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

**Desalination** is a process that takes away mineral components from [saline water](https://en.wikipedia.org/wiki/Saline_water). More generally, desalination refers to the removal of salts and minerals from a target substance as in [soil desalination](https://en.wikipedia.org/wiki/Soil_salinity_control), which is an issue for agriculture

**Salinity Levels**

**Type of saline water Salinity value (ppm)**

Fresh water <1000

Slightly saline Water 1000-3000

Moderately saline Water 3000-10,000

Highly saline water 10,000-35,000

**Principal Methods for Desalination:**

There are several methods. Each has advantages and disadvantages but all are useful. The methods can be divided into membrane-based, thermal-base, traditional process of desalination is [distillation](https://en.wikipedia.org/wiki/Distillation)

* Reverse osmosis
* Thermal distillation
* Freeze-thaw
* Evaporation
* Electro dialysis

**Reverse Osmosis**

The seawater is carefully filtered through several layers of sand or [charcoal](https://www.planete-energies.com/en/content/charcoal) to eliminate microalgae and suspended particles, leaving only the salts behind. The water is then fed under high pressure (50 to 80 bar) through a very fine, semi-permeable membrane, whose pores measure one millionth of a millimeter. The membrane barrier lets the water molecules through but traps the salt. This method is called reverse osmosis

Reverse osmosis can remove many types of dissolved and suspended species from Reverse osmosis can remove many types of dissolved and suspended.

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**

**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.

* **Thermal Distillation**

Thermal distillation is the oldest and simplest method. Seawater that has been drawn from the sea or ocean is filtered to remove the larger impurities. It is then heated to produce vapor in a vessel that collects the salts. The vapor is subsequently condensed and converted to a mineral-free liquid.

**Freeze-thaw**

Freeze-thaw desalination uses freezing to remove fresh water from salt water. Salt water is sprayed during freezing conditions into a pad where an ice-pile builds up. When seasonal conditions warm, naturally desalinated melt water is recovered. This technique relies on extended periods of natural sub-freezing conditions.

* Ice formation
* Ice washing and
* Ice melting to obtaining fresh water with subsequent removal of contaminants.

**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.

**Electro dialysis:** Electro dialysis utilizes a membrane, and sends an electric charge though 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.**More effective method:**

Membrane filtration using reverse osmosis is a technology that is increasingly being used in many water related organizations. Reverse osmosis is now the most important technology for making fresh water out of seawater. For anyone interested in the fascinating world of membrane technology in drinking water production and industrial water treatment, this course will provide you with the fundamental knowledge to better understand the process and its applications. Your dependence on external advisors will be reduced and your ability to make decisions regarding investment and maintenance within the organization will be greatly enhanced.

**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? Merits and demerits of 4 types of water distribution layouts?**

Considering four types of water distribution, following are the merits and demerits,

|  |  |  |
| --- | --- | --- |
|   | Merits | Demerits |
| Dead End System | 1. It is possible to calculate accurately the discharge and pressure at any point in the distribution system. Calculations are simple and easy to do.2. This method requires comparatively less number of cut off valves, hence cheap.3. Pipe lines can be laid in the street of any pattern which may not be standardized.4. The diameter of mains are to be designed for the population they have to serve. This fact may make the system cheap and economical. | 1. (a) In this system there are large number of dead ends, where water does not circulate but remains static, which may get contaminated due to stagnation.2. (b) During break downs and repairs large areas which are served by this pipe, go without water and thus cause great inconvenience to the public.3. (c) Water available for firefighting will be limited is being supplied by only one water main. |
| Radial System | Result is Quick Services Eliminates Stagnation | 4. The end of distributor near to the substation gets heavily loaded;5. When load on the distributor changes, the clients at the distant end of the distributor face serious voltage fluctuations; &6. As users are dependent on single feeder and distributor, a fault on any of these two causes interruption in supply to all the users connected to that distributor. |
|
| Grid-Ion System | 1. At the time of repair or breakdown only small portion of the distribution layout is affected.2. As there are no dead ends and water circulation is free throughout, it is not liable to contamination.3. Water reaches all the points with minimum loss of head.4. At the time of fires, by manipulating the cut off valve, plenty of water supply may be diverted and concentrated for firefighting. | Proper designing is relatively difficult.(a) Cost of pipe laying is more because relatively more length of pipe is required.(b) It is difficult to calculate pressures and discharges at various points of distribution systems(c) More number of valves are required. |
| Ring System | Water can be supplied to any point from at least two directions | 1. A ring-main circuit installation and testing is more rigorous than radial circuit.2. In a ring-main circuit if not break or disconnect in load middle point, then there is a possibility of an overload the wire and breaker.3. During break or disconnect the ring circuit is vulnerable in ground protection |

**Recommendation:**

water distribution layout should be cost efficient and effective, In hilly area, source of supply is at sufficient height, i-e having gravitational edge, in supplying water to communities, with no energy cost and is easy, efficient and effective, in such case mostly recommended layout is Dead End system, it also helps in discharging pressure. It is most reliable and economical distribution. The water head availability at the consumer is just minimum required. The remaining head is consumed in the frictional and other losses. Following are the justification on recommendation of dead end system

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

**Surface reservoirs:**

Surface reservoirs are built structures for water storage that help improve water security for local communities, these are also called ground reservoir. They are mostly circular or rectangular tanks .The types and sizes of reservoirs vary, from damming natural water bodies for storage to ground excavation in low-lying plains fed either by rainwater or diverted rivers. Stored water can be used for numerous purposes, including irrigation, industry, domestic use, hydropower generation and flood control. 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.

Surface reservoirs are particularly important in regions with lengthy dry seasons and high rainfall variability, as well as areas where seasonal water availability is predicted to increase as a result of a changing climate. Surface reservoirs are therefore one of the most important adaptation technologies in regions with limited and varying water availability.

**Elevated reservoirs:**

When sufficient high ground above the distribution area is not available for the construction of ground reservoirs, from where water can flow under gravitational force in the distribution system, elevated reservoirs are constructed. The elevated reservoirs reduce the initial cost of pumps, reduce the peak demands on the pumps and reduce the maximum pressure required at the pumps discharge.

Generally two types of elevated reservoirs are used, which are

(a) Stand Pipes, and

(b) Elevated Tanks.

**Importance:**

Reservoirs have a high level of multi-functionality. They are used for water supply, energy production, flood protection, ecological services and recreation. As a multi-purpose construction and drastic intervention into nature there are a lot of aspects to be accommodated in a highly responsible manner. Due to growing populations and expanding economies, artificial reservoirs are necessary for storage and transport of water, in order to cover the continuous, anthropogenic demand for water from the non-continuous, natural water supply and to attain and preserve the fundamental human right for access to clean water. Hydropower plays an important role in regenerative power generation in base load and especially in peak load times in the electricity network. Other benefits are the high degree of saturation, the highest efficiencies and high durability combined with low utilisation servicing cost.

**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).

1. **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

1. **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.



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

**Pump requirements in Water supply:**

Pumps are used in different purposes, mostly in water system pumps are used to move the water from produced source to desired place, containers or direct to consumers. Sometime the source of water is at lower elevation and requirement is to raise to higher level, for this purpose pumps are utilized.

Pumping is required for

 a) Lifting water from the source (surface or ground) to purification works or the service reservoir.

 b) Transfer of water from source to distribution system.

c) Pumping water from sump to elevated/ground surface tanks.

Many different types of pumps can be used with the selection depending on the work that needs to be done. One type would be used for transferring water from a well to a tower; another would be better suited for pumping sludge containing a lime byproduct from a softening plant; still another would be used for feeding a chemical into the water for treatment.

For constant flow of water at a constant pressure for any given set of conditions, the centrifugal pump is ideal for delivering water to customers. Most well pumps are centrifugal pumps. They are ideal for use in the distribution system since they do not produce pulsating surges of flow and pressure.

**Calculating pump curve:**

The pump characteristic is normally described graphically by the manufacturer as the pump performance curve. The pump performance curve describes the relation between the flow rate and the head for the actual pump. Other important information for a proper pump selection is also included - like efficiency curves, NPSHr curve, pump curves for several impeller diameters and different speeds, and power consumption. Increasing the impeller diameter or speed increases the head and flow rate capacity - and the pump curve moves upwards. The head capacity can be increased by connecting two or more pumps in series, or the flow rate capacity can be increased by connecting two or more pumps in parallel.

