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Subject: Water Demand supply and Distribution

Q.No.1

## Desalination:

Desalination is the process of removing salts and other minerals from the saline water to render it suitable for drinking, irrigation, or industrial uses.

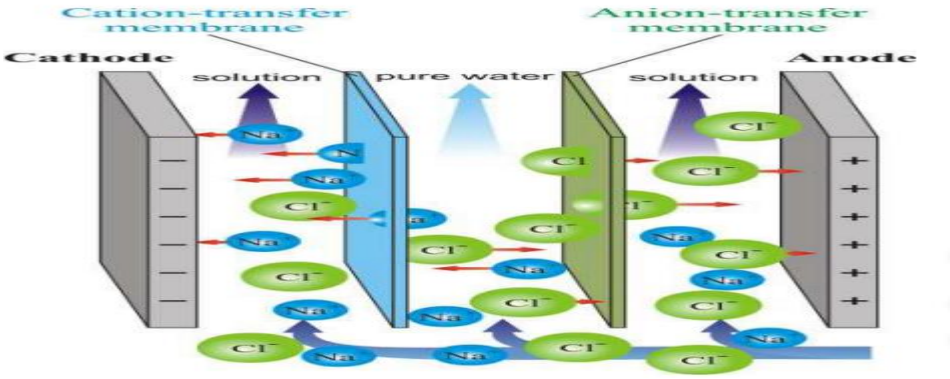
Various Desalination Methods:

1) Distillation (Evaporation)
2) Electro dialysis
3) Freezing
4) Reverse osmosis

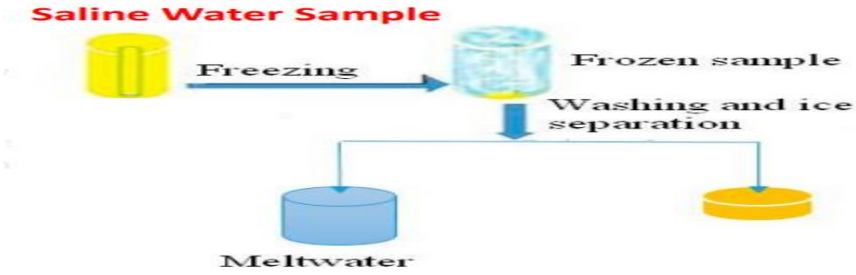
Now discussing the above mentioned methods in detail:

1) Distillation (Evaporation) :
   - Salt water is heated in one container to make the water evaporate, leaving the salt behind.
   - The desalinated vapor is then condensed to form water in a separate container.
   - Although long known, it has found limited applications in water supply because of the fuel costs involved in converting salt water to vapor is very high.


2) Electro dialysis:
   - Electro dialysis utilizes a membrane, and sends an electric charge through the solution
   - It draws metal ions to the positive plate on one side, and other ions (like salt) to the negative plate on the other side.




3) Freezing:
   - It is based on the principle that water excludes salts when it crystallizes to ice.
   - It involves three steps: Ice formation, ice washing, and ice melting to obtain fresh water with subsequent removal of contaminants.




4) Reverse Osmosis:
   - Reverse osmosis (RO) is a water purification technology / method that use a semi-permeable membrane to remove ions, molecules, and larger particles from saline water.
   - Reverse osmosis can remove many types of dissolved and suspended species from water, including bacteria, and is used in both industrial processes and the production of potable water.
   - It significantly decreases the salts and other potential impurities in the water, resulting in a high quality and great-tasting water.

Various Steps Involved in Reverse osmosis:

1st Step:
   - Removal of sediments from the water. In this step all the sediments like clay, silt and stones are removed from the water.
   - For this, a 5-micron filter is used. The sediments are filtered in order to make sure that no damage is done to the membrane.
   - The micron filter does not let these particles pass by and thus they are suspended.

2nd Step:

- In the second step carbon filter is used to remove the chlorine and other harmful chemicals that enter the water sources.
- These chemicals are harmful to human health and thus it is necessary to remove them.

3rd Step:

- The third step focuses on passing the water from a dense and compacted carbon filter. Most of the contaminants are removed here.

4th Step:

- Water passes through the membrane and all the heavy metals present in the water are removed.
- Along with the metals, radioactive metals too are removed. In this step, the impurities are drained out of the reverse osmosis system and clean water is separated.

5th Step:

- in this last stage, the bacteria, chlorine, and bad odour are removed from water. After water passes from this stage, it comes out of the faucet and is perfect for consumption.
- This step involves tertiary treatment or polishing.

Distillation desalination is one of mankind's earliest forms of water treatment, and it is still a popular treatment solution throughout the world today. In ancient times, many civilizations used this process on their ships to convert sea water into drinking water. Today, desalination plants are used to convert sea water to drinking water on ships and in many arid regions of the world, and to treat water in other areas that is fouled by natural and unnatural contaminants. Distillation is perhaps the one water treatment technology that most completely reduces the widest range of drinking water contaminants.

## Q.No.2

- Water Supply System is concerned with extraction / provision, treatment and supply of water for municipal, industrial and / or irrigation purposes.
- The distribution pipes are generally laid below the road pavements, and as such their layouts generally follow the layouts of roads.
- There are in general four different types of pipe networks; any one of which either single or in combination, can be used for a particular place.

### Merits and demerits of four layout distribution systems:

The Four Layout Distribution system Includes:

### Dead End System:

It is suitable for old towns and cities having no definite pattern of roads.

### Merits:

- Relatively cheap.
- Determination of discharges and pressure easier due to less number of valves.
- Pipes in this network can be laid easily.
- The pressure and discharge in each pipe can be determined very easily and accurately which makes design calculations very simple.
- The diameters of pipes of main, sub mains and branches can be designed based on the required demand of population. So, cost of the project can be reduced.
- Dead end system requires less number of cutoff valves.

### Demerits:

- Due to many dead ends, stagnation of water occurs in pipes.
- The pressure is not constant and is very less at remote parts.
- Because of dead ends water stagnation takes place which results in deposition of sediment. To remove these sediments, more number of scour valves is to be provided at the dead ends which increase economy.

- If there is any damage occurs in the branch line, the whole portion should be stopped to repair that which creates discomfort to the other users in that sub main line.
- In this system, Limited discharge is available for firefighting.

## 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.

## Merits:

- It gives quick service.
- Stagnation does not occur.

## Demerits:

- Cost of the project is more because of number of individual distribution reservoirs.

## Grid Iron System:

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

## Merits:

- Water is kept in good circulation due to the absence of dead ends.
- In the cases of a breakdown in some section, water is available from some other direction.
- Water will flow continuously without any dead ends or sediment deposits.
- Head loss is minimum in this case because of interconnection of pipes.
- The discharge will meet the required discharge for firefighting.
- Repair works can be easily done just by closing cutoff valve in that line which do not affect the other users.

## Demerits:

- Proper designing is relatively difficult.
- Because of circulating flow from all directions, the pipes used in this system should be of large diameters and longer lengths.

- We cannot determine the accurate discharge, velocity or pressure in a particular pipe. So, design is difficult.
- Laying of pipes will be done by skilled workers which consume more cost.
- Cutoff valves required should be more in this system.

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.

Merits:

- Water can be supplied to any point from at least two directions.
- No stagnation of water
- Repair works can be done without affecting larger network.
- Large quantity of water is available for firefighting.

Demerits:

- Longer length and large diameter pipes are required.
- More number of cutoff valves are necessary.
- Skilled workers are necessary while laying pipes.

The layout recommended for hilly areas is dead end system. Because we have read in dead end system that is suitable for areas having unplanned structure, no definite pattern of roads. So Dead End system is suitable for hilly areas.

## Q.No.3

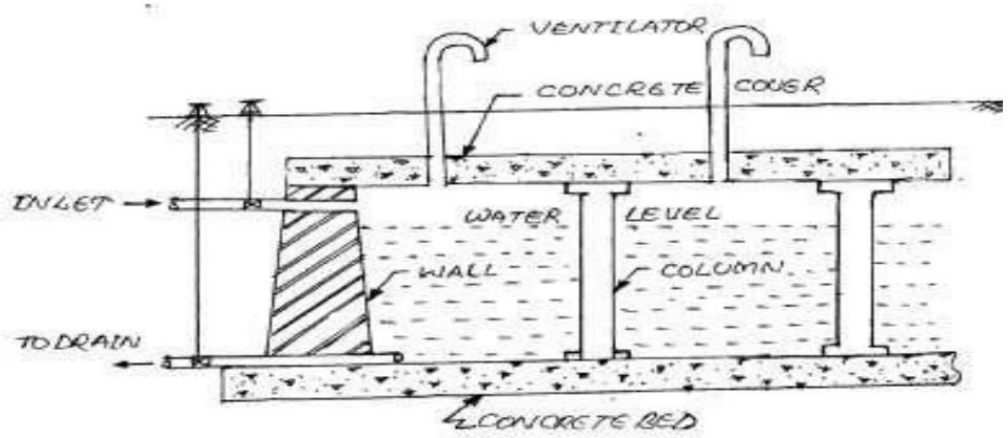
- Distribution reservoirs, also called service reservoirs, are the storage reservoirs, which store water for distributing during emergencies (such as during fires, repairs, peak demand etc.) and also to help in absorbing the hourly fluctuations in the normal water demand.

- 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.

## Types of reservoirs:

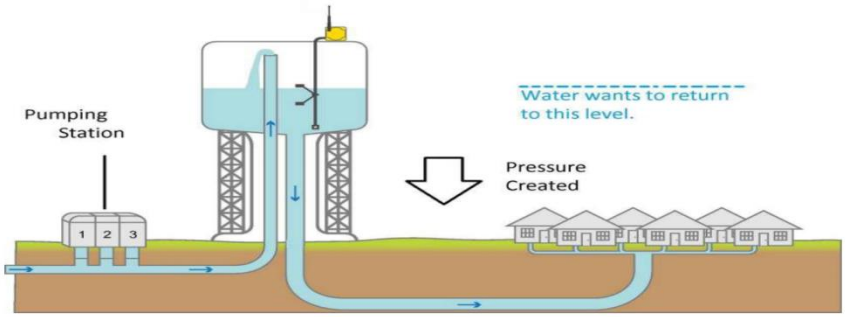
Depending upon their elevation w.r.t ground it may be classified into:

1. Surface reservoirs:
    - These are also called ground reservoir.
    - Mostly circular or rectangular tank.
    - Underground reservoirs are preferred especially when the size is large.
    - In case of gravity system, underground reservoirs are generally constructed on high natural grounds and are usually made of stones, bricks, plain or reinforced cement 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 reservoirs:
    - 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 Reservoirs:

The total storage capacity of a distribution reservoir is the summation of:

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. Breakdown Storage:

   The breakdown storage or 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. Fire Storage:

   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:

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

$Q_F$ = 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;

The total reservoir storage can finally be worked out by adding all the three storages.

The importance of reservoirs in water supply system are:

1) Overhead Tanks are required at distribution areas which are not governed and controlled by the gravity system of distribution.
2) We have storage of water when some problem comes in.
3) We have storage of water when there is a breakage of electricity.

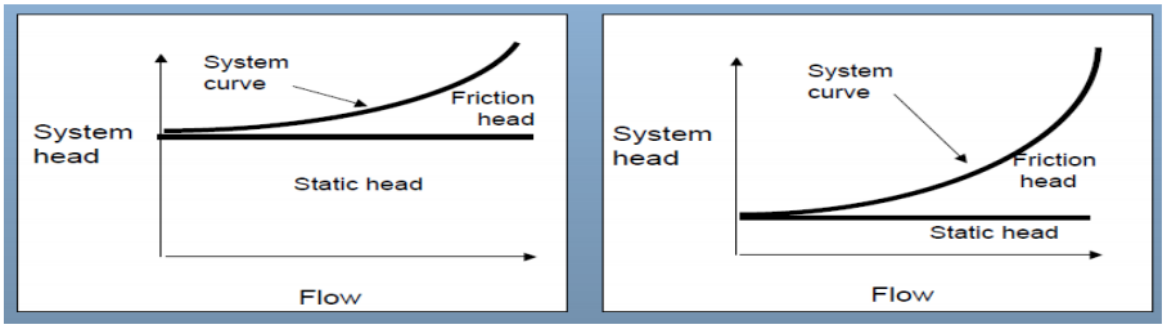
## Q.No.4

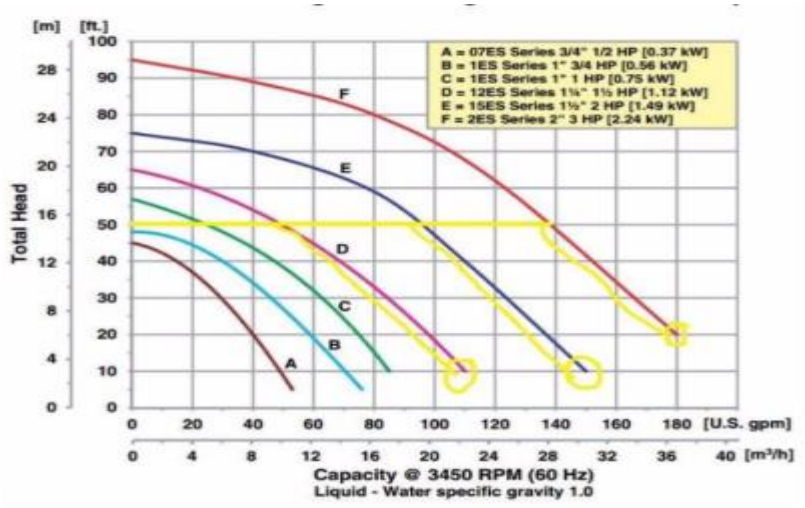
Primary objective of pumping system is to:

1. Transfer liquid from source to destination.
2. Circulate liquid around a system.

Pumping systems are generally designed for:

1. Head: Sum of kinetic and potential energy of liquid expressed in unit of length (meters / feet)
2. Flow / Discharge: Quantity of water pumped per unit time. It is expressed in gallons / day, Liters / minute etc.
3. Pressure: The flowing liquid / water should have sufficient pressure at the destination and is normally expressed in pounds per square inch (psi).




The Formula for PSI:

Pressure (PSI)*2.31/specific gravity = Head (feet)

A basic pump curve shows a pump's performance range. In this curve, head is measured in Feet; flow is measured in gallons per hour.

From the graph and Head found from the above equation we will start our line at graph from that left portion of graph which is System head. Let us we have a Total Head of 50. Draw a straight line from 50 of that head. Now the different colors lines show the capacity of different pumps. Now look at the demand. Draw a straight line down from that , now we have a capacity for which we are designing looking into that and that one in graph you can select a proper type machine of that capacity.