Iqra National University Peshawar

Civil Engineering Department

Water Demand Supply and Distribution

Course Code: CE-562

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Q:1

Desalination:

The process of removing salts or other minerals and contaminants from sea water, brackish water, and waste water effluent and it is an increasingly common solution to obtain fresh water for human consumption and for domestic or industrial utilization.

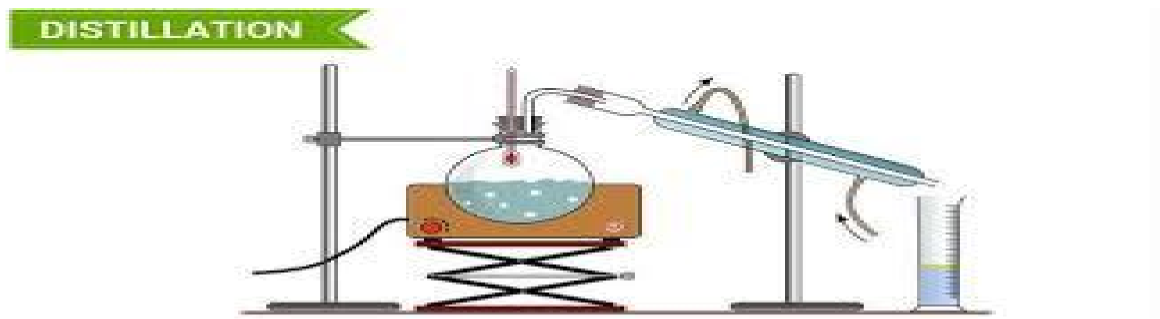
Desalination Methods:

There are various methods of Desalination which are discuss as below:

1. Distillation or Evaporation.
2. Electrodialysis.
3. Freezing
4. Reverse Osmosis.

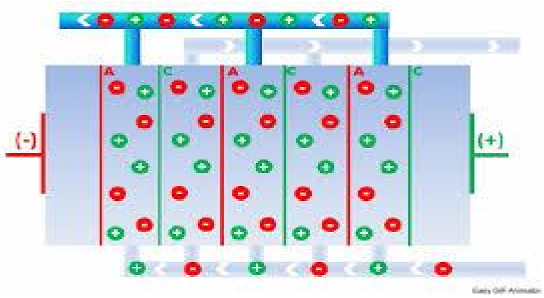
1.Distillation:

In this method desalination, the salt water is heated in one container where the water evaporates and salt is left behind. The desalinated vapor is then condensed to form water in a separate container. Distillation has got limited application due to high fuel cost in converting salt water to vapor.



2.Electrodialysis:

Electrodialysis reversal utilizes a membrane like that in reverse osmosis and send an electric charge through the solution. It sends an electric charge through the solution to draw metal ions to the positive plate on one side, and other ions like salts to the negative plate on the other side.

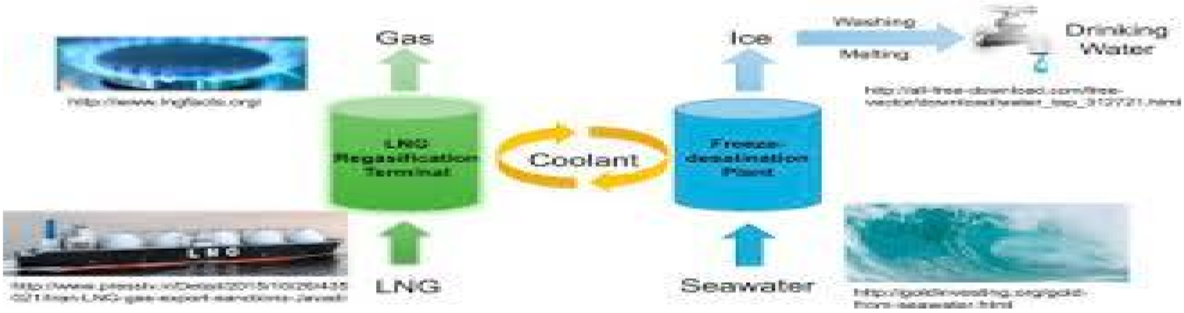


3.Freezing Method:

It is based on the principle that water excludes salts when it crystallizes to ice.

There are three steps involved in freezing method.

1. Ice formation
2. Ice washing
3. Ice melting to obtain fresh water with subsequent removal of contaminants.



4.Reverse Osmosis:

It 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:

Step1:

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.

Step2:

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:

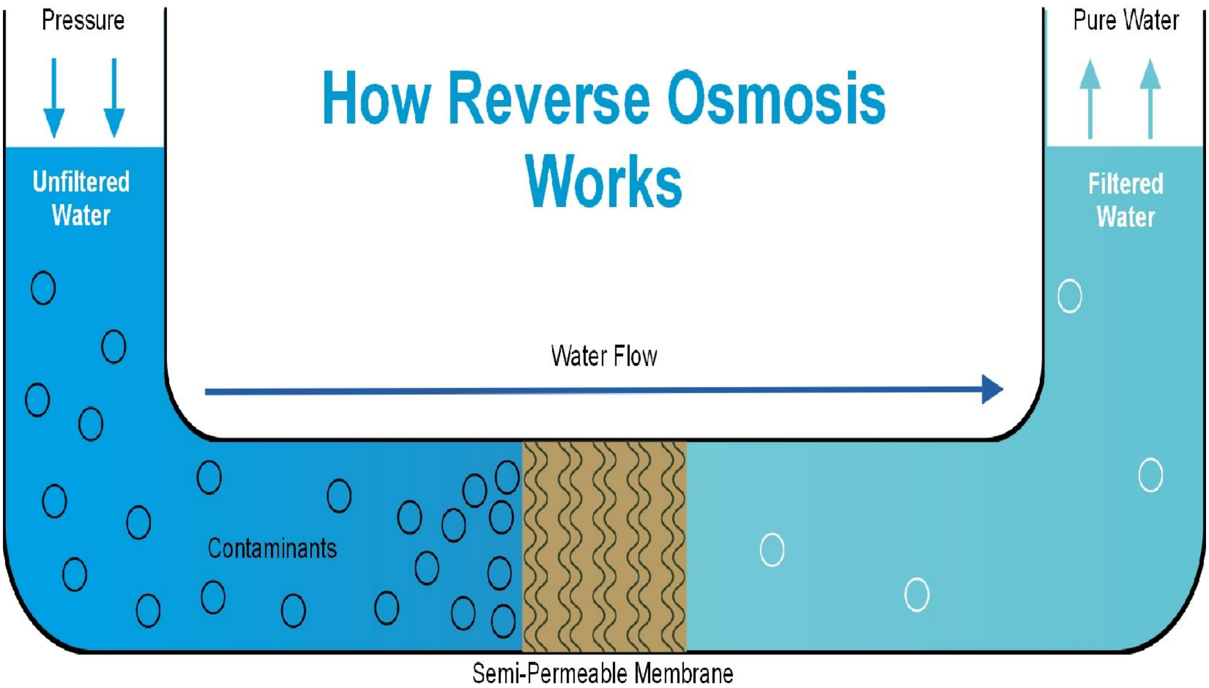
The third step focuses on passing the water from a dense and compacted carbon filter. Most of the contaminants are removed here.

Step 4:

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:

In this last stage, the bacteria, chlorine, and bad odor is 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.



Effective Method of Desalination:

Distillation is one of the effective methods to be use for desalination because it offers significant savings in operational and maintenance costs compared with other desalination technologies. In most cases, distillation does not require the addition of chemicals or water softening agents to pre-treat feedwater. Many plants are fully automated and require a limited number of personnel to operate. Distillation has minimal environmental impacts, although brine disposal must be considered in the plant design. Distillation can be combined with other processes, such as using heat energy from an electric-power generation plant.

Q:2

Merits and Demerits of Water Distribution Layouts:

1. **Dead End system:**
   Advantages:
   They are relatively cheap.
   Due to a smaller number of valves determination of discharges and pressure is easier.
   Disadvantages:
   Stagnation of water in pipes occur due to many dead ends.

2. **Radial System:**
   Advantages:
   It gives quick service and there is no stagnation.
   This system of layout ensures high pressure in distribution and it gives quick and efficient water distribution.
   Disadvantages:
   It may, however, be stated that generally only any one of these four systems of layout may not be suitable for the entire city or town.

3. **Grid Iron System:**
   Advantages:
   Since the water in the supply system is free to flow in more than one direction, stagnation does not occur as readily as in the branching system.
   In case of repair or break down in a pipe, the area connected to that pipe will receive the water, as water will flow to that area from the other side.

Water reaches all points with minimum head losses. At the time of fires, by manipulating the cut off valves, plenty of water supply may be diverted and concentrated for firefighting.

Disadvantages:

Cost of pipe laying is more because relatively more length of pipe is required. More number of valves are required. The calculation of pipe sizes is more complicated.

4. **Ring System:**

   Advantages:

   Determination of pipe sizes is easy. Water can be supplied to any point from at least two directions. The advantages and disadvantages of the ring system is same as grid iron system.

Type of layout used in newly proposed township in hilly area:

In hilly areas, mostly the areas are unplanned. So the dead end system are to be used in hilly area.

Q:3

Different types of reservoirs used in water supply systems:

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.

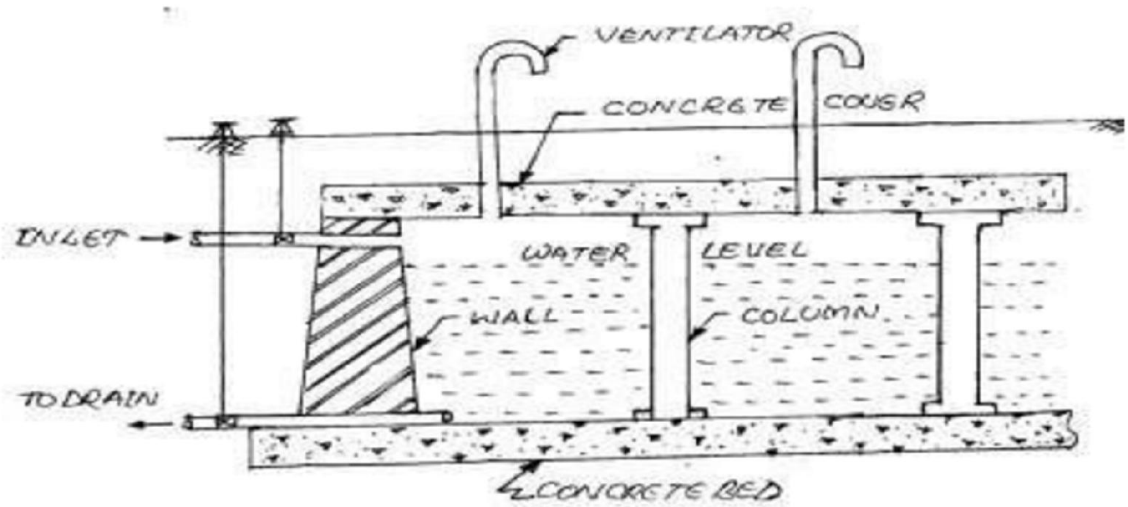
Depending upon their elevation w .r .t ground it may be classified into:

1. Surface reservoirs

2. Elevated reservoirs

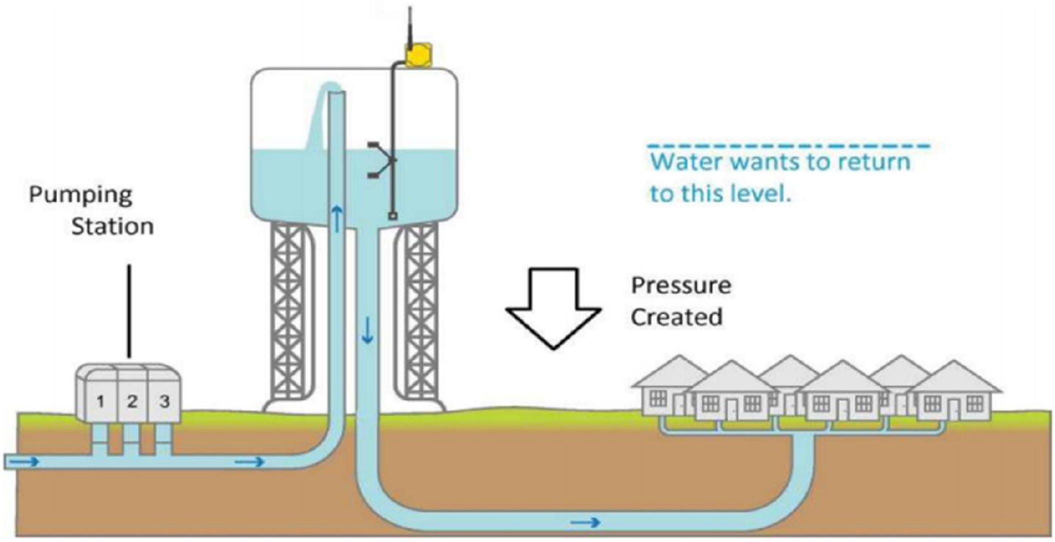
1. Surface Reservoirs:

These are also called ground reservoir. 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.



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: 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;

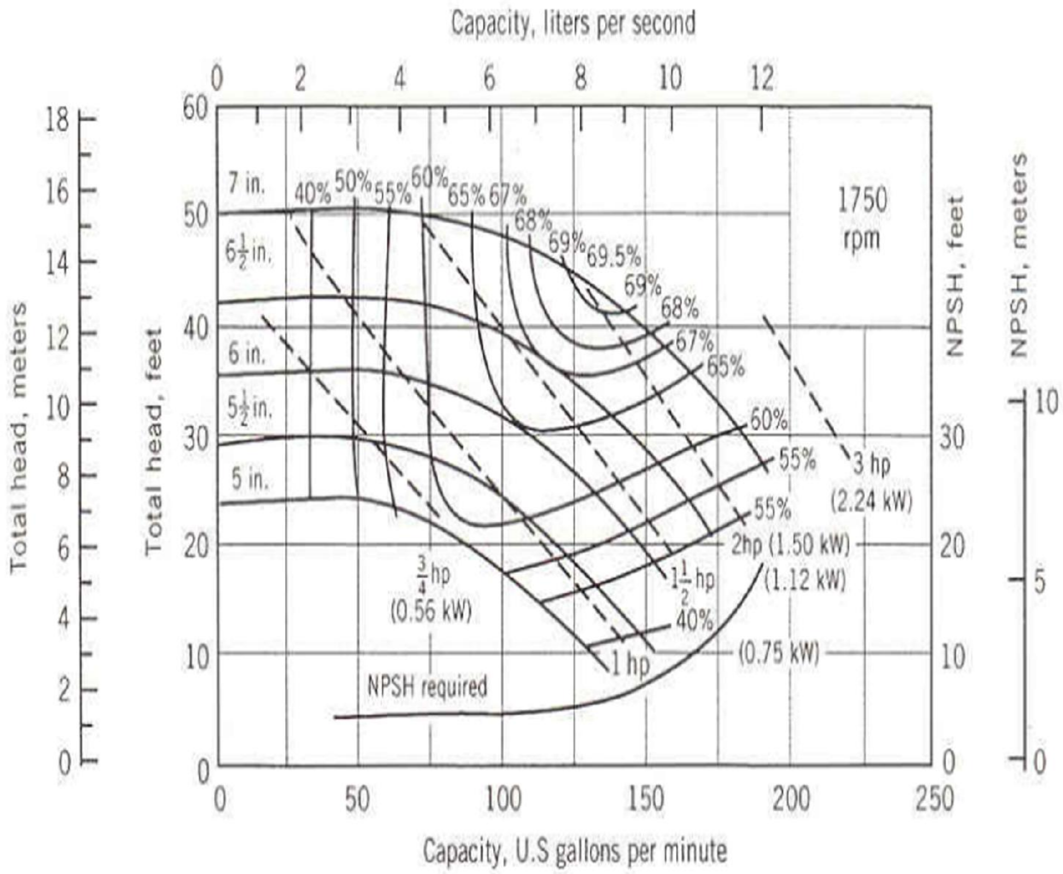
Q:4

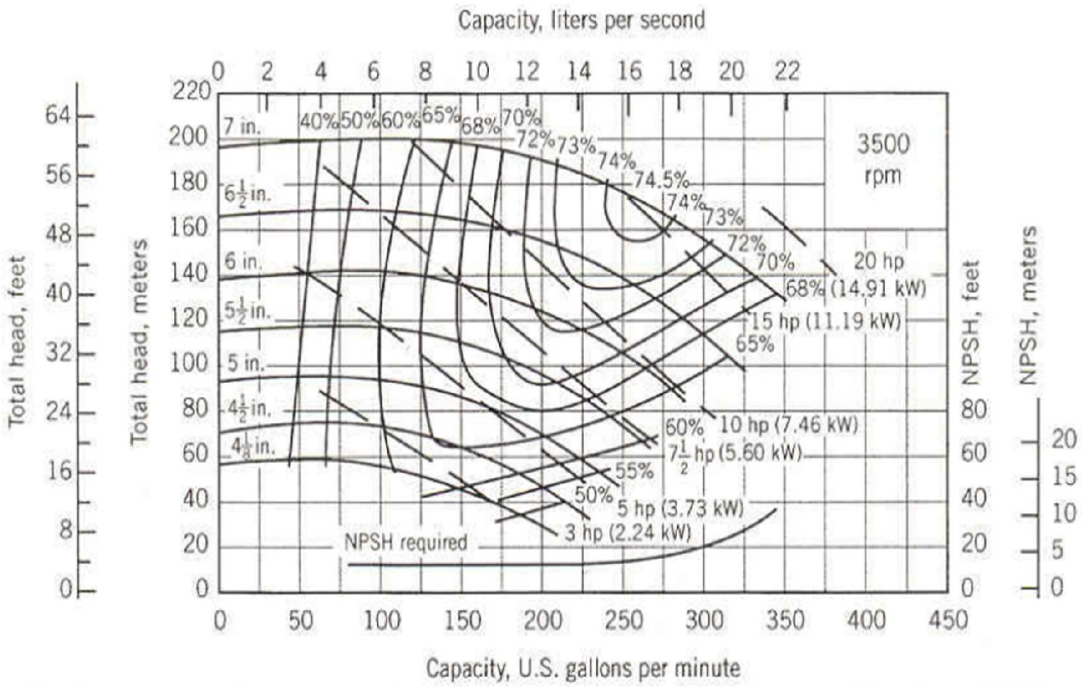
Why Pumps are used in water supply schemes:

Pumping stations in a water distribution system are necessary where water is pumped directly into the system (e.g. from a lake) or where pressure has to be increased because there is an insufficient difference in water levels in gravity flow distribution systems. There are two general types of pumps: vertical turbine pumps and centrifugal pumps. Capital costs are high, but the most expensive part is the energy supply for pumps (mostly electrical). Therefore, it is very important that pumps have a high degree of efficiency and are maintained properly.

Pump Curves:

Pumps can generate high volume flow rates when pumping against low pressure or low volume flow rates when pumping against high pressure. The possible combinations of total pressure and volume flow rate for a specific pump can be plotted to create a pump curve. The curve defines the range of possible operating conditions for the pump. If a pump is offered with multiple impellers with different diameters, manufacturers typically plot a separate pump curve for each size of impellor on the same pump performance chart. Smaller impellors produce less pressure at lower flow rates. Pump performance charts with multiple pump curves are shown below.





Typical pump performance charts. Source: McQuiston and Parker, 1994, Heating Ventilating and Air Conditioning, John Wiley and Sons, Inc.

The power required to push the fluid through the pipe, W fluid, is the product of the volume flow rate and system pressure drop.

$W_{fluid} = V \Delta P_{total}$

Graphically, fluid work is represented by the area under the rectangle defined by the operating point on a pump performance chart. Typically, the efficiency of the pump at converting the power supplied to the pump into kinetic energy of the fluid is also plotted on the pump performance chart. Pump efficiencies typically range from about 50% to 80%. Power that is not converted into kinetic energy is lost as heat. The power required by the pump, which is sometimes called the “shaft work” or “brake horse power”, can be calculated from the flow rate, total pressure, and efficiency values from the pump curve, using the following equation.

$W_{pump} = W_{fluid} / Eff_{pump} = V \Delta P_{total} / Eff_{pump}$

A dimensional version of this equation, using U.S. units for pumping water at standard conditions, is

$W_{pump}(hp) = V\ (gal/min)\ \Delta P_{total}(ft\text{-}H20) / (3{,}960\ (gal\text{-}ft/min\text{-}hp) \times Eff_{pump})$

Many pump performances graphs, including those shown above, also plot curves showing the work required by the pump to produce a specific flow and pressure. Note that these curves show work required by the pump including the efficiency of the pump. Calculating the work supplied to the pump using the preceding equation and comparing it to the value indicated on a pump performance graph is a useful exercise.