UNIT V DISINFECTION

1Q. **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.

2Q. 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.

3Q.METHODS OF DISINFECTION

Disinfection of water by different physical and chemical methods

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.
3. **ULTRASONIC RAYS:** Suitable for institutions.

CHEMICAL METHODS:

1. **CHLORINATION : U**sing chlorine gas or chlorine compounds.
2. **BROMINE AND IODINE :** It is expensive and leaves taste and odour.
3. **POTASSIUM PERMANGANATE:** This method is used for disinfection of dug well water, pond water or private source of water.
4. **OZONE :** Very expensive process, leaves no taste, odour or residual.
5. **EXCESS LIME TREATMENT:** Needs long detension time for time interval and large lime sludges to be treated.

4Q. 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. Doesnot form harmful constituents on reaction with organics of inorganics in water
6. leaves required residue in water to neutralise recontamination later.

5.Q.R ESIDUAL 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 litre and the residual is called "Chlorine Demand". Polluted waters excert more chlorine demand. If water is pre-treated by sedimentation and aeration, chlorine demand may be reduced. Normally residual chlorine of 0.2 mg/litre is required.

BEHAVIER OF CHLORINE IN WATER

When chlorine is dissolved in water forms hypo chlorous acid and hydro chloric acid.

$$Cl_2 + H_2O \rightarrow HOCl + HCl \text{ ---------- (1)}$$

After some time hydo chlorous acid further Ionizes as follows

$$HOCl \longleftrightarrow H^+ + OCl^- \text{ ------ (2)}$$

The two prevailing species (HOCl) and (OCl^-) are called free available chlorine are responsible for the disinfection of water.

Clorine reacts with ammonia in water to form Monochloramine, (NH_2Cl), dichloramine ($NHCl_2$) and trichloramine , (NCl_3) released and their distribution depends on the PH-value of water.

6Q) TYPES OF CHLORINATION

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 a resided chlorine of 0.2 mg/lit.

b. PRE-CHLORINATION :

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

c. POST CHLORINATION :

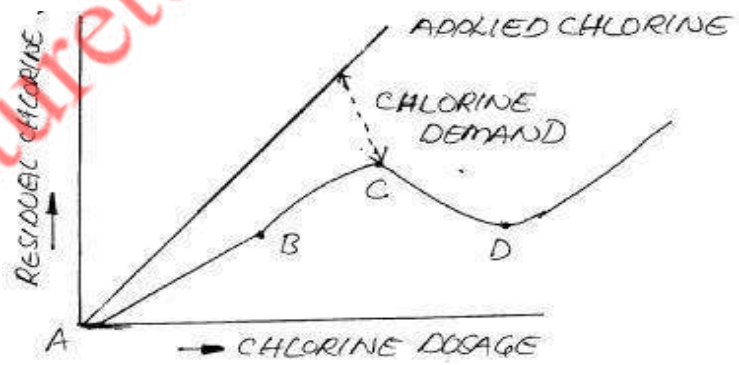
When the chlorine is added in the water after all the treatment is known as Post-chlorination.

d. 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.

e. BRAKE POINT CHLORINATION :

When chlorine is applied to water containing organics, micro organisms and ammonia the residual chlorine levels fluctuate with increase in dosage as shown in Fig. 5.6.



Fig

Upto the point B it is obsorbed 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 N_2, N_2O and NCl_3. 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.

. **DECHLORINATION :**

Removal of excess chlorine resulting from super chlorination in part or completely is called 'Dechlorination'. Excess chlorine in water gives pungent smell and corrode 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 (SO_2) , Sodium Bi-sulphate ($NaHSO_3$), Sodium Thiosulphate($Na_2S_2O_8$) are used.

6Q. DEFLUORIDATION – BY NALGONDA TECHNIQUE

Defluoridation is process of removal of excess fluoride present in the water. The excess fluoride in the water causes dental abnormalities, hypertension, peptic ulcer, Skin infections, defective vision, coronary thrombosis etc. The permissible level of fluoride in the water is 1mg/litre.

METHODS OF REMOVAL FLUORID

1. Activated carbons prepared from various materials can be used.
2. Lime – soda process of water softening removes fluorides also along with magnesium
3. The materials like calcium phosphate, bone charcoal, synthetic tricalcium phosphate a may remove excess fluoride.
4. the water may be allowed to pass through filter beds containing floride retaining materials.

In this technique, sodium aluminate or lime, bleaching powder and filter alum are added to fluoride water in sequence. The water is stored for ten minutes and settled for one hour and the water is then withdrawn without disturbing the sediments. The sodium aluminate or lime accelerates the settlement of precipitate and bleaching powder ensures disinfection. The alum dose required will depend upon the concentration of fluorides, alkanity and total dissolved solids in the raw water. It is found that this technique is simple in operation and economical. It can be used with advantage in villages either on an individual scale or on a mass scale.

Aeration

- It is the process of bringing water in intimate contact with the air
- Physical or mechanical method

Aeration

Objectives: To remove

- Iron and manganese
- Interference with chlorination
- Volatile oils
- Disinfect the water
- Oxidize organic matter
- Increase the DO

Aeration

Methods of Aeration

- Cascade aerators
- Spray nozzles
- Multiple Pan aerators
- Diffusion aerators

Aeration
Cascade aerators

Fig.1

Aeration

Cascade aerators

- The water is allowed to fall through a certain height over a series of steps or weirs in thin films
- During the fall, the water gets thoroughly mixed with the atmospheric air and gets aerated

Aeration

Spray nozzles

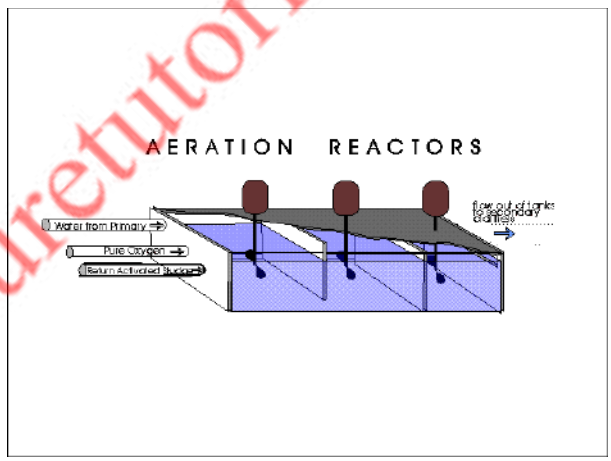


Fig.2

Aeration

Spray nozzles

- Water is sprinkled in the form of fine droplets into the atmosphere
- This increases the contact area between water and air and water gets aerated effectively

Aeration

MultiPan Aerators

Fig.3

Aeration

Multi Pan Aerators

- Water is made to trickle through perforated pans arranged one below the other

Aeration

Diffusion Aerators

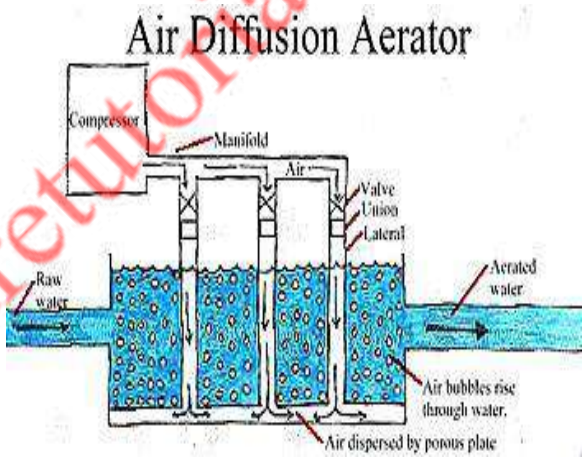


Fig.4

Aeration

Diffusion Aerators

- The compressed air is blown into the water and it comes in the form of bubbles to stir the water
- During the upward movement of the air bubbles, water is thoroughly aerated

HARDNESS OF WATER

It is a property of water, which prevents the lathering of the soap. Hardness is of two types.

1. Temporary hardness: It is caused due to the presence of carbonates and sulphates of calcium and magnesium. It is removed by boiling.
2. Permanent hardness: It is caused due to the presence of chlorides and nitrates of calcium and magnesium. It is removed by zeolite method.

Hardness is usually expressed in gm/litre or p.p.m. of calcium carbonate in water. Hardness of water is determined by EDTA method. For potable water hardness ranges from 5 to 8 degrees.

HARDNESS REMOVABLE :

Generally a hardness of 100 to 150 mg/litre is desirable. Excess of hardness leads to the following effects.

1. Large soap consumption in washing and bathing
2. Fabrics when washed become rough and strained with precipitates.
3. Hard water is not fit for industrial use like textiles, paper making, dye and ice cream manufactures.
4. The precipitates clog the pores on the skin and makes the skin rough
5. Precipitates can choke pipe lines and values
6. It forms scales in the boilers tubes and reduces their efficiency and cause in erustations
7. Very hard water is not palatable

When softening is practices when hardness exceed 300mg/lit. Water hardness more than 600 mg/lit have to rejected for drinking purpose.

2.Q.M ETHODS OF REMOVAL OF HARDNESS

1. Boiling
2. Freezing
3. Lime addition
4. Lime soda process
5. Excess Lime treatment
6. Caustic soda process
7. Zeolete process
8. Dimineralisation or exchange process.

Methods 1,2 and 3 are suitable for removal of temporary hardness and 4 to 8 for both temperory and permanent hardness. The temporary hardness is removed as follows.

Boiling

$$Ca(HCO_3)_2 \xrightarrow{\text{heat}} CaCO_3\downarrow + CO_2\uparrow + H_2O$$

$$Mg(HCO_3)_2 \xrightarrow{\text{heat}} MgCO_3\downarrow + CO_2\uparrow + H_2O$$

Addition of lime

$Ca(HCO_3)_2 + Ca(OH)_2 \text{ ----------> } 2CaCO_3\downarrow + 2H_2O$

$Mg(HCO_3)_2 + Ca(OH)_2 \text{ ----------> } CaCO_3 + MgCO_3 + 2H_2O$

Removal of permanent Hardness:

1. **Lime soda process :** In this method, the lime and is sodium carbonate or soda as have used to remove permanent hardness from water. The chemical reactions involved in this process are as follows.

   $CO_2 + Ca(OH)_2 \text{ ----------> } CaCO_3 + H_2O$ (removal of CO_2)

   $Ca(HCO_3) + Ca(OH)_2 \text{ ----------> } 2CaCO_3 + 2H_3O$ (removal of temporary hardness)

   $Mg(HCO_3) + Ca(OH)_2 \text{ ----------> } CaCO_3 + Mg(CO_3) + 2H_2O$

   $MgSO_4 + Ca(OH)_2 \text{ ----------> } Mg(OH)_2 + CaSO_4$ { conversion of $MgSO_4$ to

   $CaSO_4$} $CaSO_4 + Na_2CO_3 \text{ ----------> } CaCO_3 + Na_2SO_4$ {removal of sulphates}

   $CaCl_2 + Ca(OH)_2 \text{ ----------> } Ca(OH)_2 + CaCl_2$

   $MgCl_2 + Ca(OH)_2 \text{ ----------> } Mg(OH)_2 + CaCl_2$ { removal of chlorides}

   $CaCl_2 + Na_2CO_3 \text{ ----------> } CaCO_3 + 2NaCl$

   $MgCl_2 + Na_2CO_3 \text{ ----------> } Mg\ CO_3 + 2NaCl$ {removal of chlorides}

Advantages of lime soda process

1. The PH value of water treated by this process bring down to 9 and which results in decrease in corrosion of the distribution system.
2. Less quantity of coagulant will be required, if this process is adopted
3. Removal of iron and manganese to some extent
4. Reduction of total mineral content of water
5. Hardness of water is reduced to 40mg/lit (of $CaCO_3$) and magnesium upto 10mg/lit
6. The process is economical
7. This process is most suitable for tubed and acidic waters where it will not possible to adopt zeolite process.

Disadvantages

1. Large quantity of sludge formed during this process to be disposed off by some suitable method
2. This process requires skilled supervision for its successful working
3. If recarbonation is omitted, a thick layer of calcium carbonate will be deposited in the filtering media, distribution pipes etc.

Zeolite process

This is also known as the base-exchange or Ion exchange process. The hardness may be completely removed by this process.

Principle

Zeolites are compounds (silicates of aluminium and sodium) which replace sodium Ions with calcium and magnesium Ions when hardwater is passes through a bed of zeolites. The zeolite can be regenerated by passing a concentrated solution of sodium chloride through the bed. The chemical reactions involved are

$2SiO_2\ Al_2O_3\ Na_2O + Ca(HCO_3)_2$ ----------> $2SiO_2\ Al_2O_3\ CaO + 2NaHCO_3$

(Zeolite)

$2SiO_2\ Al_2O_3\ Na_2O + CaSO_4$ ---------- > $2SiO_2\ Al_2O_3\ CaO + Na_2SO_4$

$2SiO_2\ Al_2O_3\ Na_2O + CaC1_2$ ---------- > $2SiO_2\ Al_2O_3\ CaO + 2NaCl$

Regeneration

$2SiO_2\ Al_2O_3\ Na_2O + 2NaCl$ ----------> $2SiO_2\ Al_2O_3\ Na_2O + CaCl_2$

$2SiO_2\ Al_2O_3\ MgO + 2NaCl$ ----------> $2SiO_2\ Al_2O_3\ Na_2O + MgCl_2$

Advantages

1. In this process, the sludge is not formed hence problem of sludge disposal does not arise
2. It can be operated easily and no skilled supervision required
3. The hardness of water reduces to zero and hence used for boiler and texile industries
4. The process is economical where salt is cheaply available
5. The load on Zeolite can be reduced by combining it with lime or aeration process

Disadvantages

1. The Zeolite process cannot be used for turbed or acidic water
2. The Zeolite process is unsuitable for water containing Iron and Manganese
3. The Zeolite should be operated carefully to avoid injury or damage to the equipment

Demineralisation

Both cations and anions are removed by resins similar to zeolites in two columns by iron exchange method. Resins may be regenerated with sulpuric acid and sodium carbonate. This process is used in industries to get distilled water or quality water motion of water through the atmosphere, earth, plants, trees, rivers and oceans in a cyclic motion through liquid, solid and gaseous phases is called HYDROLOGICAL CYCLE.