Q1. Define desalination and briefly describe various desalination methods? Which method is more effective, please elaborate briefly?

A: Definition:

It is defined as the process of removing salts and other minerals from saline water to render it suitable for drinking, irrigation and industrial use.

It is known that less than 3% of earth water is fresh and the rest water is seawater and is not fit for drinking. Out of this 3%, 2% of water is frozen and locked up at Antarctica, Artic and Glaciers and is not in human use so only 1% of water is available for human and ecosystem fresh water need. So the saline water in sea is needed for desalination so as to cater the demand for fresh water. Sea water has the salinity level ranges from 1000-35000 PPM, desalination is carried out accordingly considering the

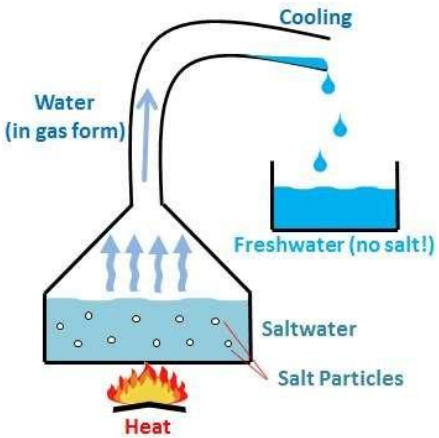
1. Demand for fresh water (domestic, industry and agriculture)
2. Lack of conventional water sources like springs, underground water etc.
3. Availability of salt water.
4. Availability of infrastructure.
5. Interest for financing**.**

Principal Methods for Desalination:

Following are the methods of Desalination:

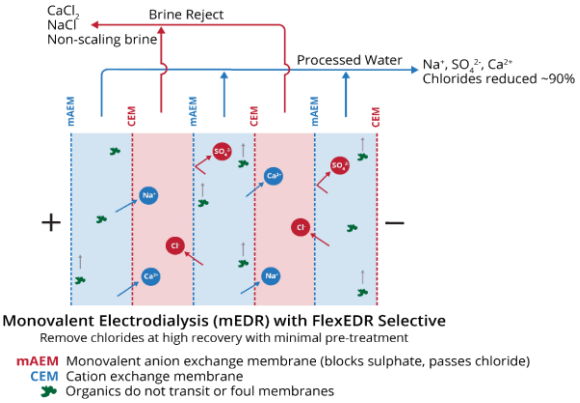
1. **Distillation 2. Electro dialysis 3. Freezing 4. Reverse Osmosis.**

1. **Distillation:**
   In this process of desalination, salt water is heated in a container to make the water evaporate leaving the salt in container. The water vapor is then condensed to form water in a separate container. This process is known from long time. Application of this method is limited as it is costly because of high fuel cost that occurs inn burning the water to evaporate.



2. Elect dialysis:

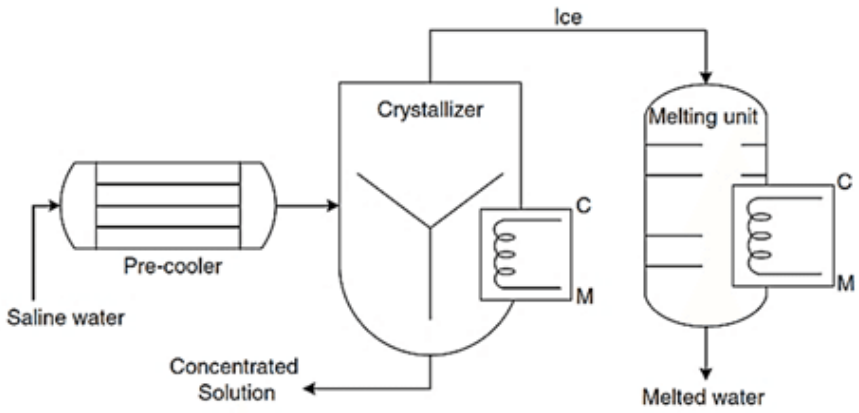
In this process a membrane is utilized and sends an electric charge through the solution to draw metal ions to positive plate on one side and salt ions to negative plate on other side. Thus water becomes clear when the negative salt ions get separates from the water.



3. Freezing Method:

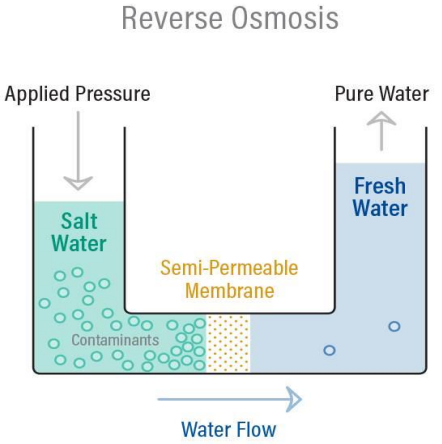
It is natural phenomenon that whenever water gets freezes, crystalizes to ice, excludes salts. So by making the saline water freezes to ice one can remove the salts. This process includes the following steps:

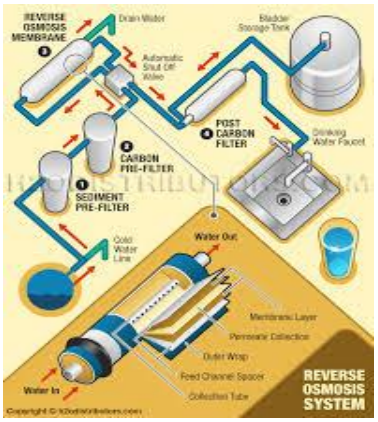
- Formation of ice
- Washing ice to drain the salts.
- Melting the ice to obtain water followed by containments removal.



4. Reverse Osmosis:

It is abbreviated as **RO,** it is a water purification method. The process involved using of semi-permeable membrane to remove ions, molecules and larger particles from saline water. It can remove many type of dissolved and suspended species from water including bacteria. It is used in industries as well as production of potable drinking water. It significantly reduces salts and other impurities resulting in high quality and greater taste.





Steps involved in Reverse Osmosis:

Step 1. Removal of suspended particles/Sediments from water by using 5-micron filter.

Step 2. Removal of Chlorine and other harmful material is filtered by means of carbon filter.

Step 3. Removal of contaminants by passing through more dense carbon filter.

Step 4. Removal of heavy metals by passing the water through semi permeable membrane.

Step 5. Removal of Bacteria, chlorine, and bad odor is removed and pure water is obtained.

Effective Method of Desalination:

As discussed above, most effective method is reverse osmosis as tt can remove many type of dissolved and suspended species from water including bacteria. It is used in industries as well as production of potable drinking water. It significantly reduces salts and other impurities resulting in high quality and greater taste. Hence RO process is most significant process of desalination.

Q2 Briefly describe merits and demerits of 4 types of water distribution layouts? Which layout will you recommend for newly proposed township in hilly area? Support your answer with justification?

Water Distribution Layout:

Water distribution is a network of pipeline supply water to community for their use. Water distribution network is decided so that water can easily reach to door step of the users. This is done by layout of the pipe network. The network of pipeline or layout of distribution system is generally of 04 types:

1. Dead End System
2. Radial System
3. Grid Iron System
4. Ring System

1. Dead End System:

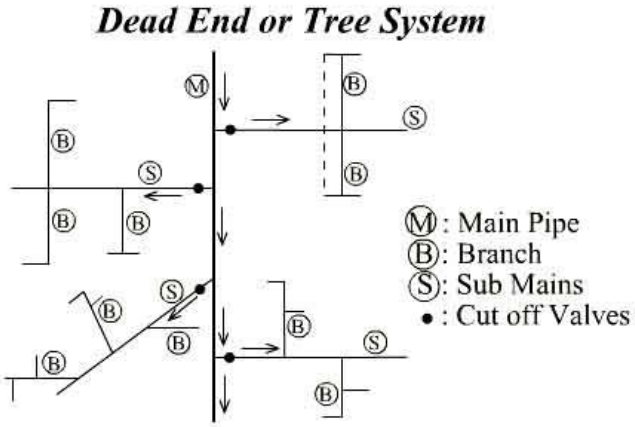
This system is also called Tree system. The branches are not even and spreads almost irregular like tree branches. It is suitable for old towns and cities having no definite pattern of roads.

Advantages:

1. Relatively cheap
2. Simple to design and build.
3. Determination of discharges and pressure easier due to less number of valves

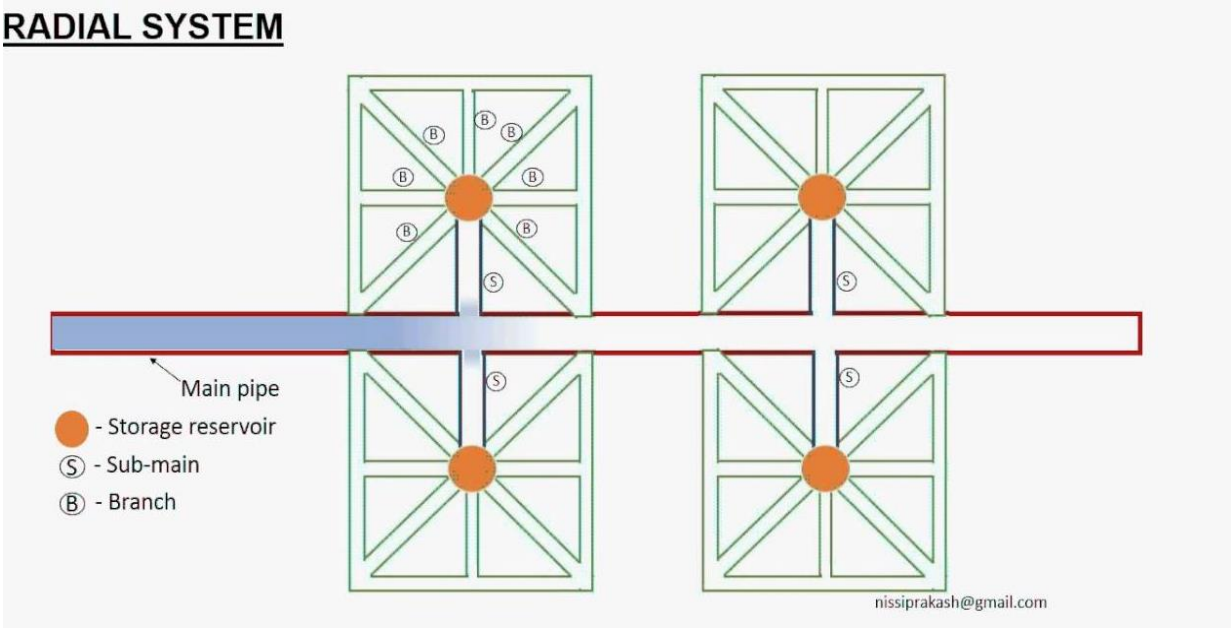
Disadvantage:

1. Due to many dead ends, stagnation of water occurs in pipes.
2. When repair have to be made at any part of the system, large portion of the community may be struggled.



2. Radial System:

The area is divided into different zones. The water is pumped into the distribution reservoir kept in the middle of each zone. The supply pipes are laid radially ending towards the periphery.



Advantages:

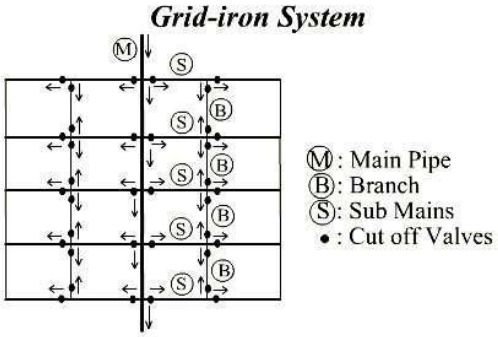
1. It gives quick service.
2. Stagnation does not occur.

Disadvantages:

Exact calculation of pipe size is not possible due to valves.

3. Grid-Iron System:

It is suitable for cities with rectangular layout, where the water mains and branches are laid in rectangles



Advantages:

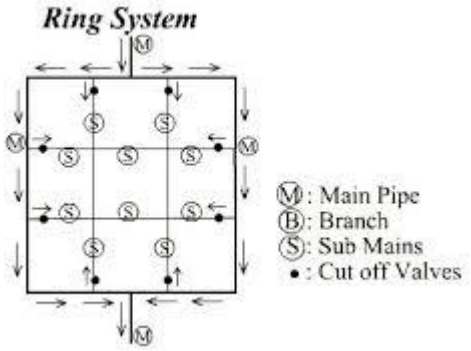
1. Water is kept in good circulation due to the absence of dead ends.
2. In the cases of a breakdown in some section, water is available from some other direction.

Disadvantage:

1. Proper designing is relatively difficult.

4. **Ring System:**

The supply main is laid all along the peripheral roads and sub mains branch out from the mains. This system also follows the grid iron system with the flow pattern similar in character to that of dead end system. So, determination of the size of pipes is easy.



Advantage:

Water can be supplied to any point from at least two directions.

Layout recommend for newly proposed township in hilly area:

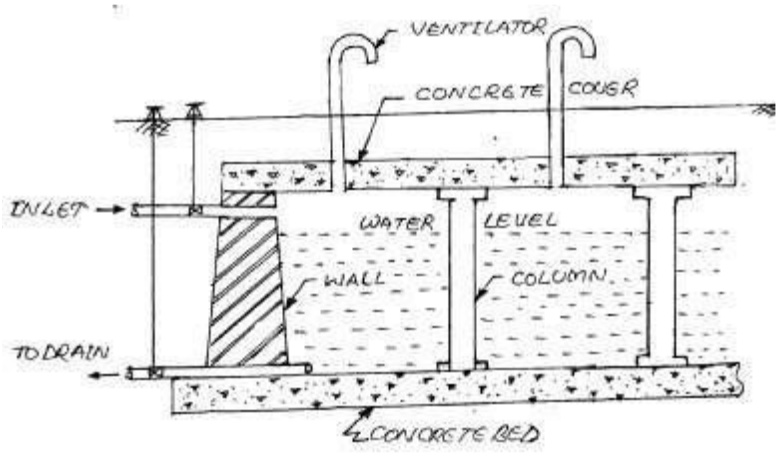
The recommended layouts of water distribution networks for hilly area newly proposed township is **Tree or dead end systems**. The tree system proposed comprises of a trunk line to which are joined mains that are connected to sub-mains. The sub - mains further branch out to become laterals which are further reduced in size to branches. The advantages of this system are ease of calculating pipe systems, use of comparatively small sized pipes and use of fewer fittings. Suitable for rural area or where minimum residual pressure is required. The disadvantage is disruption of water supply beyond a repair point. For rural water supply systems the tree or dead end system is widely used.

Q3. What are different types of reservoirs used in water supply systems? Briefly describe its importance and how its storage capacity be calculated?

Distribution Reservoirs:

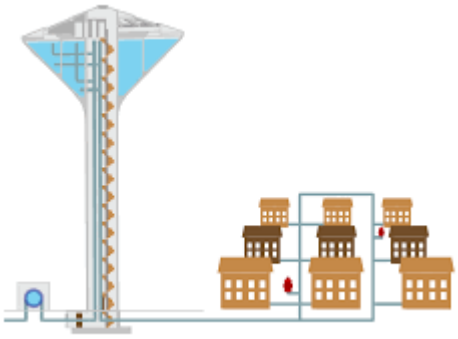
It is an important component of water supply scheme. Distribution reservoirs, also called service reservoirs, are the storage reservoirs, which store water for distributing during emergencies (such as during fires, repairs, peak demand etc.) and also to help in absorbing the hourly fluctuations in the normal water demand.
It should be located as close as possible to the center of demand. Water level in the reservoir must be at a sufficient elevation to permit gravity flow at an adequate pressure.
There are two types of storage reservoirs depending upon the elevation:

1. Surface Reservoir:
These are also ground reservoir. These are constructed on hills or elevated portion of ground to maintain required head. The head is achieved due to difference in ground level. Mostly circular in shape or rectangular. It is preferred where large diameter reservoirs are required. It is usually made of stones, bricks or concrete. The side walls are designed to take up the pressure of the water, when the reservoir is full and the earth pressure when it is empty. The position of ground water table is also considered while designing these reservoirs. The floors of these reservoirs may be constructed with R.C.C slab or stone blocks with sufficient water proofing. To obtain water tightness bitumen compounds are used at all construction joints. For aeration of water and inspection, manholes, ventilation pipes and stairs are provided.



2. Elevated Storage Reservoir:

Elevated Storage Reservoirs (ESRs) also referred to as Overhead Tanks are required at distribution areas which are not governed and controlled by the gravity system of distribution. These are rectangular or circular in shape. If the topography of the town is not suitable for gravity system, the elevated tank or reservoir are used to provide sufficient pressure head. They are constructed where combine gravity and pumping system of water distribution is adopted.



Storage Capacity of Water Reservoir:

Water reservoir storage capacity is the summation of balancing storage, breakdown storage and fire storage.

1. Balancing Storage:
   The quantity of water required to be stored in the reservoir for equalizing or balancing fluctuating demand against constant supply is known as the balancing storage (or equalizing or operating storage).
2. The breakdown storage:
   It is often called emergency storage is the storage preserved in order to tide over the emergencies posed by the failure of pumps, electricity, or any other mechanism driving the pumps. A value of about 25% of the total storage capacity of reservoirs, or 1.5 to 2 times of the average hourly supply, may be considered as enough provision for accounting this storage.
3. The third component of the total reservoir storage is the fire storage. This provision takes care of the requirements of water for extinguishing fires. Fire demand maybe calculated by the given formulas. The total reservoir storage can finally be worked out by adding all the three storages.

$$Q_F = 65\sqrt{P}(1-0.01\sqrt{P})$$

Q_F = fire demand l/s
P = population in thousands

$$Q_F = 53\sqrt{P}$$

Q_F = fire demand l/s
P = population in thousands

$$Q_F = 320 * C\sqrt{A}$$

Q_F = fire demand flow m^3/d
A = areas of all stories of the building under consideration (m^2)
C = constant depending on the type of construction;

Q4. Why pumps are used in water supply schemes and how to calculate pump curve to meet water demand?

Water Pumps/Water Pumping:

For efficient distribution system, adequate water pressure is required depending upon the need at various points / locations in the distribution system. Depending upon the level of source, topography of the area and other local conditions, water may be supplied into distribution network by either of the following system:

1. Gravity system
2. Pumping system
3. Combined gravity and pumping

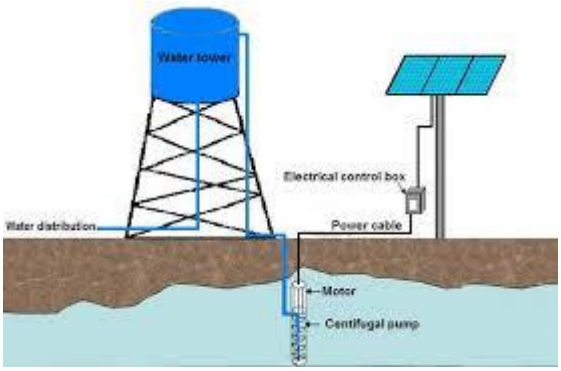
Pumping system:

Water pumps are used in water supply schemes. Water pumping is concerned with:

1. Lifting of water from source to storage.
2. Forcing water through water treatment faculties
3. Forcing water through transmission and distribution facilities.

In pumping system water is directly pumped from the source into the distribution main without storing. Water source may be surface source or ground water source. Also called pumping without storage system. Depending upon the demand, high lift pumps are required. Pressure in the distribution system reduces along the length of flow and depends on area topography as well.

If power supply fails, complete stoppage of water supply occurs. Operational cost of this system is much higher than gravity system. This system is suitable in areas where high residual pressure and continuous flow is demanded. Normally electricity or solar energy is used for pumping.



Pump curve:

A **pump curve** denotes flow on the x-axis (horizontal) and head pressure on the y-axis (vertical). The **curve** begins at the point of zero flow, or shutoff head, and gradually descends until it reaches the **pump** run out point or maximum flow rate.

A pump curve shows the performance characteristics of a particular pump. Some pump manufacturers use charts rather than curves, the idea is the same, curves just tend to be more flexible to use. Pump curves are created by the pump manufacturer based on test results of the

various pump models the manufacturer produces. The pump manufacturer should be able to provide you with performance curves for the pumps you are considering. Remember, there is always an inverse relationship between pressure and flow. Higher pressures mean lower flows. Lower pressures result in higher flows. Sample pump curve is shown below:

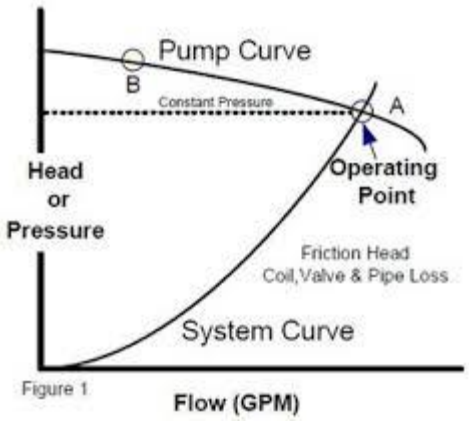
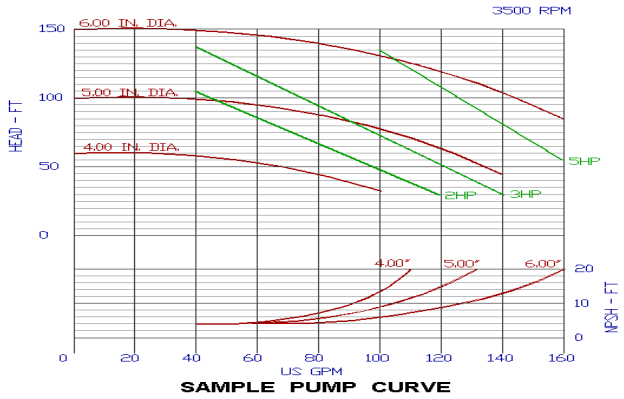


Figure 1



Using the Curves:

Notice the red color curved lines in sample pump cuve (the top one in the pump curve above is labeled “6.00 IN. DIA.”). These represent the various impeller sizes. Now notice the green color straight lines which intersect the impeller curves (the top one in the pump curve above is labeled 5 HP). These lines represent the motor horsepower ratings available for this pump. Together the impeller curves and horsepower lines represent the best performance the pump is capable of if that horsepower or impeller size is selected. Some pump curves do not have horsepower lines, and some pump curves combine the horsepower and impeller lines into one single line. This is usually because the pump only is available with one motor, so you don’t get to select the horsepower. The pump may also only come with one size of impeller, so you will only see a single line on the entire pump curve!

To use the curves you select the pressure you want on the left and then move horizontally across the chart to the vertical line that corresponds with the flow (GPM) that you want. You then select an impeller size curve and horsepower line that are **above** this point to determine the impeller size and horsepower you will need for your pump.