Discipline: **MS Civil Engineering**	***Course Title:*** **Water Demand Supply and Distribution**
Course Code: **CE- 562**	***Instructor Name:*** **Engr. Nadeem Ullah**
Student ID#: **14686**	***Student Name:*** **Wahid Ullah Wahdat** ***Degree:*** **MS (WR. E)**

Final-Term Assessment

Question #1: *Define desalination and briefly describe various desalination methods? Which method is more effective, please elaborate briefly?* ***(15 Marks)***

Answer #1:

Desalination is the process of removing salts and other minerals from the saline water to convert it into safe potable or usable water for drinking, irrigation, or industrial uses. There are four methods. Each has advantages and disadvantages but all are useful.

1: Distillation Method:

Distillation is a procedure by which we can separate salt and other minerals form saline water. The process involving the conversion of a liquid into vapour that is subsequently condensed back to liquid form in a separate container.

2: Electro Dialysis:

Electro Dialysis is a membrane process, during which ions are transported through semi permeable membrane, under the influence of an electric potential. It draws metal ions to the positive plate on one side, and other ions to the negative plate on the other side.

3: Freezing Method:

Freeze desalination is a method, based on salt rejection from water during freezing. Salt rejection in freeze desalination is due to the small dimensions of the ice crystal lattice that excludes the salt ions during partial freezing instead of being incorporated in the crystal lattice of the ice. It is based on the principle that Saline Water Sample 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 Method:

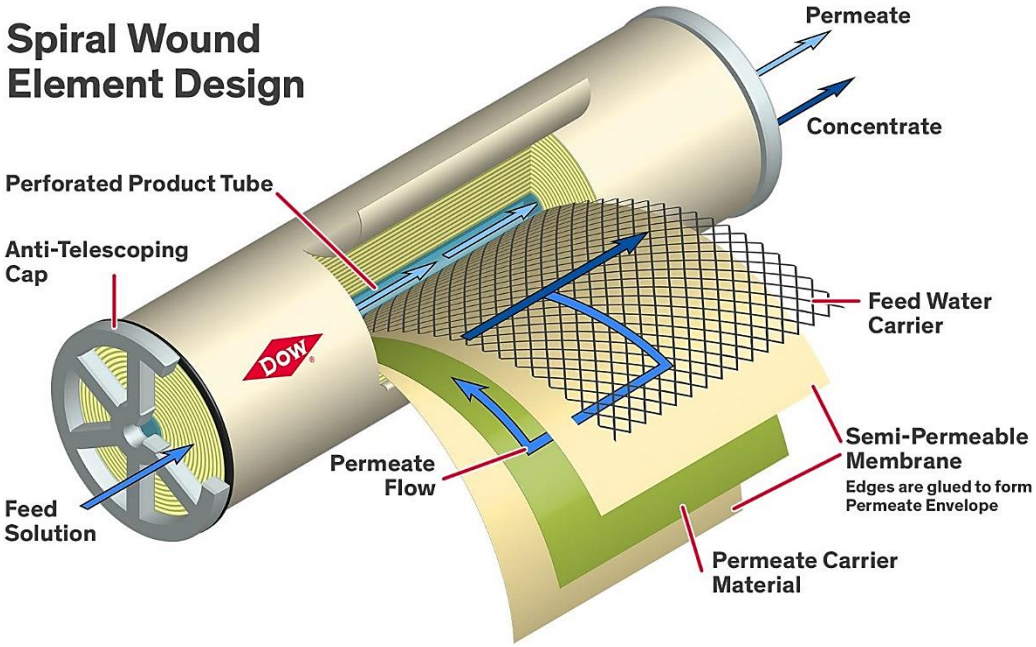
Reverse Osmosis (RO) is a water treatment process that removes contaminants from water by using pressure to force water molecules through a semipermeable membrane. During this process, the contaminants are filtered out and flushed away, leaving clean, delicious drinking water. Note that this reversed flow produces pure water from the salt solution, since the membrane is not permeable to salt.

There are generally four stages in the reverse osmosis process:

1. Sediment Filter
2. Carbon Filter
3. Reverse Osmosis Membrane
4. Polishing Filter

Which method is more effective?

Reverse osmosis is an effective means to desalinate saline water, but it is more expensive than other methods. As prices come down in the future the use of reverse osmosis plants to desalinate large amounts of saline water should become more common.



Question #2: *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?* ***(15 Marks)***

Answer #2:

There are four principal methods to design a distribution system:

1. Dead end or Tree system
2. Gridiron system
3. Circular or Ring system
4. Radial system

1. Dead end or tree 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.

Demerits:

- Due to many dead ends, stagnation of water occurs in Pipes.
- One main pipeline provides the entire city, which is quite risky.

2. 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

Demerits:

- Proper designing is relatively difficult.
- A large number of cut-off valves are required.
- Exact calculation of sizes of pipes is not possible due to provision of vales on all branches.

3. Circular or Ring system:

The supply main is laid all along the peripheral roads and sub mains branch out from the mains. Thus, 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
- In this system, no stagnation of water occurs.
- In the ring or circular system without affecting larger network repair work can be done.
- For firefighting a large quantity of water is available.

Demerits:

- Large diameter and longer length pipes are required in this system.
- While laying pipes, skilled workers are necessary.
- The numbers of cutoff valves are more.

4. Radial system:

The area is divided into different zones. The water is pumped into the distribution reservoir kept in the middle of each zone and the supply pipes are laid radially ending towards the periphery.

Merits:

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

Demerits:

- Because of the number of individual distribution reservoirs, the cost of the project is more.

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

For newly proposed township in hilly area the in my opinion Radial System is more suitable, because in hilly area the elevation changes more than plain area. The radial Water distribution system divide hilly areas into several zones due to the undulating terrain. Thus, the hilly area is divided into different zones. The water is pumped into the distribution reservoir kept in the middle of each zone and the supply pipes are laid radially ending towards the periphery. So Radial System is perfect choice.

Question #3: *What are different types of reservoirs used in water supply systems? Briefly describe its importance and how its storage capacity be calculated?* ***(10 Marks)***

Answer #3:

According to the situation with respect to ground, the distribution reservoirs are classified in the following two types:

1. **Surface Reservoirs:**

   Surface reservoirs are circular or rectangular in shape. These reservoirs are constructed at ground level or below ground level and hence these are also called ground reservoirs or non-elevated reservoirs. The treated water stored in these reservoirs is pumped to elevated reservoirs from which it is supplied to the consumers.

2. **Elevated Reservoirs:**

   Elevated reservoirs are constructed at an elevation from ground level. These reservoirs are also known as overhead tanks. These reservoirs may be rectangular, circular or elliptical in shape. However, with the advancement in structural analysis it is possible to construct the elevated reservoirs in any shape to suit the architectural requirements.

Importance of Reservoirs:

The Importance of water-storage reservoirs, therefore, is to impound water during periods of higher flows and then permit gradual release of water during periods of lower flows.

Importance of Surface Reservoirs:

Ensures water security through bridging seasonal (or unexpected) water shortages and stress, reducing pressures on groundwater and avoiding potential depletion.

Importance of Elevated Reservoirs:

An elevated tank is less easy for vermin to access, so elevating water tanks may also prevent some forms of water contamination, like from rats or mice.
Eliminates the need for an electric pump to pump water out, which means less fossil fuels consumed and therefore less harm to the environment.

Calculation of Storage Capacity of Distribution Reservoir:

The total storage capacity of a distribution reservoir is the summation of: Balancing Storage, Breakdown Storage, Fire Storage.

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). The balance storage can be worked out by mass curve method.

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. A provision of 1 to 4 per person per day is sufficient to meet the requirement.

$$Q_F = 65\sqrt{P}\,(1 - 0.01\sqrt{P})$$
$$Q_F = 53\sqrt{P}$$
$$Q_F = 320 * C\sqrt{A}$$

Q_F = Fire Demand
P = Population in thousands
A = Area of all stories of the building under consideration
C = Constant depending on the type of construction.

Total Storage Capacity of a Distribution Reservoir = Balancing Storage + Breakdown Storage + Fire Storage

---

Question #4: *Why pumps are used in water supply schemes and how to calculate pump curve to meet water demand?* ***(10 Marks)***

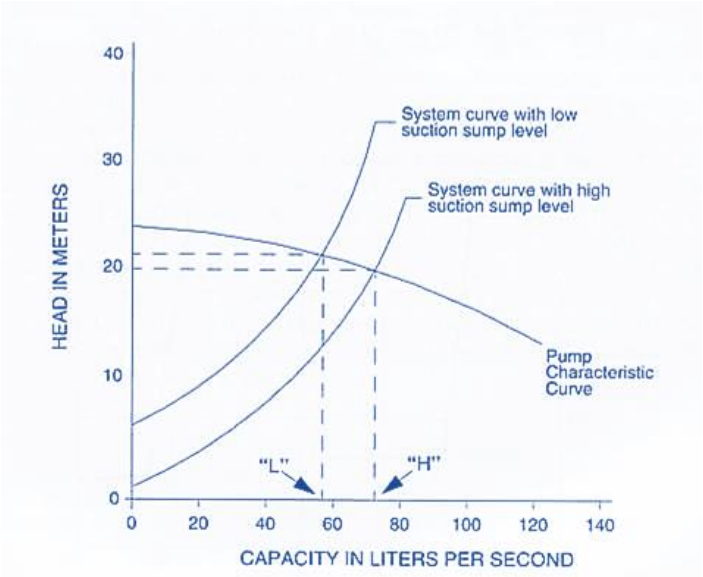
Answer #4:

Pumps are use in water supply schemes for following purposes:

- To lift raw water from wells.
- To deliver treated water to the consumer at desired pressure.
- To supply pressured water for fire hydrants.
- To boost up pressure in water mains.
- To fill elevated overhead water tanks.
- To back-wash filters.
- To pump chemical solutions, needed for water treatment.

Calculation of pump curve to meet water demand:

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



Head is the height to which a pump can raise water straight up. Water creates pressure or resistance, at predictable rates, so we can calculate head as the differential pressure that a pump has to overcome in order to raise the water. Normally expressed in Meters and Feet.

Head is of two types:

1) Static Head:

- Vertical distance between the source and destination.
- It is independent of flow conditions.

2) Friction head:

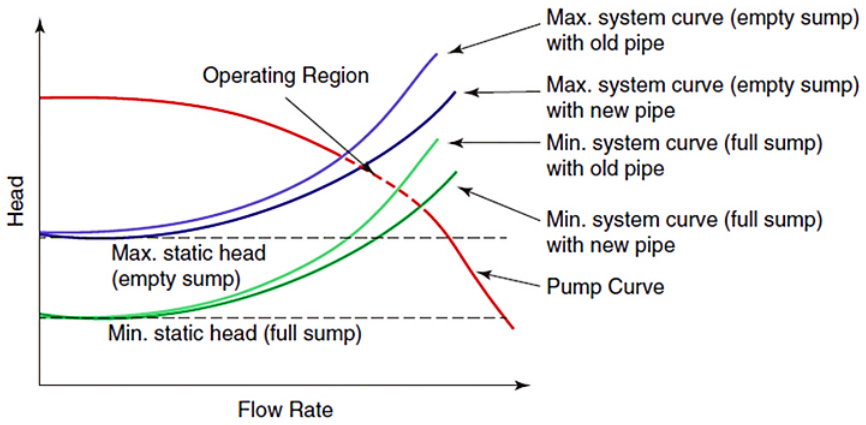
- Resistance to flow in pipe and fittings.
- Depends on size, pipes, pipe fittings, flow rate, nature of liquid.
- Closed loop system only has friction head (no static head).

Flow is the volume of water a pump can move at a given pressure and indicated on the horizontal axis in units like Liters per minute, or gallons per Day.

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

Static Head at any pressure is given as:

$$Head\ (in\ feet) = \frac{Pressure\ PSI\ x\ 2.31}{\text{Specific Gravity}}$$



A system head curve is a common type of tool used in pump selection and system design and sizing. It combines elements of the performance (H-Q) curve of the specific pump under consideration with the combined static, operating, and frictional loss heads **(The Total Dynamic Head Or TDH)** of the system under design.

You can calculate the TDH of a system by measuring the PSI on the effluent side (pressure side) of the pump, and the Hg (inches of mercury) on the influent (suction side). Here's the formula:

(PSI * 2.31) + (Hg * 1.13) = TDH.

Once you have determined the TDH of the system, you then must plot it to the main circulation pump curve as shown in the example curve on the left. In this example, the TDH is 55. Go straight across until you hit the pump curve, then go down to get the flow rate — in this case it's 80 GPM. The picture also shows a TDH of 30, with a flow rate of 110 GPM.

Example