WATER

SAFE AND WHOLESOME WATER

1. Free from pathogenic agents.
2. Free from harmful chemical substances.
3. Pleasant to the taste, free from colour and odour.
4. Usable for domestic purposes.

Water requirement

The basic requirement for drinking water have been at about 2 liters per head per day

USES OF WATER

1. **Domestic use:** used for drinking, washing, bathing, flushing toilets, gardening.
2. **Public purposes:** cleaning streets, swimming pool, public fountains.
3. **Industrial purpose**
4. **Agricultural purpose**
5. **Power production from hydropower, steam power.**

SOURCE OF WATER SUPPLY

- **Rain**
- **Surface water:** Impounding reservoir
  Rivers and streams
  Tanks, ponds and lakes
- **Ground water:** Shallow well
  Deep well
  Springs

RAIN

Main source of all water

Characteristics:

1. Pure water in nature
2. Physically it is clear, bright and sparkling
3. Chemically it is soft water containing only traces of dissolved solids
4. Free from pathogenic organism

SURFACE WATER

Surface water originates from rain water. E.g; rivers, tanks, man made reservoir, sea water.

1. **Impounding reservoirs:** These are artificial lakes constructed usually of earthwork or masonry in which large quantities of surface water is stored.

   The area draining into the reservoir is called catchment area Disadvantages of storing water for long period in reservoir causes growth of algae and other microscopic organism which give bad taste and odour to water.

Characteristics:

i) Good quality of water, clear, palatable and ranks next to rain water in purity

ii) Water is soft and considered to be free from pathogenic organism.

RIVERS

It is always polluted unfit for drinking without treatment.

Characteristics:

1. It is turbid during rainy season.
2. Clarity of water is no guarantee that the river water is safe for drinking.

3. Contains dissolved, suspended impurities
4. Bacterial count is high.

TANKS

Tanks are large excavation in which surface water is stored.

Improvement of tanks:

- ✓ The edges of tank should be elevated in order to prevent the entry of surface washing
- ✓ There should be fence around the tank to prevent access to animals
- ✓ No one should be permitted to get into the tank directly
- ✓ There should be elevated platform from where the people can draw water.
- ✓ The weeds should be periodically removed.
- ✓ The tank should be cleaned at the end of dry season.

SEA WATER

Although the source is more but is not useful because highly salt conc., contains dissolved solids such as Na, K, choride

GROUND WATER

Rain water percolating into ground constitutes ground water. It is safer than surface water as ground itself act as a successful filtering

Advantages:

- ❖ It is free from pathogenic agent.
- ❖ The supply is likely to be certain even during dry season.
- ❖ It requires no treatment.
- ❖ It is less subject to contamination than surface water.

Disadvantages:

- ✓ High in mineral content. Eg: Salt of calcium, magnesium.
- ✓ It requires pumping or some arrangements to lift the water.

WELLS

Technically wells are two types

1. **Shallow well :** shallow wells tap subsoil water that is the water from above the first impervious layer in the ground . They yield limited quantities of water and the water is liable to pollution unless care is taken in well construction
2. **Deep well:** It is one which tapes water from the water bearing stratum below the first impervious layer in the ground. These are machine dugged and may be several hundred meters deep.

Features	Shallow well	Deep well
Definition	Taps water from above the first impervious layer	Taps the water from below the first impervious layer
Chemical quality	Moderately hard	Much hard
Bacteriological quality	Grossly contaminated	Tapes pure water
yield	It dries in summer	Constant supply

SANITARY WELL

Is one which is properly located, well-constructed and protected against contamination with a view to yield to supply of safe water.

Criteria:

1. **Location:** the well should be located not less than 15 meters(50 feet) from likely sources of contamination.
2. **Lining:** Lining of the well should be build of bricks or stones set in cement up to depth of at least 6mts (20feet), so that water enters from the bottom of well and not from the sides.
3. **Parapet:** There should be parapet wall up to a height of at least 70-75cm (28 inches) above the ground.
4. **Platform:** There should be cement concrete platform round the well extending at least 1mtr (3 feet) in all direction. It should have gentle slope outwards towards a drain built along its edges
5. **Drain:** There should be pucca drain.
6. **Covering:** The top of well should be closed by cement concrete cover.
7. **Open:** Open wells are not considered sanitary well.
8. **Hand pump:** The well should be equipped with hand pump to lift water in a sanitary manner.
9. **Consumer responsibility**
10. **Quality:** It mainly determines physical, chemical, biological quality of water.

TUBE WELLS

They yield water which is bacteriologically safe and also cheap compare to other source.

SPRINGS

When ground water comes to the surface and flows freely under natural pressure it is called spring

2 types:

- ✓ Shallow spring
- ✓ Deep spring

Shallow spring : Dry up quickly during summer month.

Deep spring: Do not show seasonal fluctuation in the flow of water.

WATER POLLUTION

1. **Natural impurities:**

- ❑ Dust, dissolved gases: H_2, N2, CO_2, NH_3.
- ❑ Dissolved minerals such as salt of Calcium, Mg &Na.
- ❑ Microscopic plants & animals.
- ❑ Suspended impurities such as clay, mud sand etc.
- ❑ Pathogenic bacteria

2. **Acquired impurities :**

a) **Sewage:** it contains organic matter that absorbs oxygen and water, kills fish and produces offensive smell and develop water borne disease.

b) **Industrial waste :** the effluent from the industrial waste contains some toxic agent that is harmful to man.

c) **Agricultural :** Fertilizer, pesticide drained in some streams resulting in serious water pollution

d) **Physical pollution:** Heat (thermal) and radioactive substances.

Water Pollution Law: 1974.

Water (prevention and control of pollution) Act.

WATER RELATED DISEASES

Biological (waterborne disease)

1) Viral: Viral hepatitis-A, hepatitis-E, polio myelitis, diarrhoea in infants.

2) Bacterial: Typhoid and paratyphoid, dysentery, diarrhoea, cholera.

3) Protozoal: Amoebiasis, giardiasis.

4) Helminthic: Round worm, thread worm.

Chemical

1. **Dental health:** High levels of fluorides cause mottling of enamel.
2. **Cyanosis of infant:** High nitrate content of water is associated with anemia.
3. **Cardio-Vascular diseases**
4. **Some diseases are transmitted because of inadequate use of water like conjunctivitis, scabies, etc.**

HARDNESS OF WATER

Hardness may be defined as the destroying power of water. It is due to mainly 4 dissolved compounds

- **Ca bicarbonate, Mg bicarbonate**
- **Ca sulphate, Mg sulphate**

Presence any one of these compound produces hardness.

Chloride & Nitrates of Ca, Mg can also cause hardness but they occur generally in small amount.

- Hardness is classified as carbonate and noncarbonate

Carbonate hardness is also called temporary hardness is due to the presence of Ca and Mg bicarbonate.

The noncarbonate hardness is called permanent hardness is due to Ca and Mg sulphates, chloride and nitrates.

Disadvantage of hard water

- ✓ Hardness of water consumes more soap and detergents.
- ✓ When hard water is heated, the carbonate are precipitated and bring about furring or scaling of boilers. this leads to great fuel consumption, loss of efficiency and some time cause boiler explosion
- ✓ Hard water adversely affects cooking, food cooked in soft water retains its natural color and appearance.
- ✓ Fabrics washed with soap in hard water do not have a long life.
- ✓ In industrial process, hard water is unsuited and give rise to economic losses
- ✓ Hardness shortens the life of pipes and fixtures.

REMOVAL OF HARDNESS

a) Temporary hardness:

b) Boiling:

$$Ca(HCO3)2 \longrightarrow CaCO3+H20+CO2$$

c) **Addition of lime:**

$$Ca(OH)2+Ca(HCO3) \longrightarrow 2CaCO3+2H2O$$

d) Addition of sodium bicarbonate:

It removes both temporary and permanent hardness

$$Na2CO3+Ca(HCO3)2 \longrightarrow 2NaHCO3+CaCO3$$

$$CaSO4+Na2CO3 \longrightarrow CaCO3+Na2SO4$$

d) Permutit process/base exchange process

Na Permutit is a complex compound of Na, Aluminium and silica.

When hard water is passed through the permutit the calcium & magnesium ions are entirely removed by Base Exchange.

PURIFICATION OF WATER ON A LARGE SCALES

1. Storage:
2. Filtration:
3. Disinfection:

STORAGE

Stored in natural or artificial reservoirs.

a) **Physical change:** 90% of suspended impurities are settle down in 24 hrs by gravity.

b) **Chemical change:** Aerobic bacteria oxidizes the organic matter present in water.

c) **Biological change:** bacterial count decreases.

FILTRATION

Two types of filters are used

1. Slow sand or biological filters
2. Rapid sand or mechanical filters

SLOW SAND OR BIOLOGICAL FILTERS

a) Supernatant(raw)water: It is above the sand bed depth varies from 1 - 1.5 meter, here sedimentation , Oxidation ,particle agglomeration occurs.

2) Sand bed : most important part thickness of sand bed is 1meter. Filter sand, coarse sand, fine gravel, coarse gravel.

c. Vital layer: the surface of sand bed gets covered with slimy growth known as Schmutzdecke, vital layer , biologic layer. It is a heart of the slow sand filter.

d. Under drainage system: It consist of porous or perforated pipes which serve the dual purpose of providing an outlet for filtered water and support the filter media above.

Filter box: the 1st 3 elements (supernatant water, sand and under drainage system) are contained in the filter box. Rectangular in shape. 2.5 – 4m deep.

1. Supernatant water: 1-1.5m
2. Sand bed: 1.2m
3. Gravel support: 0.30m
4. Filter support: 0.16m

4. Filter control: Measurement of bed resistance is measured by venturi meter.(valves).

5. Filter cleaning: when the bed resistance increase to such an extent that the regulating valve has to kept fully open, it is time to clear the filter bed, since any further increase in résistance is bound to reduce the filtration rate.

ADVANTAGE OF SLOW SAND FILTER

- Simple to construct and operate
- Cost of the construction is cheaper than that of rapid sand filters
- Physical, chemical, bacteriological quality of filtered water is very high

RAPID SAND FILTERATION

Two types:

- Gravity type
- Pressure type

Steps:

1. **Coagulation:** Alum is added. The dose varies from 5-40mg or more per liter depending upon the turbidity, colour, temperature, pH value of water.
2. **Rapid mixing:** The treated water is then subjected to violent agitation in a mixing chamber for few minutes. Alum is mixed with water
3. **Flocculation:** The gentle slow stirring of treated flow in a flocculation chamber for about 30 mt, it consist of paddles which rotate at 2-4 rpm.This stirring results in the formation of a thick copious white flocculant precipitate of alluminium hydroxide. Thicker precipitate settle down.
4. **Sedimentation:** Water is now led into sedimentation tanks where it is detained for periods varying from 2-6 hours. sludge is removed time to time.
5. **Filtration:** The partly clarified water is now subjected to rapid sand filtration

FILTER BEDS: each unit of filter bed has a surface of about 80-90m2.sand is filtering media. Below the sand bed is a layer of graded gravel,30-40cm.The gravel supports the sand bed and permits the filtered water to move freely towards the underdrains. Underdrains at the bottom of filter beds collect the filtered water.

Filtration:

- As filtration proceeds, the “alum floc" not removed by sedimentation is held back on the sand bed.
- It forms slimmy layer same like zoogleal layer. it absorbs bacteria from water and effect purification.
- Oxidation of NH3 also takes place during the passage of water through the filter.
- Back washing : Rapid sand filters need frequent washing daily or weekly washing is accomplished the reversing the flow of water through sand bed ,which is called back washing

Adv of rapid sand filter;

- ✓ Rapid sand filters can deal with raw water directly , no preliminary storage is needed.
- ✓ The filter beds occupy less place
- ✓ Filtration is rapid 40 – 50 times that of slow sand filters.
- ✓ Washing of filter is easy

DISINFECTION

CHLORINATION

Properties;

1. Germicidal effect
2. It oxidizes iron, manganese ,hydrogen sulphide
3. It destroys some taste and odour
4. It controls and slime organisms and aids in coagulation

ACTION OF CHLORINE

- $H_2O+Cl_2 \longrightarrow HCl+HOCl$
- $HOCl \longrightarrow H+OCl$

Disinfecting action of chlorine is mainly due to hypochlorous acid and to a small extent due to hypochlorite ions

PRINCIPLES OF CHLORINATION

- ❖ Water to be chlorinated should be clear and free from turbidity.
- ❖ Cl2 demand of water is estimated.
- ❖ Contact period
- ❖ The minimum recommended conc. Of free Cl2 is 0.5/L for 1 hour
- ❖ The some of the Cl2 demand of the specific water plus the free residual Cl2 of 0.5mg/L constitutes the correct dose of Cl2 to be applied

METHOD OF CHLORINATION

1. Chlorine gas: Special equipment – "chlorinating equipment" is required, Paterson's chloronome is one device.

2. Chloramine: Loose compound of chlorine and NH3

3. Perchloron (high test hypochlorite) it is a Calcium compound

- Break point chlorination
- Super chlorination
- Orthotolidine(OT)test
- Orthotolidine arsenite(OTA)test

Other agents:

Ozonation: removes undesirable odour color,& taste.

UV radiation: germicidal property.

PURIFICATION OF WATER ON A SMALL SCALE

1. Household purification of water: Boiling:
2. Chemical disinfection: 1.bleaching powder/chlorinated lime-$CaOCl_2$
3. Chlorine solution
4. High test hypochlorite/perchloron chlorine tablets: ex: halazone tablets
5. Iodine: 2 drops of 2% ethanol solution of iodine is sufficient for 1 liter.
6. Filtration: Berkfeld filter.

2. Disinfection of wells: steps

a) Find the volume of water in a well

$$\frac{3.14 \times d^2 \times h}{4} \times 1000$$

h=depth of water column in meter

d= diameter of well in meter

b) Find the amount of bleaching powder required for disinfection

c) Dissolve bleaching powder in water

d) Delivery of chlorine solution into the well.

e) Contact period

f) Orthotolide arsenite test

DOUBLE POT METHOD

It is devised by National Environmental Engineering Research Institute, Nagpur. India.