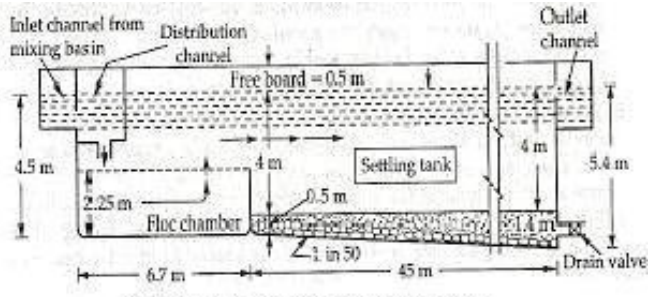
2.3 COAGULATION, CHLORINATION AND DISINFECTION

When water contains fine clay and colloidal impurities which are electrically charged are continually in motion and never settle down due to gravitational force. Certain chemicals are added to the water so as to remove such impurities which are not removed by plain sedimentation. The chemical form insoluble, gelatinous, flocculent precipitates absorb and entangle very fine suspended matter and colloidal impurities during its formation and descent through water. These coagulants further have an advantage of removing colour, odour and taste from the water. Turbidity of water reduced upto 5-10 ppm and bacteria removes up to 65%. The following are the mostly used Coagulants with normal dose and PH values required for best floc formation. Coagulant PH Range Dosage mg/l

1. Aluminium sulphate Al2(SO4)3, 18 H2O 5.5 – 8.0 5 – 85
2. Sodium Aluminate, Na2Al2O4 5.5 – 8.0 3.4 – 34
3. Ferric Chloride (Fecl3) 5.5 – 11.0 8.5 – 51
4. Ferric Sulphate Fe2 (SO4)3 5.5 – 11.0 8.5 – 51
5. Ferric Sulphate FeSO47H2O 5.5 – 11.0 8.5 - 51

Coagulants are chosen depending upon the PH of water. Alum or Aluminium sulphate is normally used in all treatment plants because of the low cost and ease of storage as solid crystals over long periods. The dosage of coagulants, which should be added to the water, depends upon kind of coagulant, turbidity of water, colour of water, PH of water, temperature of water and temperature of water and mixing & flocculation time. The optimum dose of coagulant required for a water treatment plant is determined by a Jar test. For starting the experiment first of all the sample of water is taken in every jar and added the coagulant in a jar in varying amounts. The quantity of coagulant added in each jar is noted. Then with the help of electric motor all the paddles are rotated at a speed of 30-40 R.P.M. for about 10 minutes. After this the speed is reduced and paddles are rotated for about 20-30 minutes. The rotation of paddles is stopped and the floc formed in each Jar is noted and is allowed to settle. The dose of coagulant which gives the best floc is the optimum dose of coagulants.



Dimensions of the Coagulation-cum-Sedimentation tank

The coagulants may be fed or allowed to enter either in powder form called dry feeding or in solution form called wet feeding. The mixing of coagulant with the water to form the floc by the following method:

1. Centrifugal pump
2. Compressed air
3. Hydraulic jump
4. Mixing channel
5. Mixing basins with buffle walls
6. Mixing basins with mechanical means

Now a day's some firms manufacture combined unit comprising of feeding, mixing, flocculator and clarifier device.

Sedimention with Coagulation:

Water enters in this tank through central inlet pipe placed inside the deflector box. The deflector box deflects the water downwards and then it goes out through the holes provided sides of the deflector box. The water flows radially from the deflector box towards the circumference of the tank, where outlet is provided on the full periphery. All the suspended particles along with floc settle down on the sloppy floor and clear water goes through outlet. The sludge is removed by scrapper who continuously moves around the floor with very small velocity. Disinfection and repainting is to be carried out once in a year before monsoon. Sludge pipes are to be flushed and kept clean. Bleaching powder may be used to control the growth of algae on the weirs. Scraper mechanism should be oiled and greased periodically.

2.3.1 CHLORINATION

Chlorination is the addition of chlorine to kill the bacteria Chlorination is very widely adopted in all developing countries for treatment of water for public supply. Chlorine is available in gas, liquid or solid form (bleaching powder)

ADVANTAGES OF CHLORINE

1. Chlorine is manufactured easily by electrolytes of common salts (NaCl).
2. It is powerful oxidant and can penetrate the cell wall of organism and its contents.
3. Dosage can be controlled precisely.
4. Can be easily detected by simple orthotolidine test.
5. Does not form harmful constituents on reaction with organics of inorganic in water.

RESIDUAL CHLORINE AND CHLORINE DEMAND

When chlorine is applied in water some of it is consumed in killing the pathogens, some react organs & inorganic substances and the balance is detected as "Residual Chlorine". The difference between the quantity applied per liter and the residual is called "Chlorine Demand". Polluted waters exert more chlorine demand. If water is pre-treated by sedimentation and aeration, chlorine demand may be reduced. Normally residual chlorine of 0.2 mg/liter is required.

DOSAGE OF CHLORINE

(A) PLAIN CHLORINATION

Plain chlorination is the process of addition of chlorine only when the surface water with no other treatment is required. The water of lakes and springs is pure and can be used after plain chlorination. A rate of 0.8 mg / lit / hour at 15N / cm^2 pressure is the normal dosage so as to maintain in resided chlorine of 0.2 mg/lit.

(B) SUPER CHLORINATION

Super chlorination is defined as administration of a dose considerably in excess of that necessary for the adequate bacterial purification of water. About 10 to 15 mg/lit is applied with a contact time of 10 to 30 minutes under the circumstances such as during epidemic breakout water is to be dechlorinated before supply to the distribution system.

(C) BRAKE POINT CHLORINATION

When chlorine is applied to water containing organics, micro organisms and ammonia the residual chlorine levels fluctuate with increase in dosage Upto the point B it is absorbed by reducing agents in water (like nitrates, Iron etc) further increases forms chloramines with ammonia in water. Chloramines are effective as CL and OCL formed. When the free chlorine content increases it reacts with the chloramines and reducing the available chlorine. At the point „D" all the chloramines are converted to effective N2, N2O and NCl3. Beyond point „D" free residual chlorine appear again. This point „D" is

called break point chlorination. Dosage beyond this point is the same as super chlorination. In super chlorination no such rational measurement is made and the dosage is taken at random.

(D) DECHLORINATION

Removal of excess chlorine resulting from super chlorination in part or completely is called „Dechlorination". Excess chlorine in water gives pungent smell and corrodes the pipe lines. Hence excess chlorine is to be removed before supply. Physical methods like aeration, heating and absorption on charcoal may be adopted. Chemical methods like sulphur dioxide (SO2), Sodium Bi-sulphate (NaHSO3),Sodium Thiosulphate(Na2S2O8) are used.

POINTS OF CHLORINATION

Chlorine applied at various stages of treatment and distribution accordingly they are known as pre, post and Re-chlorination.

a) PRE-CHLORINATION

Chlorine applied prior to the sedimentation and filtration process is known as Prechlorination. This is practiced when the water is heavily polluted and to remove taste, odour, color and growth of algae on treatment units. Pre-chlorination improves coagulation and post chlorination dosage may be reduced.

b) POST CHLORINATION

When the chlorine is added in the water after all the treatment is known as Post chlorination.

c) RE-CHLORINATION

In long distribution systems, chlorine residual may fall tendering the water unsafe. Application of excess chlorine to compensate for this may lead to unpleasant smell to consumers at the points nearer to treatment point in such cases chlorine is applied again that is rechlorinated at intermediate points generally at service reservoirs and booster pumping stations.

2.3.2 DISINFECTION OF WATER

The process of killing the infective bacteria from the water and making it safe to the user is called disinfection. The water which comes out from the filter may contain some disease – causing bacteria in addition to the useful bacteria. Before the water is supplied to the public it is utmost necessary to kill all the disease causing bacteria. The chemicals or substances which are used for killing the bacteria are known as disinfectants.

REQUIREMENTS OF GOOD DISINFECTANTS

1. They should destroy all the harmful pathogens and make it safe for use.
2. They should not take more time in killing bacteria.
3. They should be economical and easily available.
4. They should not require high skill for their application.
5. After treatment the water should not become toxic and objectionable to the user.
6. The concentration should be determined by simply and quickly.

METHODS OF DISINFECTION

Disinfection of water by different physical and chemical methods

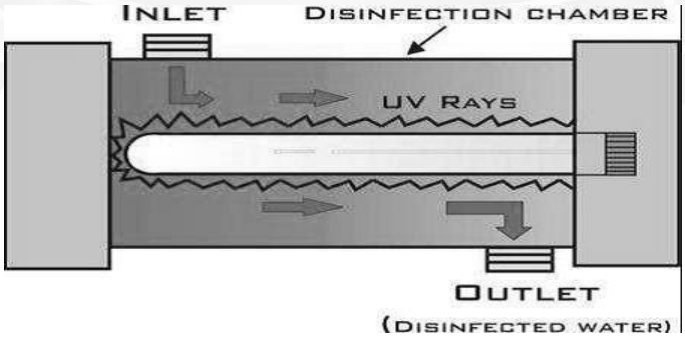
I. PHYSICAL METHODS

1. Boiling:

Boil the water for 15 to 20 minutes and kills the disease causing bacteria. This process is applicable for individual homes.

2. Ultra-violet rays:

Water is allowed to pass about 10cm thickness by ultraviolet rays. This process is very costly and not used at water works. Suitable for institutions.



II. CHEMICAL METHODS

1. Treatment with Excess Lime:

Lime is used in water treatment plant for softening. But if excess lime is added to the water, it can in addition, kill the bacteria also. Lime when added raises the pH value of

water making it extremely alkaline. This extreme alkalinity has been found detrimental to the survival of bacteria. This method needs the removal of excess lime from the water before it can be supplied to the general public. Treatment like recarbonation for lime removal should be used after disinfection.

2. Chlorination:

The germicidal action of chlorine is explained by the recent theory of *Enzymatic hypothesis*, according to which the chlorine enters the cell walls of bacteria and kill the enzymes which are essential for the metabolic processes of living organisms.

3. Bromine and Iodine:

Use of iodine or bromine is limited to small water supplies such as swimming pools, troops of army, private plants, etc.

- Dosage of iodine or bromine is about 8 p.p.m.
- Contact period with water is 5 minutes.
- Available in the form of pellets or small pills.

4. POTASSIUM PERMANGANATE TREATMENT ($KMnO_4$)

- It is a powerful oxidising agent, effective in killing cholera bacteria
- Restricted to disinfection of water of village wells and ponds
- Dosage is about 2.1 ppm
- Contact period of 3 to 4 hours
- The treated water produces a dark brown coating on porcelain vessels and this is difficult to remove except with scratching or rubbing

5. SILVER TREATMENT

- Colloidal silver is used to preserve the quality of water stored in jars.
- Metallic silver is placed as filter media. Water get purified while passing through these filters.
- Dosage of silver varies from 0.05 to 1 p.p.m.
- Contact period is about 15 minutes to 3 hours.
- It is costly and limited to private individual houses only.