Final Term Assignment (Spring 2020)

Subject :WATER DEMAND SUPPLY AND DISTRIBUTION

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Program: M.S (T.E)

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

Ans.1) DESALINATION:

Desalination refers to the process of removal of salt (sodium chloride) and other minerals from the sea water to make it suitable for human consumption, irrigation and/or industrial use.

DESALINATION METHODS

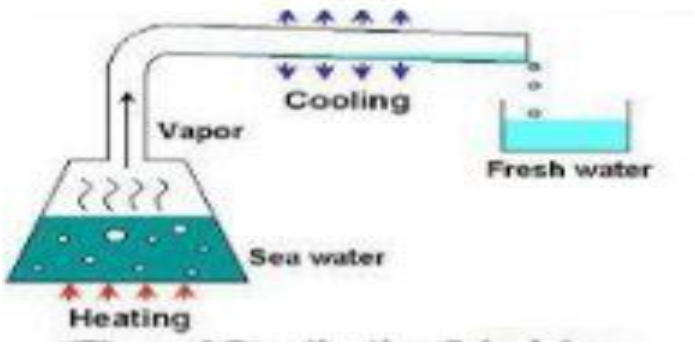
Basically there are four principle methods of desalination;

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

1. Distillation(Evaporation):

In this method, Salt water is heated in one container which will lead to the water evaporation, leaving the salt behind.

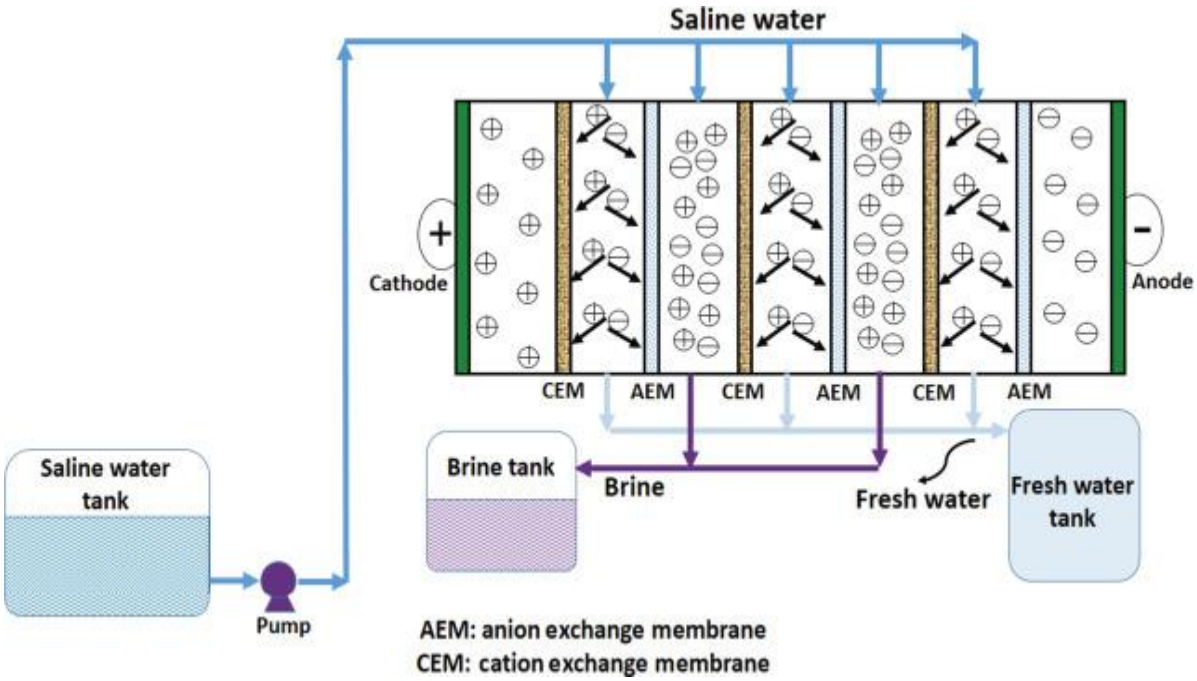
- The desalinated vapor is then condensed to form water in a separate container.
- Although long known, this method has limited applications in water supply because of the fuel costs involved in converting salt water to vapor is very high**.**



2. **Electro dialysis:**

Electrodialysis systems use a selectively permeable membrane to move ions from one side to the other under the influence of an electric 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 Method:**

The freezing method is based on the principle that water excludes salts when it is crystallized into ice.

- It involves three steps: Ice formation, ice washing, and ice melting to obtain fresh water with subsequent removal of contaminants.

4. **Reverse Osmosis (RO)**

Reverse osmosis (RO) is a water purification technology / method that uses 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.

Steps Involved in Reverse Osmosis

Step-1 : 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.

Step-2: Removal of chlorine and other harmful chemicals

➢ 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.

Step-3: Removal of contaminants from the water.

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

Step-4: Removal of heavy metals from the water.

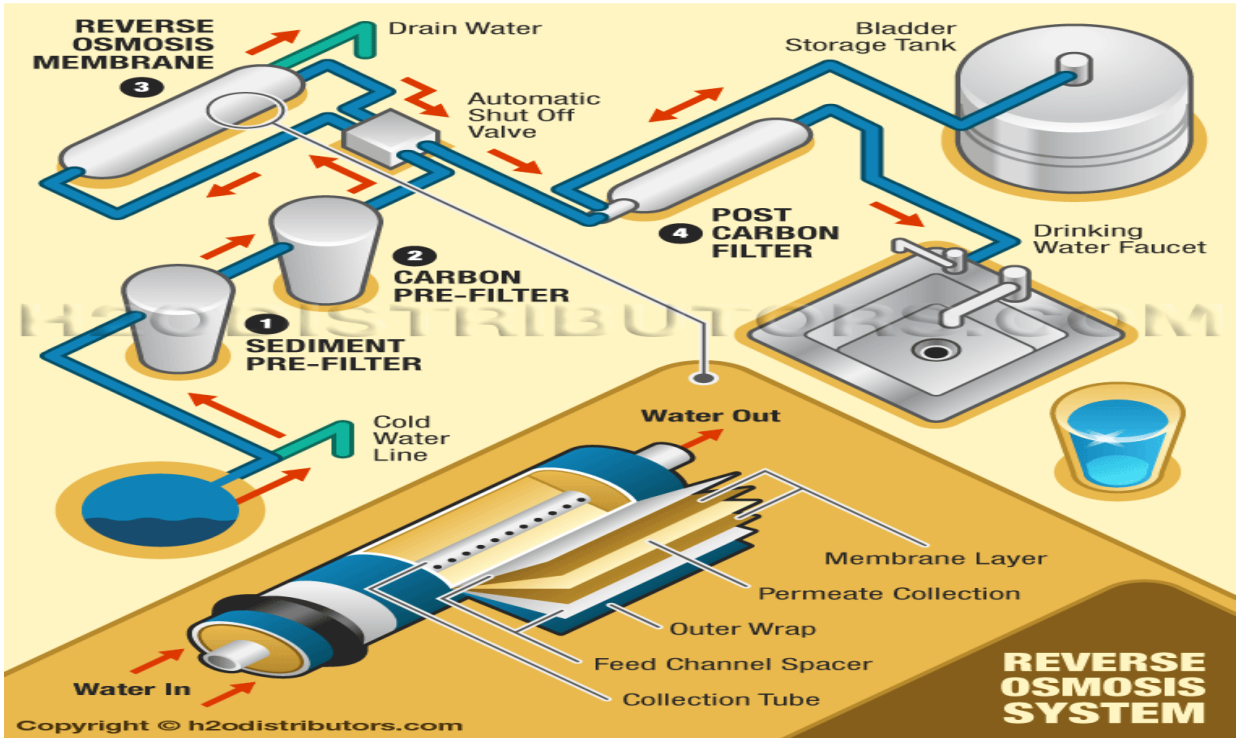
Water passes through the membrane and all the heavy metals present in the water are removed.

➢ 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.

Step-5 : Removal of Bacteria.

➢ 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.



EFFECTIVENESS OF DESALINATION METHODS:

Among all the methods used for desalination of salt water, the reverse osmosis method is more effective since it involves the removal of all contaminants, potential impurities and suspended species from water resulting in a high quality and great-tasting water.

Desalination is primarily done in developed countries with enough money and resources. If technology continues to produce new methods and better solutions to the issues that exist today, there would be a whole new water resource for more and more countries that are facing drought, competition for water, and overpopulation

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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?

Ans.2) Merits and Demerits of 4 types of water distribution layouts:

Water Distribution system System is concerned with the distribution of adequate quantity of water at adequate pressure to individual consumers wherein, the treated water transmitted and/or stored is distributed.

The layout of distribution system is based on pipes that 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. Each type of network/layout has some merits and demerits that can be enlisted as under;

1. **Dead End System**
   It is suitable for old towns and cities having no definite pattern of roads.

Merits:

1. Pipes in this network can be laid easily.
2. This layout is Relatively cheap since it is based on simple network of pipes.
3. The determination of discharges and pressure is easier due to less number of valves.
4. Dead end system requires less number of cutoff valves.

Demerits:

1. The pressure is not constant and is very less at remote parts.
2. Due to many dead ends, stagnation of water occurs in pipes which results in deposition of sediment.
3. In this system, Limited discharge is available for firefighting.

2. Radial System:

In this system, the area is divided into different zones where, 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:

1. This layout gives quick service.
2. Water will flow continuously without any dead ends or sediment deposits.
3. The water distributed with high velocity and high pressure.
4. Head loss is very small because of quick discharge

Demerits:

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

3. Grid Iron System:

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

Merits:

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.
3. Water will flow continuously without any dead ends or sediment deposits.

Demerits:

1. Proper designing is relatively difficult.
2. Because of circulating flow from all directions, the pipes used in this system should be of large diameters and longer lengths
3. Laying of pipes will be done by skilled workers which consume more cost.

4. Ring System:

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:

1. No stagnation of water
2. Repair works can be done without affecting larger network.
3. Large quantity of water is available for firefighting.

Demerits:

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

Suitability of Layout for newly proposed township in hilly area:

Water distribution systems in hilly areas are always divided into several zones due to the undulating terrain. Thus the "Ring water distribution system" is more suitable and recommended for a township in hilly area. The whole area is divided into small distribution districts or zones and an individual distribution reservoir is provided for each distribution zone. The reservoir provided is generally of elevated type. From this reservoir the pipe lines are laid radially to the surrounded zones.

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

Ans.3) Reservoirs, are the storages 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:

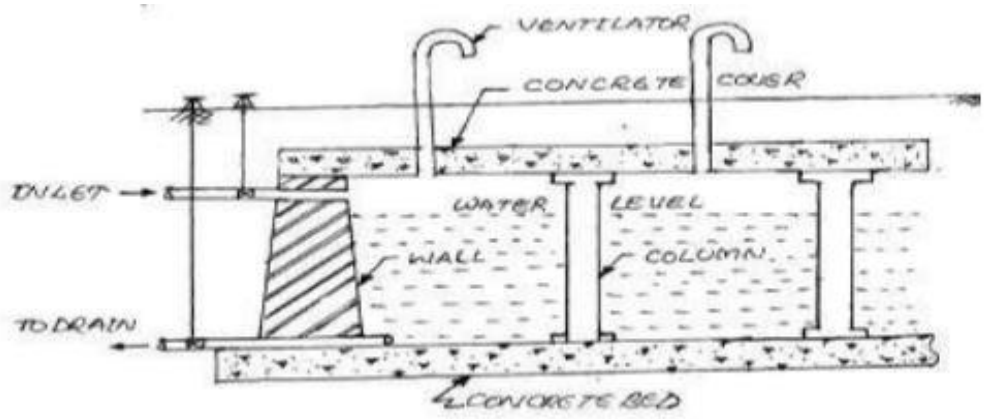
1. Surface reservoirs 2. Elevated reservoirs

1. Surface reservoirs:

These are also called ground reservoir which are 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.

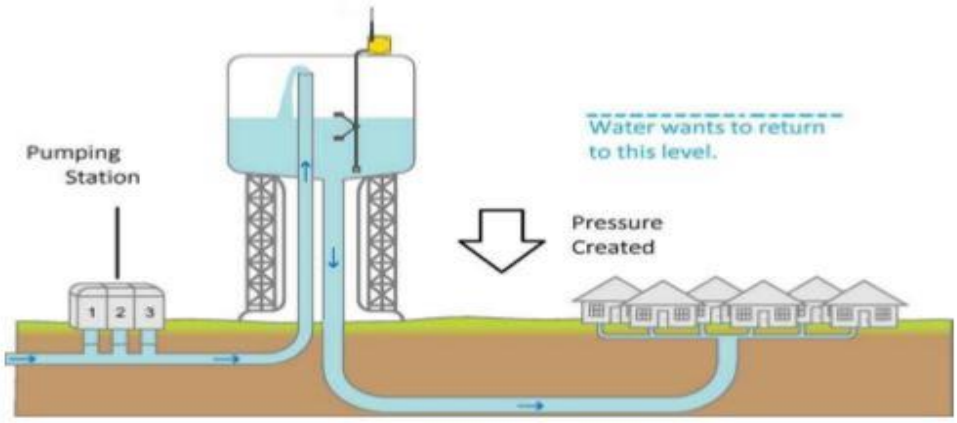


2. Elevated reservoirs:

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 of 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 = area 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.

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

Ans) Pumping System:

Primary objective of pumping system is to Transfer liquid from source to destination and to

Circulate liquid around a system. In this system water is directly pumped from the source into the distribution main without storing. Water source may be surface source or ground water source.

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.

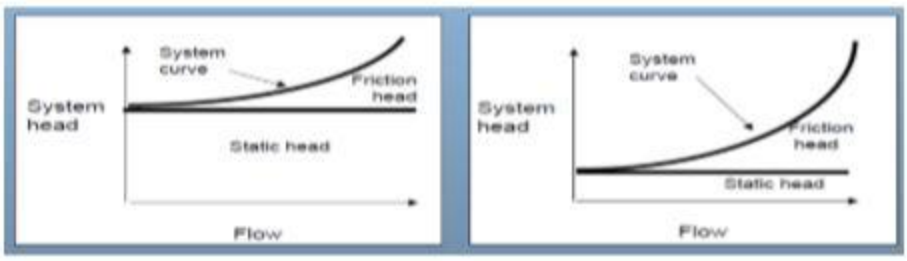
3. Pressure: The flowing liquid / water should have sufficient pressure at the destination and is normally expressed in pounds per square inch (psi).

Head is of two types:

1) **Static Head:**
   - It is the Vertical distance between the source and destination.
   - It is independent of flow conditions.

2) **Friction head**:
   - It is 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 (no static head)

Note: System Head is the sum of static head and friction head



The formula for static head at any pressure is given by:
Head (ft) = Pressure (psi) x 2.31/Specific Gravity

Pump Curve:

Pump curves help you select pumps for the specific needs of your application. Pump curves give you the information you need to determine a pump's ability to produce flow under the conditions that affect pump performance. Curves help you choose the right pump based on the application variables such as head (water pressure) and flow (the volume of liquid you have to move in a given time period).

For example, if you know the flow rate your application requires, you find the gallons per minute (or hour) rate along the bottom horizontal line of the curve and then draw a line up to the head/PSI you require. The curve will show you if the pump you have selected will perform in that application.

Curves typically include performance metrics based on pressure, flow, horsepower, impeller trim, and Net Positive Suction Head Required (NPSHr).

Pump curves are useful because they show pump performance metrics based on head (pressure) produced by the pump and water-flow through the pump. Flow rates depend on pump speed, impeller diameter, and head.