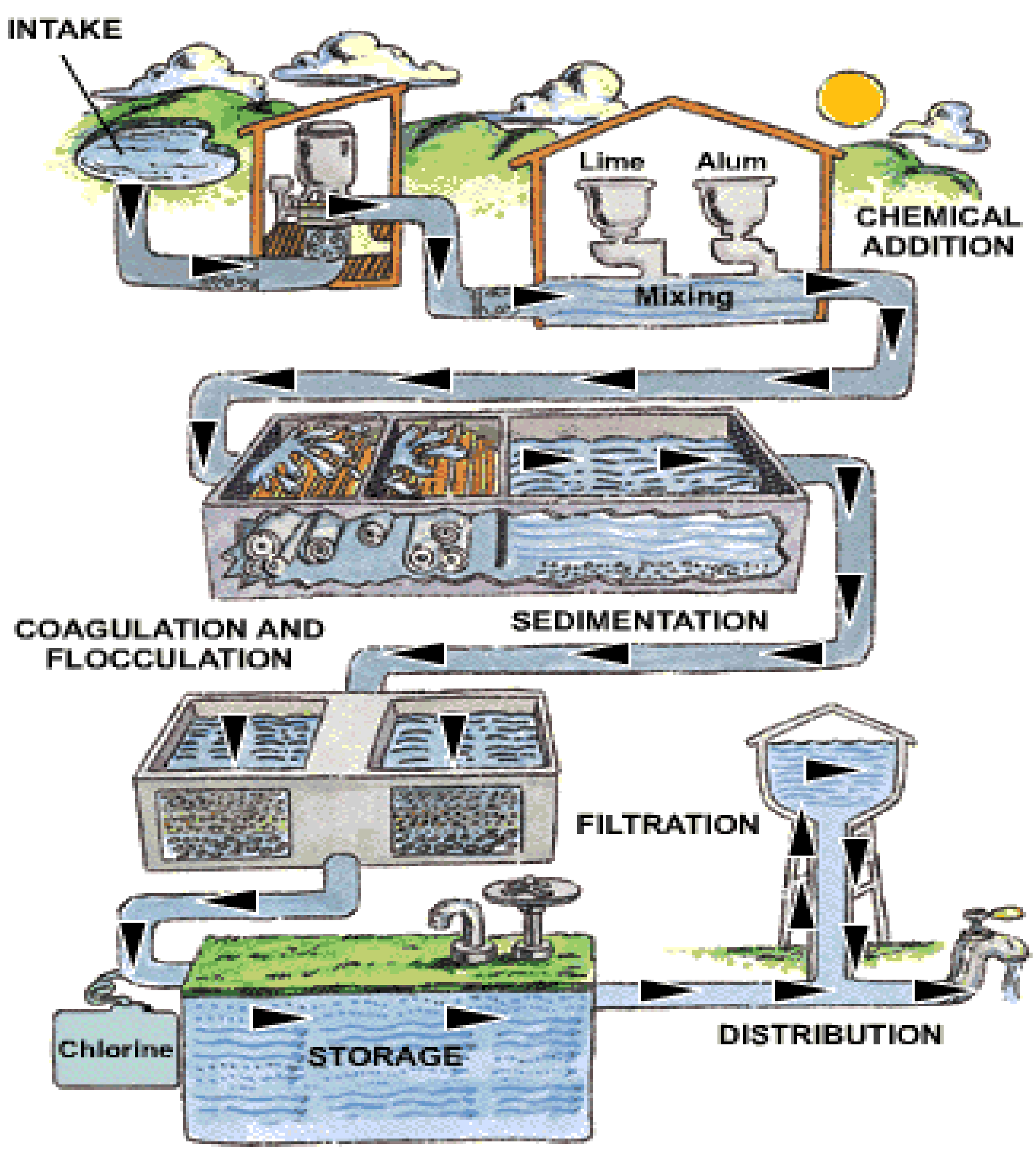
1Purification works
(Treatment works)

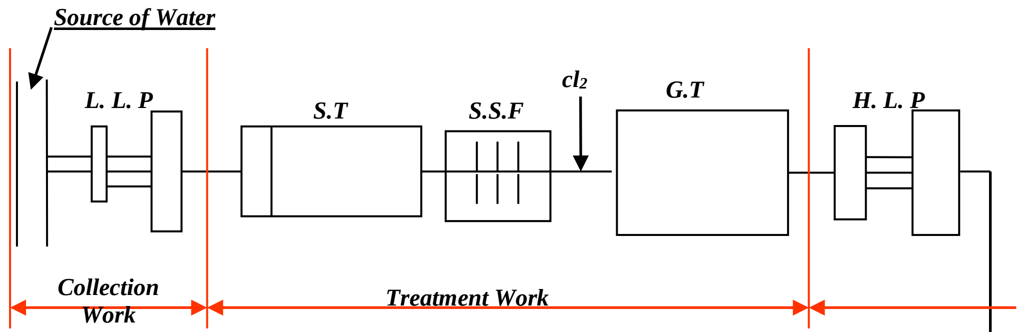
Quality of raw water depend on:

1- Suspended solids.
2- Organic matter.
3- Dissolved solids.
4- Microorganisms.
5- Bacteria (pathogenic).
6- Algae.

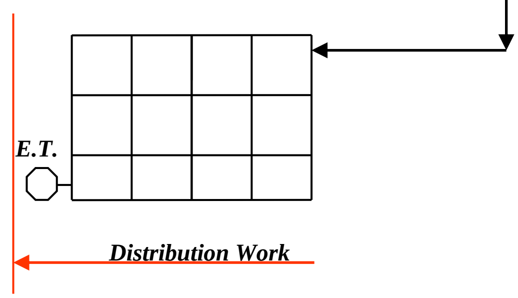
It is a must to get rid of all the previous.



Slow sand filter water treatment plant



- -L.L.P.: Low Lift Pump
- -P.S.T.: Plain Sedimentation
- -S.S.F.: Slow Sand Filter
- -Cl_2: Dosing of chlorine
- -G.T.: Ground Tank
- -H.L.P.: High Lift Pump
- -E.T.: Elevated Tank



Purpose of each step:

1- Sedimentation:

There are two kinds of sedimentation (natural & chemical).
Removal of Suspended matter and most of colloidal matter.

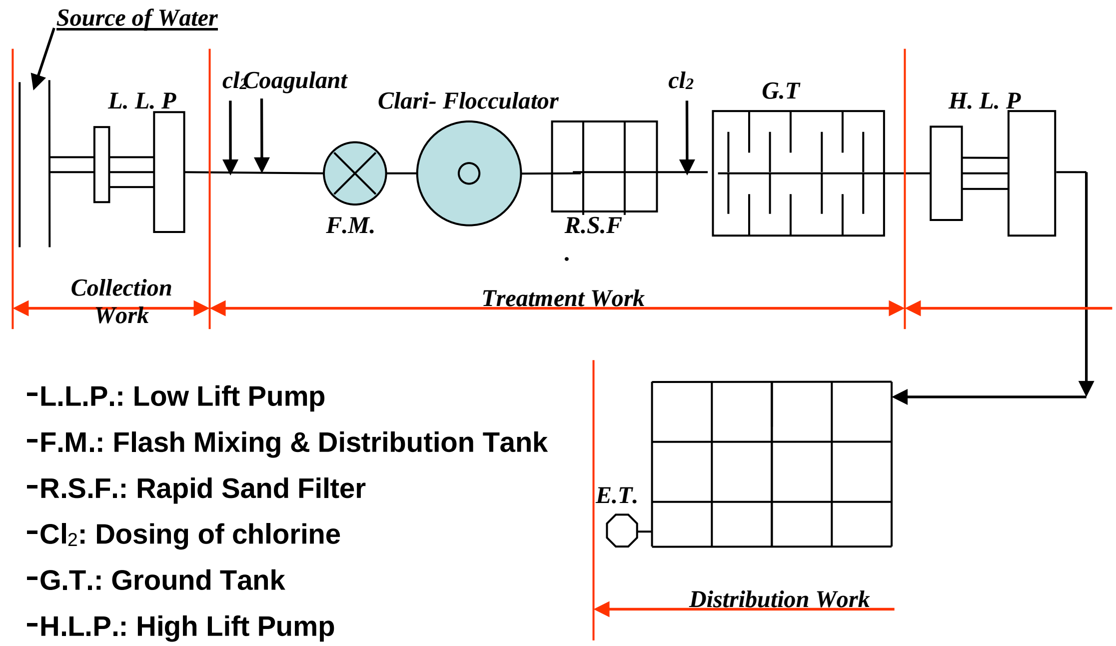
2- Filtration:

- Removal of remaining colloidal matter.
- Removal of taste, odor, and color.
- Removal of iron and magazine.
- Removal of 90% of bacteria.

3- Disinfection:

- Destroy all bacteria especially pathogenic

Rapid sand filter water treatment plant



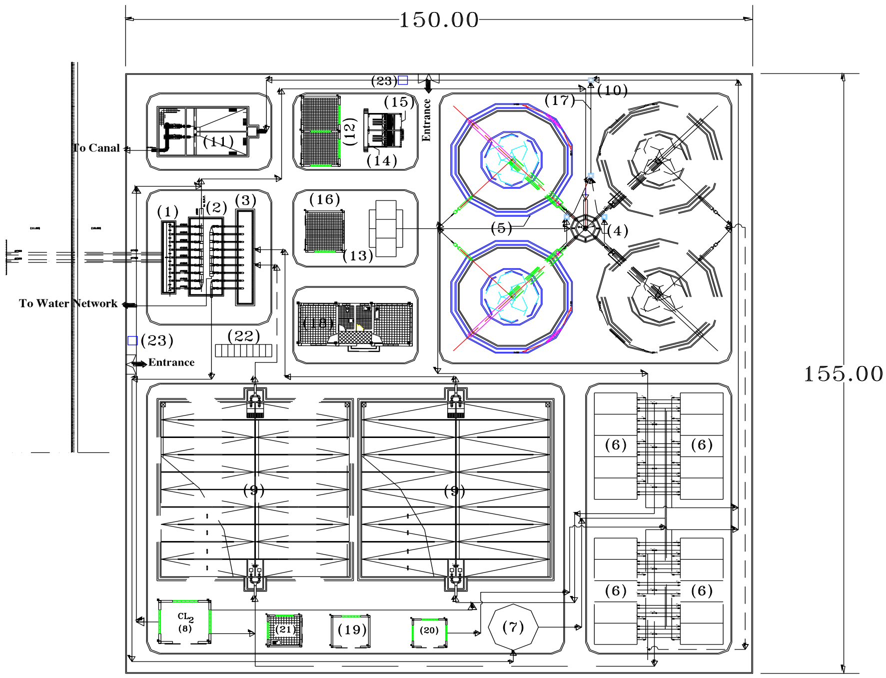
- L.L.P.: Low Lift Pump
- F.M.: Flash Mixing & Distribution Tank
- R.S.F.: Rapid Sand Filter
- Cl_2: Dosing of chlorine
- G.T.: Ground Tank
- H.L.P.: High Lift Pump
- E.T.: Elevated Tank

Adding a primary chlorine dose at the beginning of the treatment works (0.4 ~ 0.8 P.P.M) to eliminate the growth of algae and make it easily to sediment to prevent filter clogging. Post chlorination 0.5 – 1 P.P.M (0.1 - 0.3P.P.M residual)

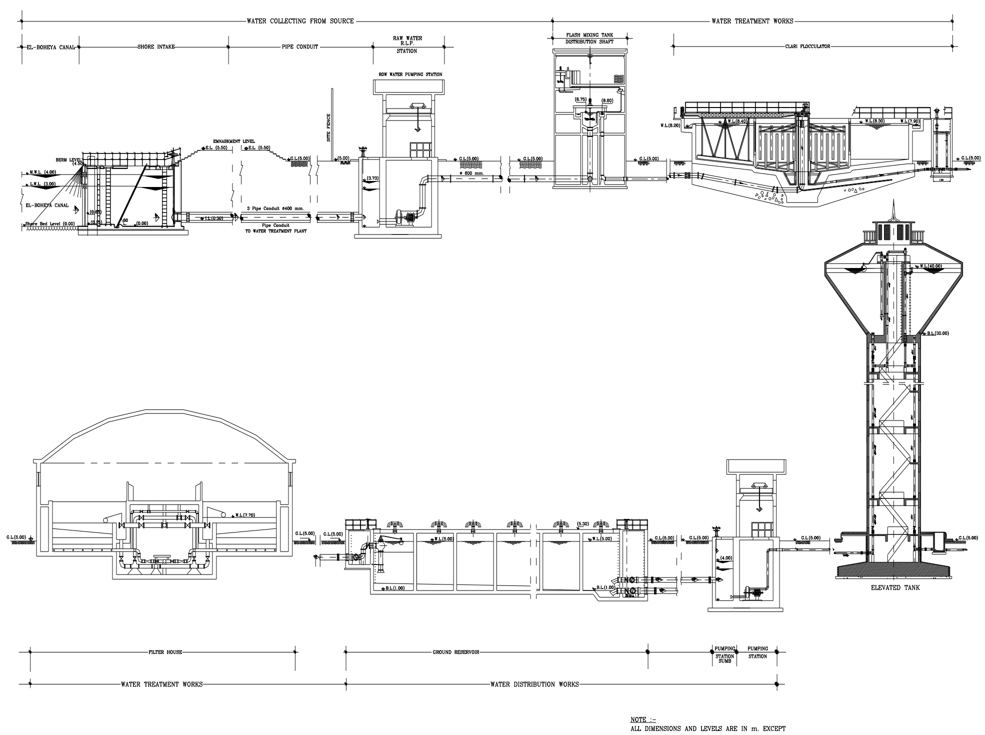
Chemical sedimentation:

1- Increase the volume of the small suspended solids to make it easier in sedimentation.
2- Reduced the sedimentation time.

Layout of Water Treatment Plant



Hydraulic Profile



Coagulation

It has been found that by the addition of certain chemicals to water an insoluble, gelatinous, flocculent precipitate will be formed.

In its formation through the water, will adsorb suspended and colloidal matter and increase their sedimentation rate. The chemicals used in water as coagulant, when properly applied are harmless to consumers.

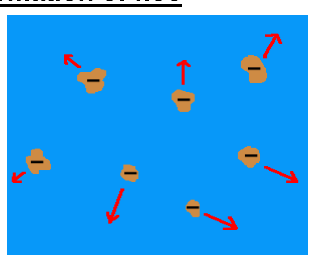
Coagulation ⟶ flash mixing.

Flocculation ⟶ gentle mixing.

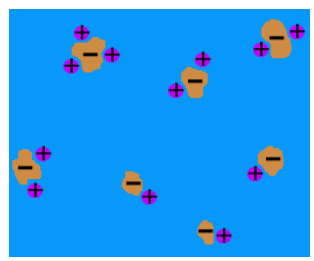
Coagulation: adding a chemical substance doesn't affect the chemical and physical characteristics of water react with the natural alkalinity of water forming gelatinous hydracids.

Flocculation: the attraction of small suspended solids to the surface of the gelatinous hydracids.

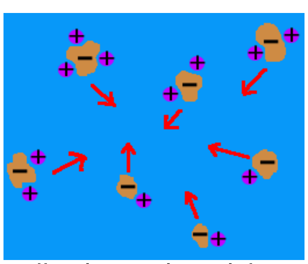
Formation of floc



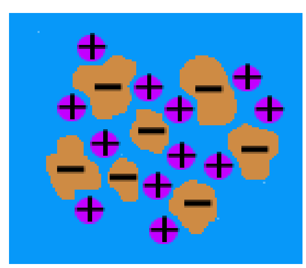
Negatively charged particles repel each other due to electricity



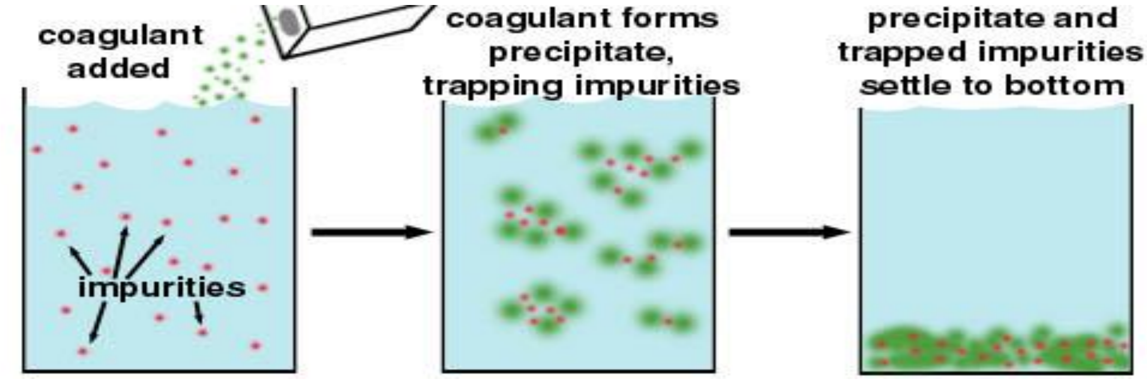
Positively charged coagulants attract to negatively charged particles due to electricity

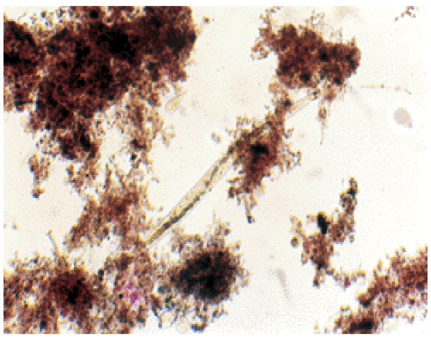


Neutrally charged particles attract due to van der Waal's forces



Particles and coagulants join together into floc.





A photograph of the flocs

Kinds of coagulants

1- Hydrous aluminum sulfate (Alum)

- easy to use
- cheap
- available

2- Ferrous sulfate $Fe_2 (SO4)_3$

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

4- Ferric chloride $Fe Cl_3$

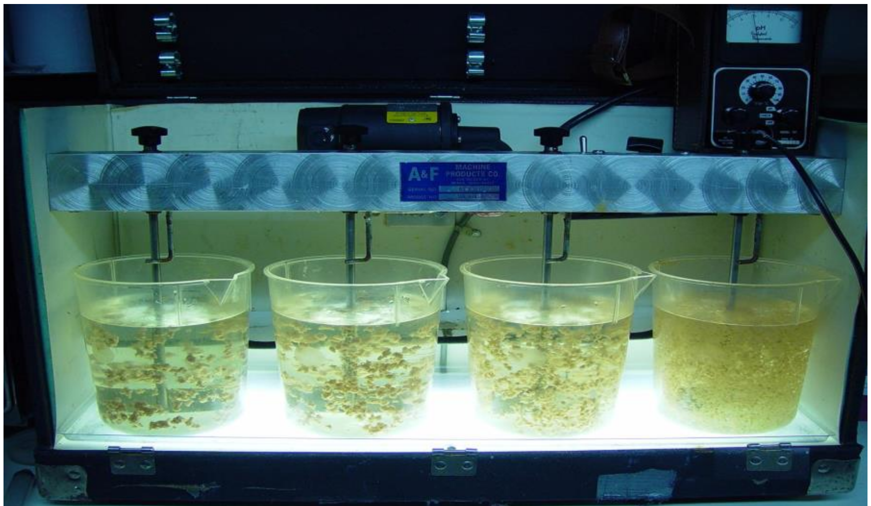
Jar test

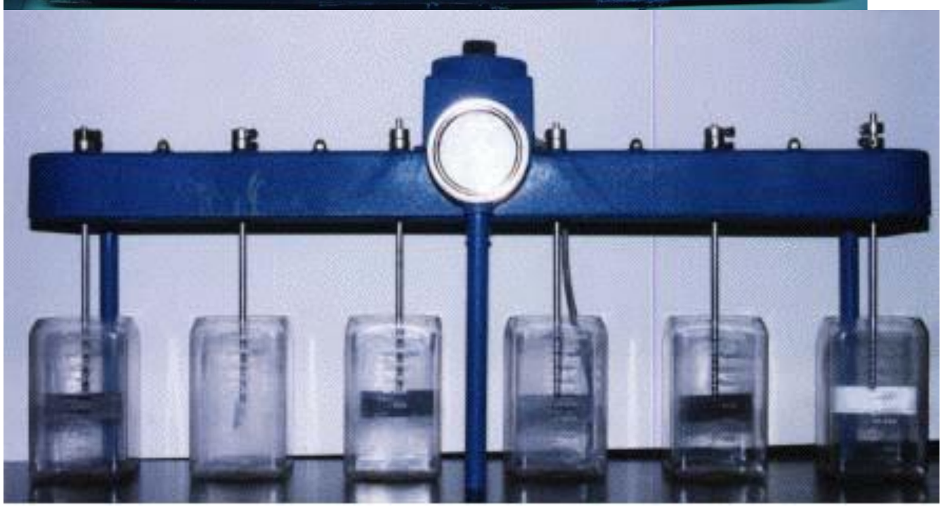
This test is used to determine:

1- The optimum dose of coagulant (alum).

2- The optimum retention time.

3- The optimum mixing velocity.





<u>Methods of feeding coagulant:</u>

<u>1- Dry feeding:</u>

<u>Advantages:</u>

1- Control the added dose.

<u>Disadvantages:</u>

1- Needs of a good aerated place to store.

2- Arch action.

3- Non homogeneous solution.

<u>2- Wet feeding:</u>

<u>Advantages:</u>

1- Homogeneous solution.

<u>Disadvantage:</u>

1- It needs mechanical maintenance.

2- Construction of alum solution preparation tanks.

Mixing coagulant

Mixing tanks

Purpose:

Distribute the coagulant uniformly in raw water.

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

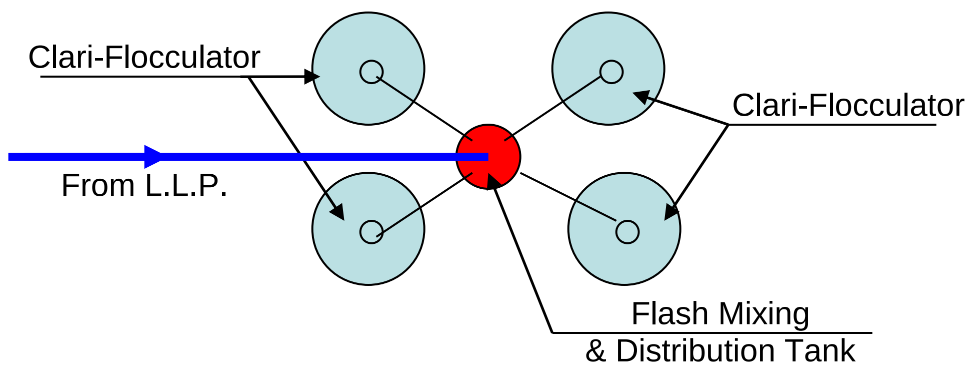
2- Adding the coagulant solution in a venture so that the turbulence which occurs mixes the coagulant with water.

3- Using flash mixing tank.

Flash mixing tank:

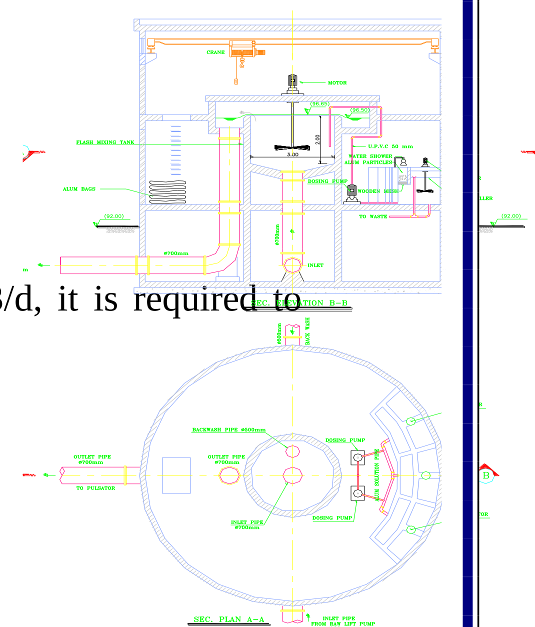
Purpose:

Distribute the coagulant uniformly in raw water.



Design criteria:

- retention time = T = (20 - 60) sec
- depth = (1- 3) m
- Diameter ≤ 35 m
- No. of tanks ≥ 1
- Speed of impeller = (100 - 300) R.P.M
- Volume = Qd x T



Example:

A water treatment plant has a discharge of 30,000 m3/d, it is required to design the flash mixing thank of this plant.

Solution:

$$Q_d = 30000 \times 1.1 = 33000 m^3/d$$

$$V = Q_d \times T$$

$$V = \frac{33000}{24 \times 60 \times 60} \times 60 = 22.91 m^3$$

$$V = n \frac{\pi\phi^2}{4} \times d$$

$$\frac{\pi\phi^2}{4}$$

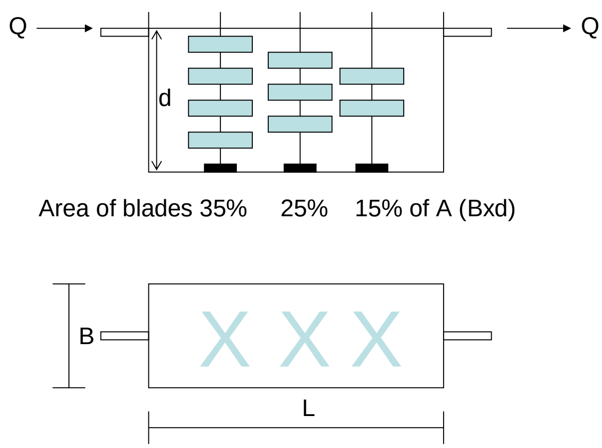
$$\phi = 3.82 m$$

Flocculation

Purpose:

1- Provide enough time for the reaction between the coagulant and the natural alkalinity of water.

2- Give enough time for the result of action (flocs) to grow and collect very fine particles and colloidal matter.



Schematic diagram of flocculation tank

Design criteria:

1- Retention time = T = (20 - 40) min

2- Depth (d) = (2 - 3) m

3- Width (b) = (1 - 2) Depth

4- Length (L) = 3 b

5- Rotation speed = 30 R.P.M.

6- Velocity ≥ 0.3 m/sec (to prevent sedimentation)

7- No. of tanks ≥ 2

Example:

For the last example design the flocculation tank.

Solution:

$$V = Q_d \times T$$

$$V = \frac{33000}{24 \times 60} \times 30 = 687.5 m^3$$

$$A = \frac{V}{d}$$

$$A = \frac{687.5}{2} = 343.75 m^2$$

$$A_{of one tank} = \frac{343.75}{\;} = 85.94\, m^2$$

A = L x b

L = 3b

A = 3b x b $\therefore$ b = 5.35 m and L = 16.06 m

B > 2 d (2x2=4) $\therefore$ increase n

Take n = 7

$\therefore$ b = 4.06 m and L = 12.14 m