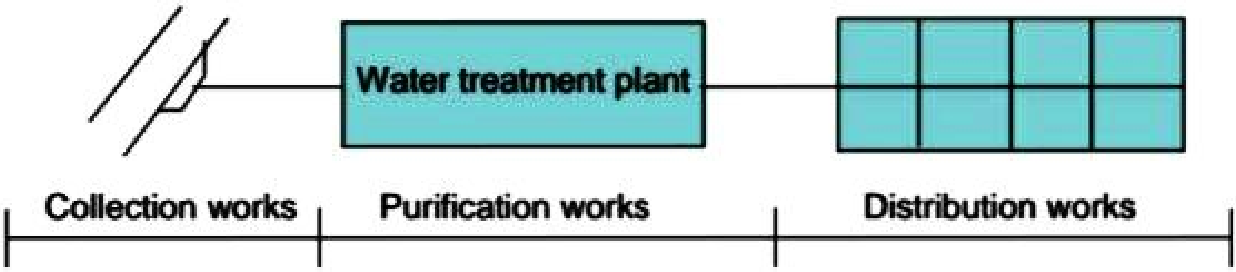
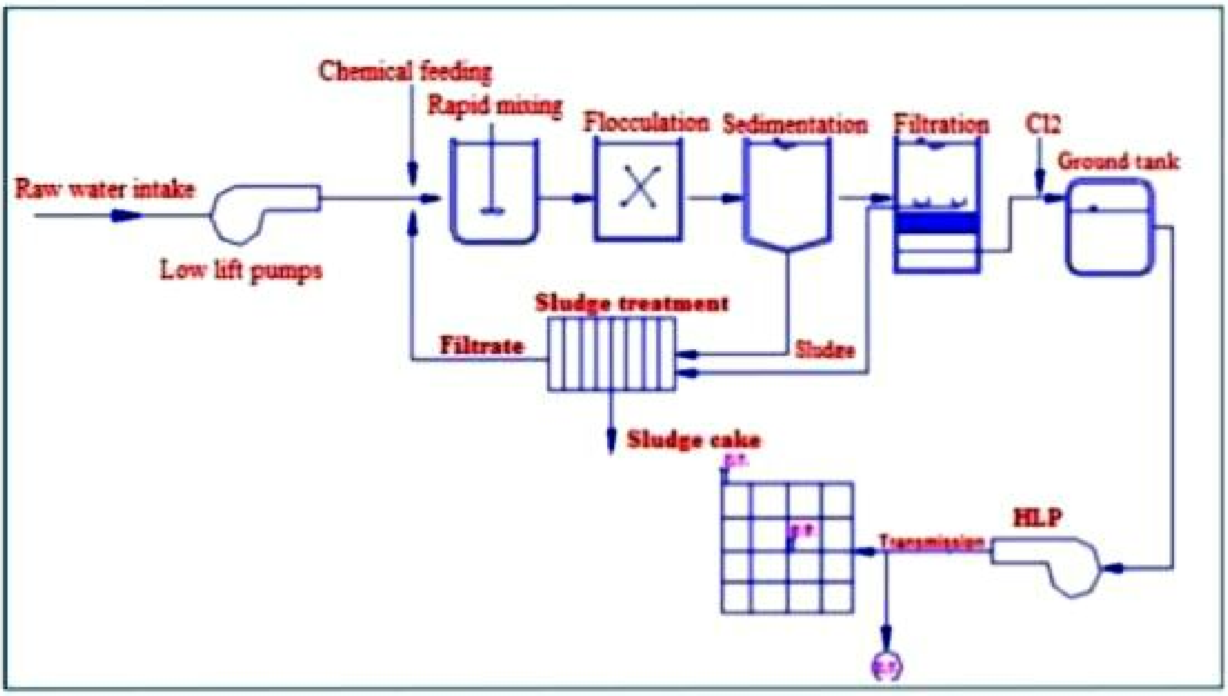
Water supply works

Water supply works consists of three main stages:

1- Collection works.
2- Purification works.
3- Distribution works.





Collection works for surface water

Collection works consist of:

1- Intake and intake conduit.

2- Sump.

3- Low lift pumps.

It is the destabilization of colloids by addition of chemicals that neutralize the negative charges

Kind of coagulants

1- Hydrous aluminum sulfate (Alum) $Al_2(SO_4)_3.18H_2O$

- easy to use
- cheap
- available

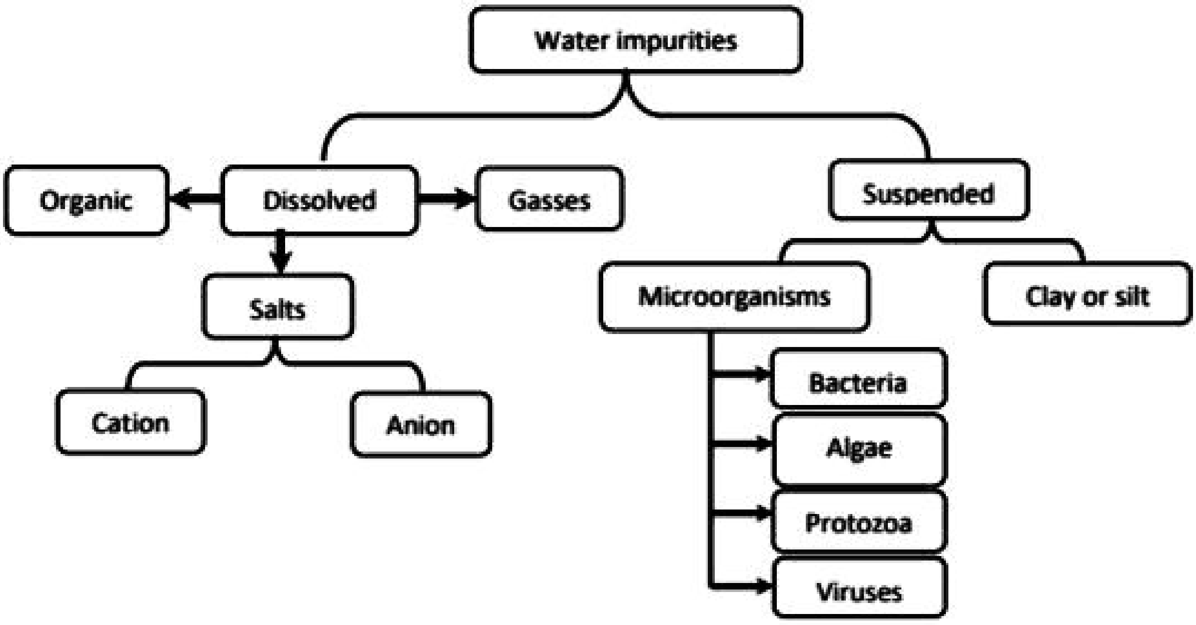
2- Ferrous sulfate $Fe_2 (SO_4)_3$

3- Ferric sulfate $Fe (SO_4).7H_2O$

4- Ferric chloride $Fe Cl_3$

Polymers: it is molecule consist of a series of chemical unit held together by covalent bond.

Water impurities:



Colloidal particles: it is small particles floated or suspended in water have small size (10 μ,1μ, 0.1 μ)

Note: ($\mu = 1 * 10^{-3}\ mm$)

Methods of feeding coagulant:

1- Dry feeding: (powder or granular)

Advantages:

1- Control the added dose.

Disadvantages:

1- Needs of a good aerated place to store.

2- Arch action.

3- Non homogeneous solution.

2- Wet feeding:

Advantages:

1- Homogeneous solution.

Disadvantage:

1- It needs mechanical maintenance.

2- Construction of alum solution preparation tanks.

Factors affect the coagulation efficiency

1. pH of raw water and temperature.
2. Mixing.
3. Coagulant type.
4. Feeding method (dry – wet).

Mixing coagulant

Purpose:

Distribute the coagulant uniformly in raw water.

1- Injection the solution of the coagulant in the delivery pipe of the low lift pump.

2- Adding the coagulant solution in a venture so that the turbulence which occurs mixes the coagulant with water.

3- Using flash mixing tank.

Mixing method

1) static (hydraulic) mixing

- economic (not need to mechanical or electrical power)
- The concentration level of coagulant is decrease when the water nearest to out flow because of head losses (0.5–1 m).
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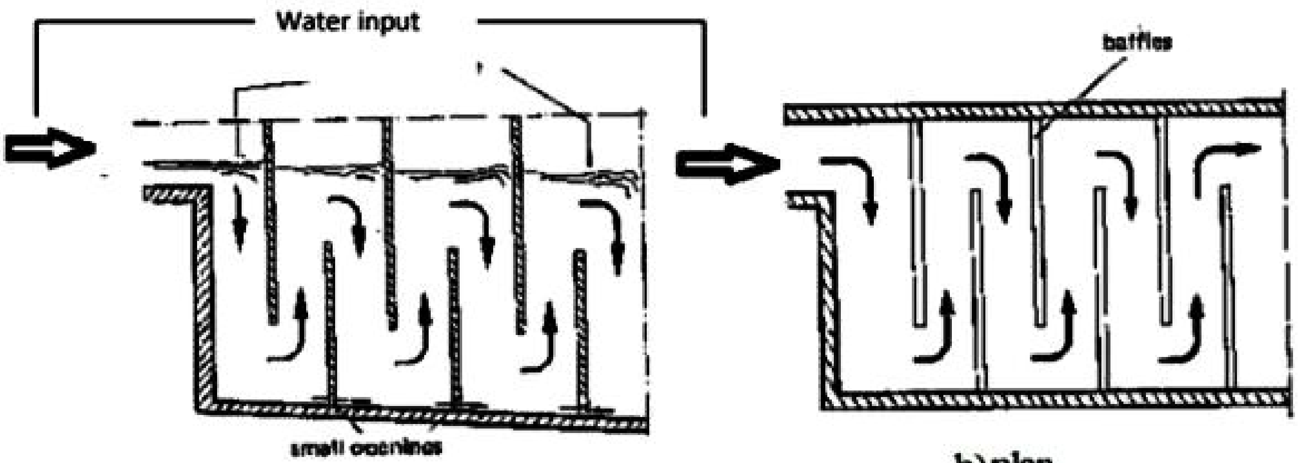


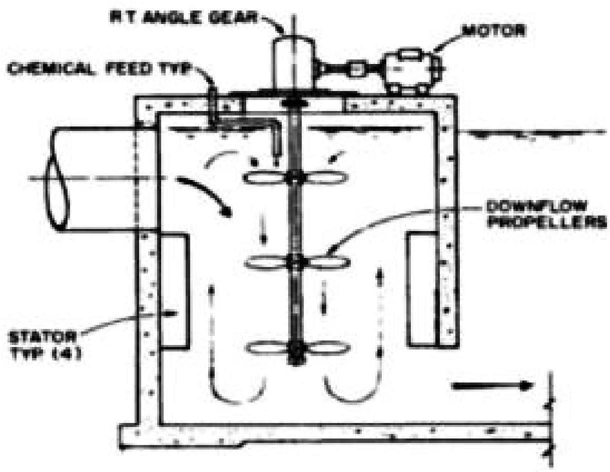
a) section

b) plan

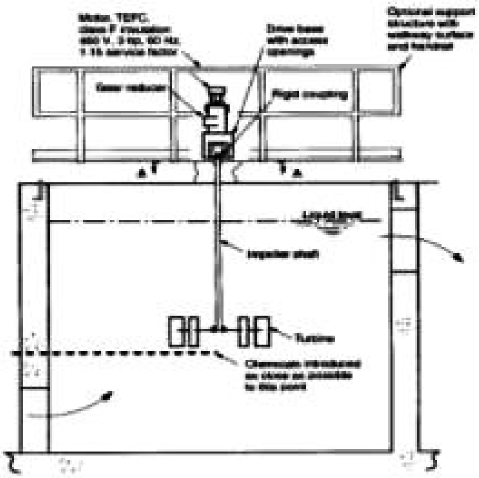
Hydraulic mixing in coagulation tank.

3. Mechanical mixing

Using impeller or turbine for mixing coagulant material

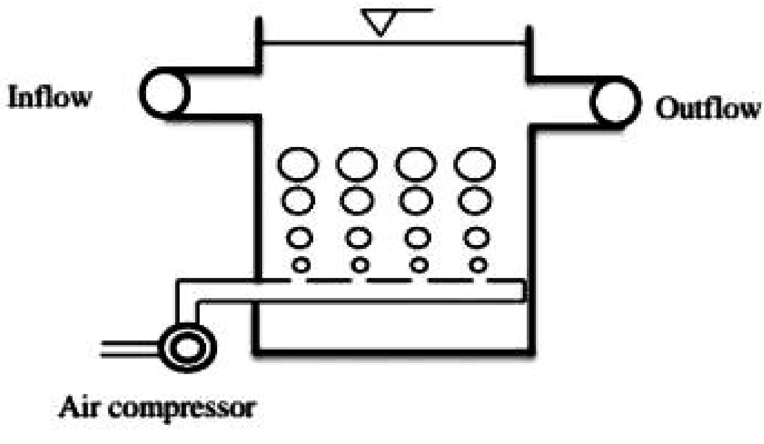


Propeller-type mechanical flash



Turbine- type mechanical flash

3- Air mixing



Design criteria:

- retention time = T = (60 - 120) sec
- depth = (1- 3) m
- Diameter ≤ 35 m
- No. of tanks ≥ 1
- Speed of impeller = (100 - 300) R.P.M
- Volume = Qd x T
- Power required = 2–5 kw for each 1 m^3/min

Power input in mixing and flocculation is frequency expressed in terms of the mean velocity G (1/T) (sec^{-1})

$$G = \sqrt{\frac{P}{\mu\, v}}$$

Where:

G: gradient velocity

P: the power dissipated (watt, watt = $\frac{N.M}{sec}$)

μ: the absolute viscosity ($\frac{N.sec}{m^2}$)

v: volume to which power is applied (m^3).

GT= 30000–60000

Example Design a rapid mixing unit (mechanical) for a discharge of 5 mgd. What is the total amount of Alum if the dose is 50 mg/L? G= 300 sec $^{-1}$, T= 60 sec and μ= 1.027 *10^{-3} $\frac{N.sec}{m^2}$

Solution

Vol. = Q* D.T., assume D.T. = 1 min

$$Q = 5 * 10^6 \frac{gal.}{day} * 3.78 \frac{L}{gal.} * \frac{m^3}{1000\,L} = 18900\, m^3/day$$

$$Q_d = 18900 * 1.1 = 20790\, m^3/day$$

$$vol. = 20790 \frac{m^3}{day} * \frac{day}{1440\, min} * 1\, min = 14.44\, m^3$$

Use two units (basin)-cubic shape

Volume of one tank = 14.44/2= 7.22 m^3

D=$\sqrt[3]{7.22}$ = 1.933 m

$$G = \sqrt{\frac{P}{\mu\, v}}$$

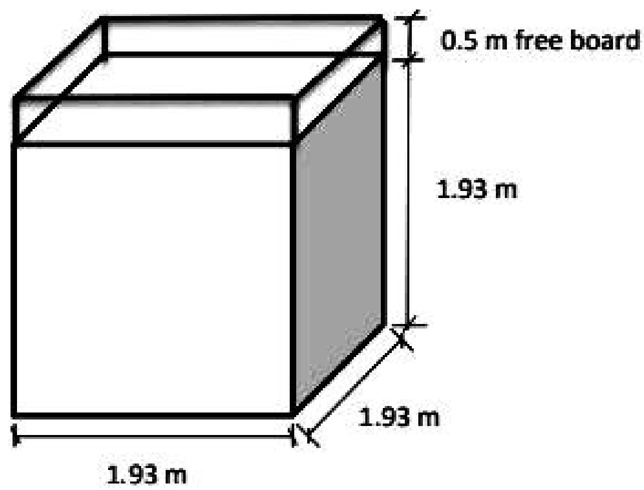
P= 90000 * 7.22 *1.027 * 10^{-3}= 667.35 watt = $\frac{667.35}{745.7}$ = 0.89 *hp*

Alum dose = $50 \frac{mg}{L} * \frac{1000\, L}{m^3} * \frac{gm}{1000\, mg} = 50 \frac{gm}{m^3}$

Total alum quantity = Q * dose

Total quantity = $20790 \frac{m^3}{day} * 50 \frac{gm^3}{m^3} = 1039500 \frac{gm}{day}$ = 1039.5 kg/day

Use 2 cubic tank as coagulation tank as shown in figure



Ex:- Design a rapid mixing unit (mechanical) for a discharge of 5 mgd. What is the total amount of alum if the dose is 50 $\frac{mg}{L}$? $G = 300\ sec^{-1}$, $T = 60$ sec and $\mu = 1.027 \times 10^{-3}\ \frac{N\ sec}{m^2}$ and assume $L = 1.5\ W$?

Solution

$Q = 5$ mgd

$= 5\,000\,000\ \frac{gal}{d} \cdot 3.78\ \frac{L}{gal} \cdot \frac{m^3}{1000\ L} \cdot \frac{d}{24\ hr} \cdot \frac{hr}{60 \times 60\ sec}$

$\therefore Q = 0.218\ \frac{m^3}{sec}$

$Q = \frac{V}{t} \Rightarrow V = Q \times t$

$V = 0.218 \times 60\ sec \Rightarrow 13.125\ m^3$

assume $n = 2$

$\therefore V = \frac{13.125}{2} \Rightarrow V = 6.56\ m^3$

If cubic tank:-

$V = d^3$

$6.56 = d^3$

$\therefore d = 1.87\ m$

If circular tank :

$A = 3.28\ m^2$

$A = \frac{\pi}{4} d^2$

$3.28 = \frac{\pi}{4} d^2 \Rightarrow d = 2.04\ m$

$G = \sqrt{\frac{P}{\mu \cdot V}}$

$300 = \sqrt{\frac{P}{1.027 \times 10^{-3} \times 6.56}} \Rightarrow P = 606\ \text{watt}$

- مطلوب السؤال الثاني هو: حساب كمية الشب الكلية اذا كل لتر من الماء الخام نضيف له 50 mg/L من الشب.

amount of alum = Q × dose

$= 18900\ \frac{m^3}{d} \times 50\ \frac{mg}{L} \times \frac{1000\ L}{m^3} \times \frac{gm}{1000\ mg} \times \frac{Kg}{1000\ gm}$

$= 945\ Kg/d$

If rectangular tank :

from design criteria depth = (1–3) m

∴ assum depth = 2m

$V = A * depth$

$5.56 = A * 2 \Rightarrow A = 3.28\ m^2$

$L = 1.5 W$ --- ①

$A = L * W$

$A = 1.5 W * W$

$A = 1.5 W^2$

$3.28 = 1.5 W^2$

∴ $W \simeq 1.5\ m$

نعوض في معادلة ① لايجاد L

$L = 1.5 * 1.5$

$= 2.25\ m$

∴ $d = 2m$

$W = 1.5\ m$

$L = 2.25\ m$