ID: 14397
Discipline: MS Civil Engineering
Course Title: Water Demand Supply and Distribution
Course Code: CE- 562
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Q1. Define desalination and briefly describe various desalination methods? Which method is more effective, please elaborate briefly?

Desalination

Desalination is the process in which salts and other minerals from the saline water are removed to make it potable water and suitable for irrigation and industrial uses also.

Methods of Desalination

Various methods of Desalination are:

- Distillation (Evaporation)
- Electro dialysis
- Freezing
- Reverse osmosis

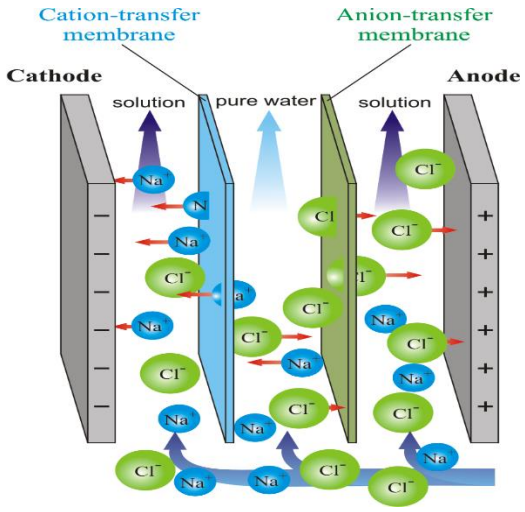
Distillation (Evaporation)

The process consists of heating water to the point at which it evaporates and then condensed to get fresh water. Water containing salt is heated in a container to the point that water evaporates leaving behind the salt. The desalinated vapor is then condensed to get water in another container.

Drawback of this method is that fuel cost of converting salt water to vapor is high.

Electro dialysis

Electro dialysis process consists of the phenomenon in which an electric current is passed through an ion solution. The positive ions (cations) move toward the negative electrode (cathode), whereas the negative ions (anions) head for the positive electrode (anode). Semi-permeable membranes are placed between both electrodes so that only Na+ or Cl- can pass through, and the water contained in the center of the electrolytic cell is desalinated, giving us freshwater.



Freezing

This method is based on the principal that when water crystalizes to ice, it removes salts. Three steps are involved in this process

- Ice Formation
- Ice washing
- Ice melting to get fresh water with subsequent removal of salt.

Reverse osmosis

It is a water purification method that uses a semi-permeable membrane to remove ions, molecules and larger particles from saline water.

The process consists of applying pressure to a salt water solution and forcing it through a semi-permeable membrane whose function is to allow the passage of the water but not the dissolved salts.

It decreases the salts and other dissolved impurities from water and results in high quality water.

Steps Involved in Reverse Osmosis

First 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, a5-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.

Second 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**.**

Third Step

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

Fourth 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.

Fifth Step

- 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.

Which method is more effective, please elaborate briefly?

Reverse osmosis is the most extensive and advanced system in the world. This method is more effective because apart from desalination, Reverse osmosis can also remove many other types of dissolved and suspended species from water, including bacteria and is used in both industrial processes and the production of potable water.

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?

There are four different types of water distribution layouts

- Dead End System
- Radial System
- Grid Iron System
- Ring System

Dead End System

Merits of Dead End System

- Pipes in this network can be laid easily
- It is relatively cheap
- The pressure and discharge in each pipe can be determined very easily and accurately which makes design calculations very simple.
- In this system of layout comparatively less number of cutoff valves are required

Demerits of Dead End System

- There are number of dead-ends in the system due to which free circulation of water is prevented and stagnation of water occurs.

- In the case of damage or repair in any section of the system, the water supply to the entire portion beyond that point will be completely cut-off.

Radial System

Merits of Radial System

- The water distributed with high velocity and high pressure.
- It gives quick service
- Water stagnation does not occur in this system.

Demerits of Radial System

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

Grid Iron System

Merits of Grid-Iron System

- Water is kept in good circulation due to absence of dead ends.
- In cases of breakdown in one portion, water is available from some other direction.
- Proper designing is relatively difficult

Demerits of Grid-Iron System

- Cutoff valves requirement should be more in this system.
- Exact calculation of sizes of pipes is not possible due to provision of valves on all branches

Ring System

Merits of Ring System

- Water can be supplied to any point from at least two directions.
- No Stagnation of water
- Repair can be done without affecting the entire network.

Demerits of Ring System

- More number of cut off valves are necessary.
- Longer length and larger diameter pipes are required

Which layout will you recommend for newly proposed township in hilly area?

I will support dead End system for newly proposed township in hilly areas. Due to uneven terrain and up downs in hilly areas, it is difficult to lay the pipes. There is no arrangement for rectangular layout in hilly areas due to uneven terrain. In Dead End layout comparatively less number of cutoff valves are required and laying of pipes is easy. Moreover construction of dead end system is cheaper as compare to other layout systems.

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

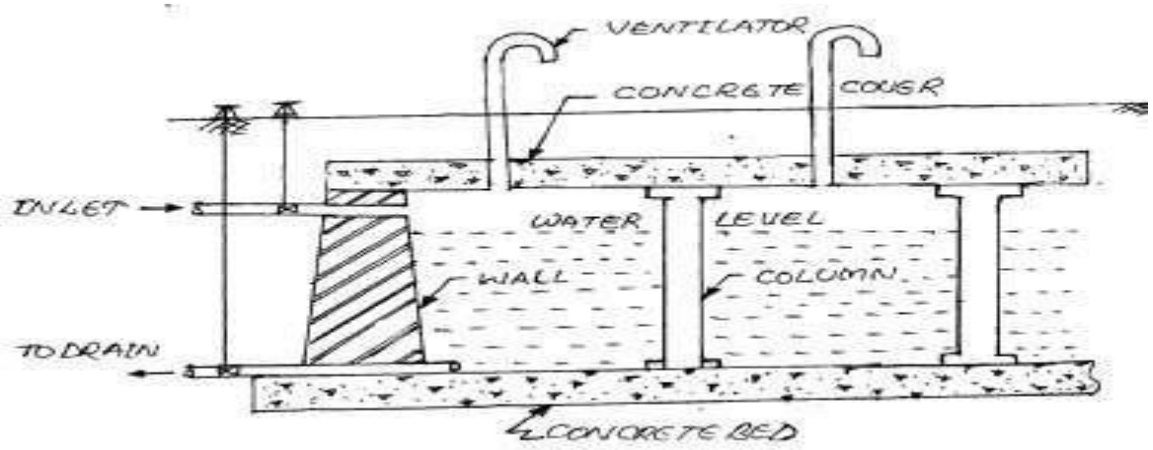
Different types of Reservoirs

Considering the elevation w.r.t ground it may be classified into:

1. Surface reservoirs
2. Elevated reservoirs

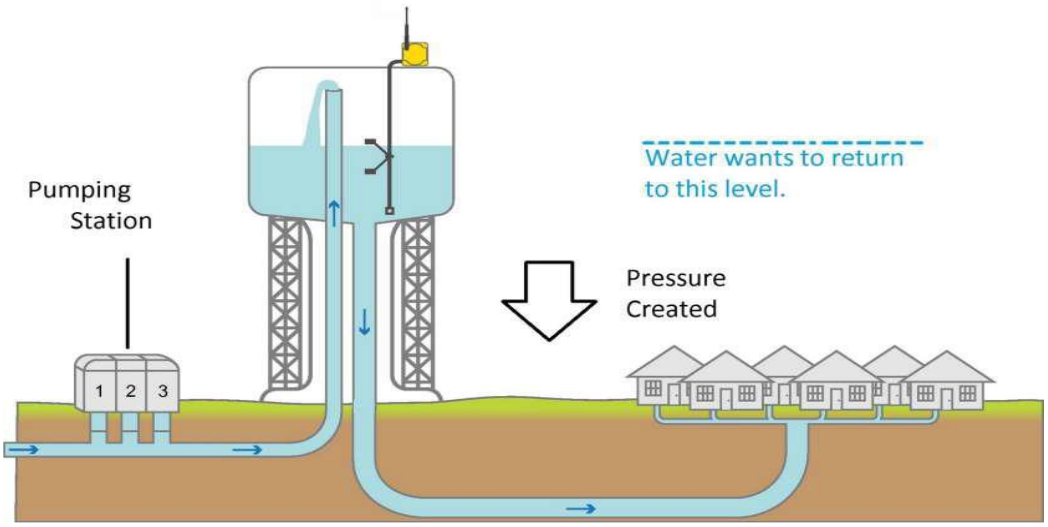
Surface Reservoirs

- Surface reservoirs are circular or rectangular tanks constructed at ground level or below ground level.
- They are also called ground reservoirs.
- 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.



Elevated Storage Reservoirs

- These are rectangular or circular in shape.
- These are required at distribution areas which are not controlled by the gravity system of distribution
- They are erected at certain suitable elevation above ground level.
- They are constructed in areas where combined gravity and pumping systems for water distribution is adopted.
- If the topography of the town is not suitable for gravity system, the elevated tank or reservoir are used to provide sufficient pressure head.



Importance of Reservoirs

- Reservoirs balance the fluctuating demand from the distribution system.
- Reservoirs provide a supply during a failure or shutdown of treatment plant, pumps, or trunk main leading to the reservoir.
- Reservoirs store water for distributing water during emergencies (such as during fires, repairs, peak demand etc.

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

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.

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.

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.

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

Pumps are used in water supply scheme to

- Transfer liquid from source to destination.
- Circulate liquid around a system.
- Force water through transmission and distribution systems.
- Pumps are also used to force water through water treatment facilities.

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).

How to calculate pump curve to meet water demand?

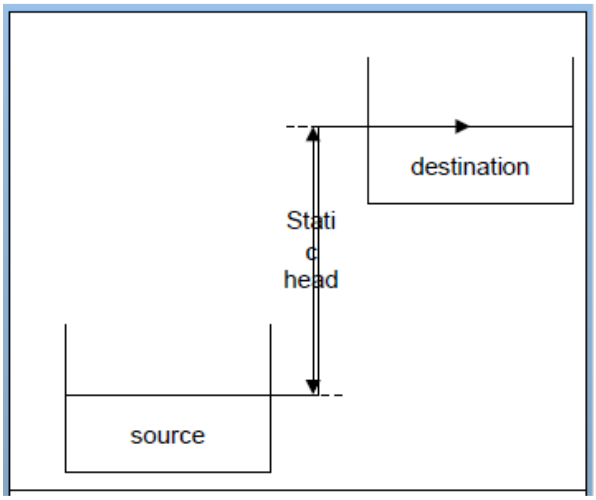
There are two types of heads

- Static head
- Friction head

Static Head

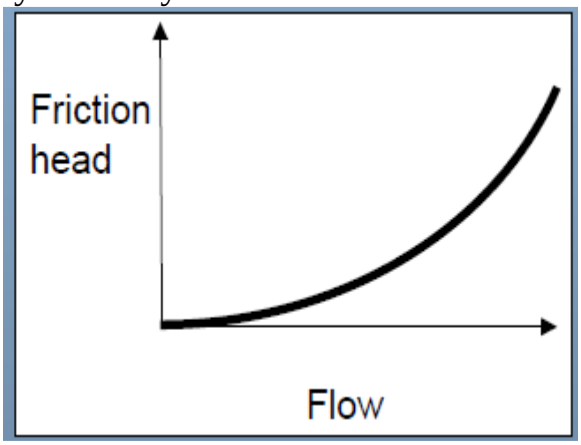
- Vertical distance between the source and destination.

- It is independent of flow conditions

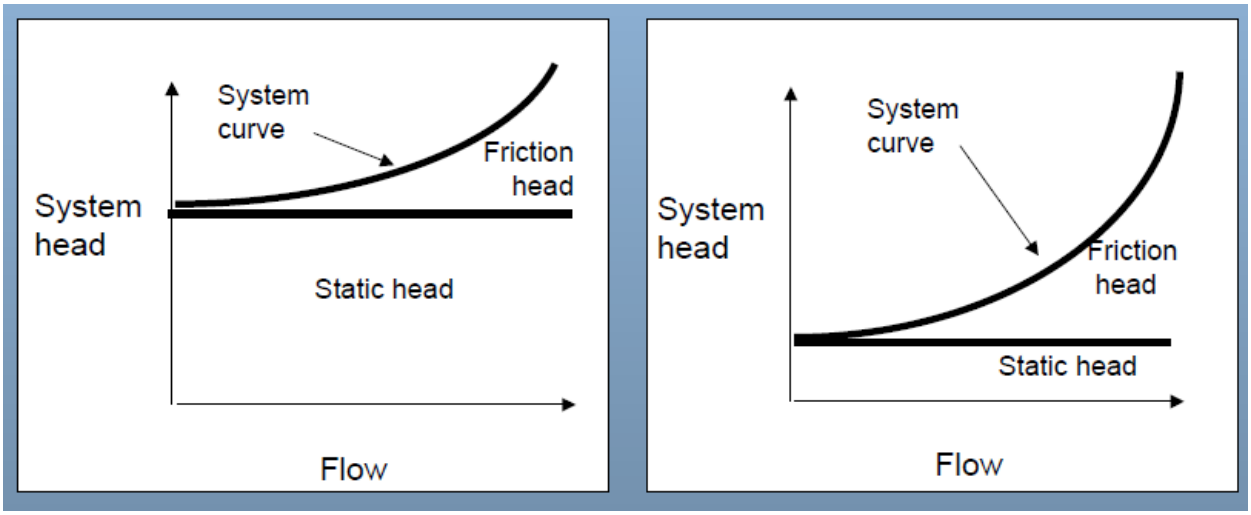


Friction head

- Resistance to flow in pipe and fittings
- Depends on size, pipes, pipe fittings, flow rate, nature of liquid.
- Closed loop system only has friction head



System head is the sum of static head and friction head.



Head can be calculated from equation given below

$$\text{Head (in feet)} = \frac{\text{Pressure (psi) X 2.31}}{\text{Specific gravity}}$$

Head can be calculated from the above equation. After finding head we will go straight in the above graph, after meeting with the curve we will go downward and it will give the total capacity (flow).