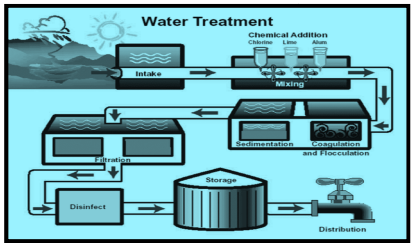
29A. FRESH WATER RESOURCES

- Fresh water is water that has no salt and that we can drink. About 2.7 % (approx. 3%) of the total water available on this earth.
- Nearly all of this fresh water is locked in the masses of ice caps, glaciers and clouds.
- The remaining small fraction of fresh water has accumulated over centuries in the lakes and underground sources. About 97.3% of this water is in the oceans.
- A small amount of the total global precipitation falls on the land which fills up the lakes and wells, and keeps the river flowing.
- **Water Resource Distribution in India**
  - The annual rainfall over India is 1170 mm. From precipitation alone, India receives 4000 billion cubic meters (BCM), including snow fall. Of this ¾ part occurs only during the monsoon
  - A good part of water is lost through the process of evaporation and plant transpiration, leaving only half of it on the land for us to use.
  - Due to topographical, hydrological and other constraints, about 700 BCM of surface water can be put to beneficial use.
- River, lakes and Ground water are three main sources of fresh water in our country.

- **Rivers**
  - Are characterized by unidirectional current with a relatively high, average flow ranging from 0.1 to 1 m/s.
  - Flow is highly variable with time depending on climatic situation and the drainage pattern.
- **Lakes**
  - Are characterized by low average current velocity of 0.001 to 0.01m/s (surface value).
  - Current within lakes are multidirectional.
  - Many lakes have alternating period of stratification and vertical mixing; periodicity of which is regulated by the climatic conditions and depth of the lake.
- **Ground water**
  - have a steady flow pattern in terms of direction and velocity. The average flow velocities
  - the groundwater dynamics can be commonly found in aquifers (groundwater reservoirs) range from 10^{-10} to 10^{-3} m/s and are largely governed by the porosity and the permeability of the geological material.
  - Mixing is rather poor highly diverse.
- **Water Collection**
  - Water is collected and distributed for various uses, like domestic, industrial and for irrigation purposes.
  - Drinking water, also known as potable water is either directly collected from sources as in most of our rural areas or supplied by municipal authorities or public health departments.
  - The surface water generally requires treatment before supply for drinking as they are often contaminated.
  - Ground water is usually free of microbes and suspended solids because of natural filtration as the water moves through soil, though it often contains relatively high concentrations of dissolved minerals from its direct contact with soil and rock.

- Cities and towns located along the rivers and lakes directly draw water from them and supply for domestic use after treatment.
- Cities located away from any surface water sources transport it though canals or pipelines.

- **Water Treatment**
  - Water in river or lakes has to be treated or purified before it is supplied for human consumption.
  - Groundwater has to be free of harmful microorganisms and chemicals to protect the health of community.
  - The water should be crystal clear, with almost no turbidity, and it should be free of objectionable colour, odour, and taste.
  - Water should not be corrosive for domestic supplies.
  - Industrial requirements may be even more stringent; many industries provide special treatment in their own premises.
  - Surface water usually needs more extensive treatment than ground water, because most streams, rivers and lakes are polluted to varying extent.

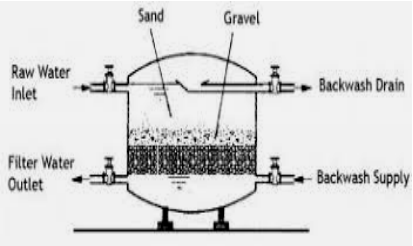


- **Methods of Water Treatment**
  - Water is treated by a variety of physical and chemical methods.
  - Treatment of surface water begins with intake screens to prevent fish and debris from entering the treatment plant.
  - Conventional treatment of water primarily involves **clarification and disinfection**.
  - Clarification removes most of the turbidity, making water crystal clear.
  - Disinfection is the final step in the treatment of drinking water, destroys pathogenic microbes.
  - Desalination processes i.e. removal of excess salt from water are used in areas where fresh water supplies are not readily available or the ground water is saline.

(a) Clarification or sedimentation

Impurities either dissolved or suspended in water. It reduces clarity, and the easiest way to remove it is to let suspended particles settle. It involves the various methods: Coagulation and flocculation

- **Coagulation and flocculation**
  - Large, heavy particles settle out readily, but smaller and lighter particles do not settle easily. These light particles are called colloidal particles. To remove these particles, alum is added.
  - Alum (Aluminum sulphate) causes flocculation.
  - Flocculation is a process through which all the finer insoluble particles form large particles called flocs, which settles down and are removed from water
  - Alum, ferric sulphate or Sodium Aluminate, are the common coagulant used for water purification.
  - After flocculation the flocs are allowed to settle in a settling tank. From here the supernatant is passed through sand filters.
  - Microstrainers are used mainly to remove algae from surface water supplies before conventional gravity-flow filtration.
  - Filtration is a physical process that removes the impurities that remain after coagulation, the water is percolated downward through a layer or bed of porous, granular material such as sand.



➢ Clean water is forced upward through the media, expanding the filter bed slightly and carrying away the impurities in wash troughs.

(b) Disinfection

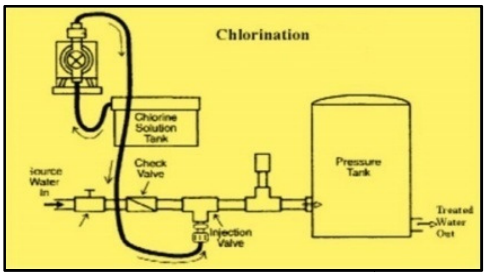
➢ Disinfection destroys pathogenic bacteria and is essential to prevent the spread of water borne disease.

➢ The final process in drinking water treatment, it is accomplished by applying either chlorine, ozone or ultraviolet radiation to clarified water

- Chlorination

➢ Chlorine or chlorine compounds to drinking water is called chlorination.

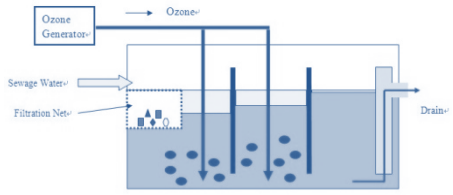
➢ Liquid sodium hypochlorite or calcium in tablet or granular form, or direct application of gaseous chlorine is used.



- **Ozone**

Ozone has the advantage of not causing taste or odour problems. It also leaves no residue in the disinfected water.

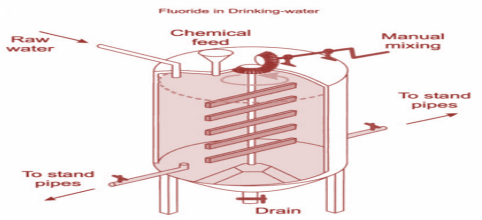
The lack of an ozone residue, however, makes it difficult to monitor its continued effectiveness as water flows through the distribution system.



- **Traditional Methods of Water Treatment**
  - ➢ Sanskrit writings from as early as 2000 BC tell how to purify foul water by boiling and filtering.
  - ➢ German bacteriologist Robert Koch proved the germ theory of disease, establishing a scientific basis for the treatment and disinfection of drinking water.
- **Other Methods of Water Purification**

Sometimes natural contaminants like fluorides, iron or arsenic are present in water. These impurities are harmful to human health.

- **Fluorides**
  - ➢ Bureau of Indian Standards prescribes 1.0 mg/l as desirable and 1.5 mg/l as maximum permissible limit for drinking water.
  - ➢ Water with high level of fluoride needs to be treated. Alum is used for removal of flourine.
  - ➢ Normally 100 to 600 ml of alum solution is required to be added in 40 litres of water containing fluoride ranging from 2 to 9 mg/l in order to remove it to acceptable level.
- **Removal of fluoride**
  - ➢ Fluoride is generally present in all natural water. Its concentration up to certain level is not harmful. Beyond that level, the bones start disintegrating. This disease is called fluorosis



- **Defluorodation at Community Level**
  - ➢ The community used technique for community water supply is called Nalgonda Technique developed by National Environmental Engineering Research Institute (NEERI), Nagpur.
- **Iron**
  - ➢ Problem is in North-East regions. Iron causes bad taste and odour to the drinking water. Desirable limit for iron is 0.3 mg/l. Removal of iron is essential.

- **At domestic level**
  - Aeration of raw water over a series of coke, marble/calcite bed followed by slow sand filtration. No chemical is required for treatment. Upto 200 l/hr of water can be treated. (By NEERI).
- **At Community Level**
  - The main part of the treatment plant is a vertical cylindrical vessel having following chambers:
    1. aeration-cum-oxidation chamber.
    2. settling-cum-filtration chamber.
    3. final collection chamber for treated water.
- **Arsenic**
  - Arsenic is found in ground water in some parts of West Bengal. Arsenic is highly toxic in nature
  - According to Bureau of Indian Standards desirable limit for arsenic as 0.05 mg/l.
  - It is removed from water by oxidation, coagulation, flocculation, sedimentation and filtration. Bleaching powder and alum are used for removal of arsenic. Arsenic in water causes a number of skin disorders or even cancer.
- **Concept of Water Quality**
  - Water is the best solvent available on earth, and is seldom found in pure state.
  - Water in nature is pure in vapour state and acquire impurities at the time of condensation.
  - In hydrological cycle, water comes in contact with atmosphere, soil and other materials lying on land and also the minerals underground. Due to which water acquires impurities.
  - Other contaminants impurities in the form of industrial, domestic wastes and agriculture chemicals contributed by human activities.
  - In India, the Central Pollution Control Board (CPCB), an apex body in the field of water quality management, has developed a concept of "designated best use".
  - Water body is put to the use which is highest quality of water is called its "designated best use", and accordingly the water body is designated as A, B, C, D, E.
- **Classification of Surface Waters in India**
  - This classification helps the water quality managers and planners to set water quality targets and identify needs and priority for water quality restoration programmes for various water bodies in the country.
  - Table shows use based classification of surface waters in India

Designated best use	**Quality class**
Drinking water source without conventional treatment, but with chlorination	A
Outdoor bathing (organized)	B
Drinking water source with conventional treatment	C
Propagation of wildlife and fisheries	D
Irrigation, industrial cooling and controlled waste disposal	E

- **Water Quality Requirement for Different Uses**
- The main uses of water are public supply, outdoor bathing and recreation, fisheries and wildlife propagation, irrigation and other agricultural uses, cooling in power plants, navigation and disposal of wastes.
- Drinking water needs highest purity of water, whereas disposal of wastes can be done with any quality of water.
- **Ecological Water Requirements**
  - Ecological quality maintenance often requires significant amount of water to flow in a river.
  - Flood flows flush out spawning areas, leaving clean new gravels, sand washed out of the hills. Controlling flows by dams prevents both cleaning and renewal.
  - High flow rates sweep debris from river channels and wash down new gravels and sand needed for spawning of many fish.
  - Dilution was considered to be an acceptable "solution to pollution" and self-purifying capacity of a stream.

- Reduced flow followed by increased waste load have rendered many rivers almost ecologically dead. Thus, special attention is required in water resource planning.

- **Major Water Quality Issues Of India**
  (a) Water scarcity
  (b) Pathogenic pollution
  (c) Oxygen depletion
  (d) Eutrophication
  (e) Salinity
  (f) Toxic pollution

- **Water Use in India**
  The uses of water in India are divided into two categories i.e. abstractive uses and in stream uses.

Abstractive Use	**In-stream use**
(a) Domestic Water Supply The cities located along the water bodies use the water for drinking and other domestic purpose after conventional treatment. **(b) Irrigation** Nearly 84% of the water is used only for irrigation as it is the most important use of water in India **(c) Industrial use** A large amount of water is used for industrial purpose. As per the estimation of CPCB about 30 BCM per annum is used as cooling water in thermal power plants.	**(a) Hydro-power** The total potential for hydropower (energy from water) development in India has been estimated at 84,000 MW at 60% load factor. **(b) Fisheries** Indian water resources are extensively utilized for fish production throughout the country.. **(c) Navigation** The inland waterways traffic constitutes only a very small part of total transport network in the country which is dominated by rail and road transport. **(d) Community Bathing and Washing** There are several human activities which have indirect and undesirable, effects on water quality. The uncontrolled and excessive use of fertilizers and pesticides has long-term effects on ground and surface water resources.

Check Yourself

1. The most common coagulant used for water purification is:
   a. Alum
   b. Sodium hypochlorite
   c. Ozone
   d. Cadmium
2. The process by which suspended particles can easily settle or filter out by adding alum is known as:
   a. Sedimentation
   b. Filtration
   c. Decantation
   d. Flocculation
3. The desirable limit for arsenic in drinking water is:
   a. 0.3 mg/l
   b. .05mg/l
   c. 0.5mg/l
   d. 1.0 mg/l
4. Name the scientist who proved germ theory of disease i.e. established the treatment and disinfection of drinking water.
   a. Alexander Fleming
   b. Robert Hooke
   c. Robert Koch
   d. Robert Edwin Peary
5. In ancient time, water was purified by ------- method.
   a. boiling and filtration
   b. adding alum
   c. adding chloride
   d. sand infiltration

Ans: 1. a 2. d 3. b 4.c 5. a

Stretch Yourself

1. Name any four fresh water resources.
2. What does BCM stand for?
3. What is the main use of microstrainer?
4. Which institute has developed Nalgonda Technique?
5. List major water quality issues in India.

Test Yourself

1. Describe the water resource distribution in India
2. Discuss two methods of water treatment
3. How do removal of fluorine done at community level.
4. Explain the concept of ways quality issue in India.
5. Mention abrasive and in-use of water in India.