Tahir Kamran, Student ID: 15505, Discipline: MS Civil Engineering, Course Title: Water Demand Supply & Distribution, Course Code: CE-562, Instructor: Nadeem Ullah, Date: 25.06.2020

Q.1. Define desalination and briefly describe various desalination methods? Which method is more effective, please elaborate briefly? (15 Marks)

Ans.1:

DESALINATION:

Desalination is the process of removing salts and other minerals from the saline water to render it suitable for drinking, irrigation, or industrial uses.

Following are the different types of Desalination methods:

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

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 uses a membrane and sends an electric charge through the solution. It draws metal ions to the positive plate on one side and the other ions like salt to the negative plate on other side.

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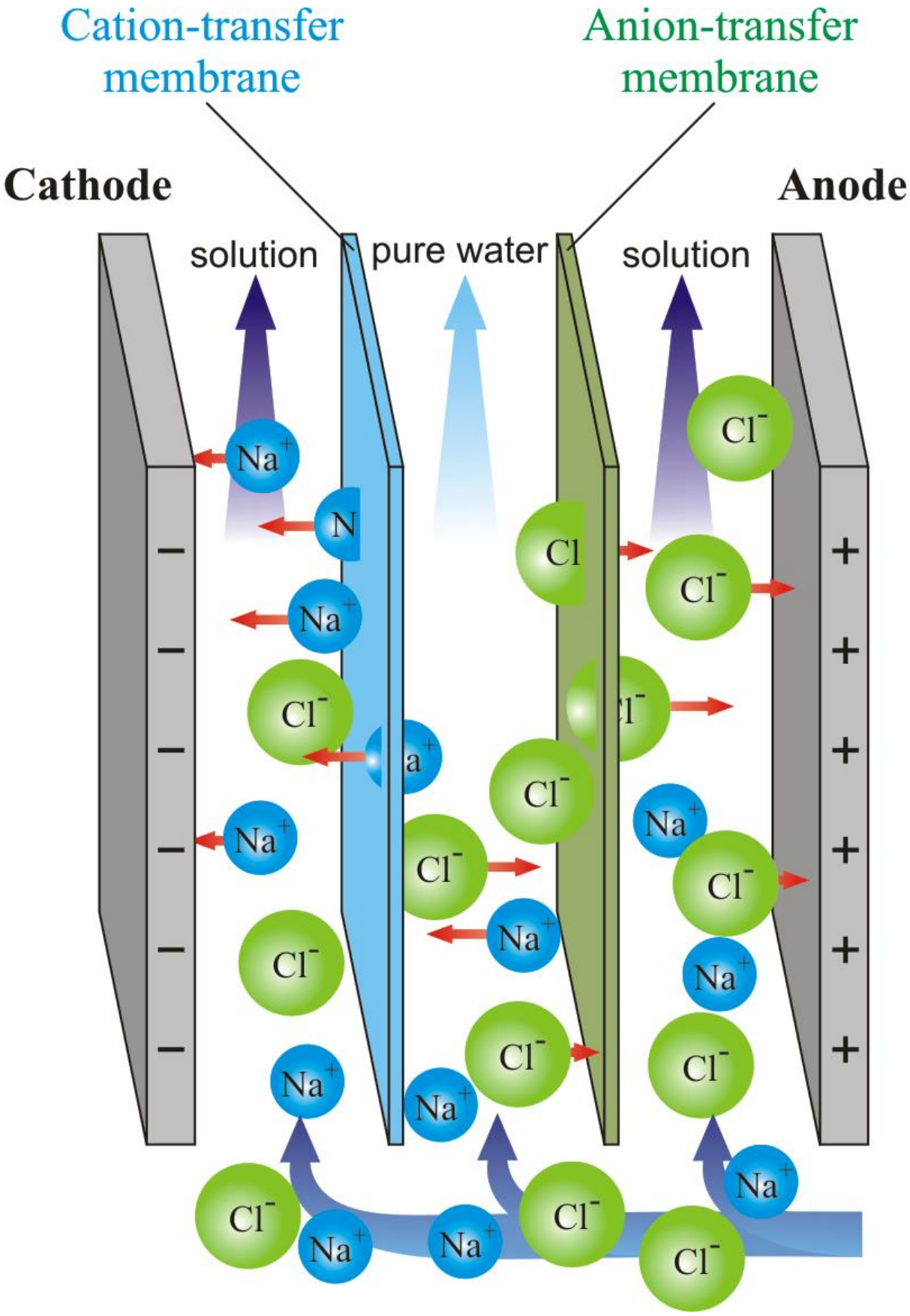
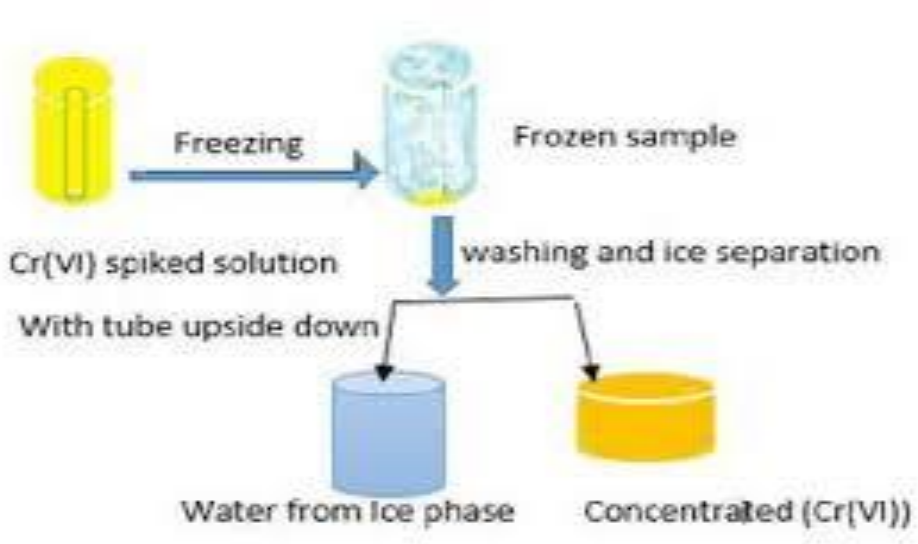


Tahir Kamran, Student ID: 15505, Discipline: MS Civil Engineering, Course Title: Water Demand Supply & Distribution, Course Code: CE-562, Instructor: Nadeem Ullah, Date: 25.06.2020

FREEZING METHOD

It is based on o, ice washing, and ice melting to obtain fresh water with subsequent removal of contaminants.

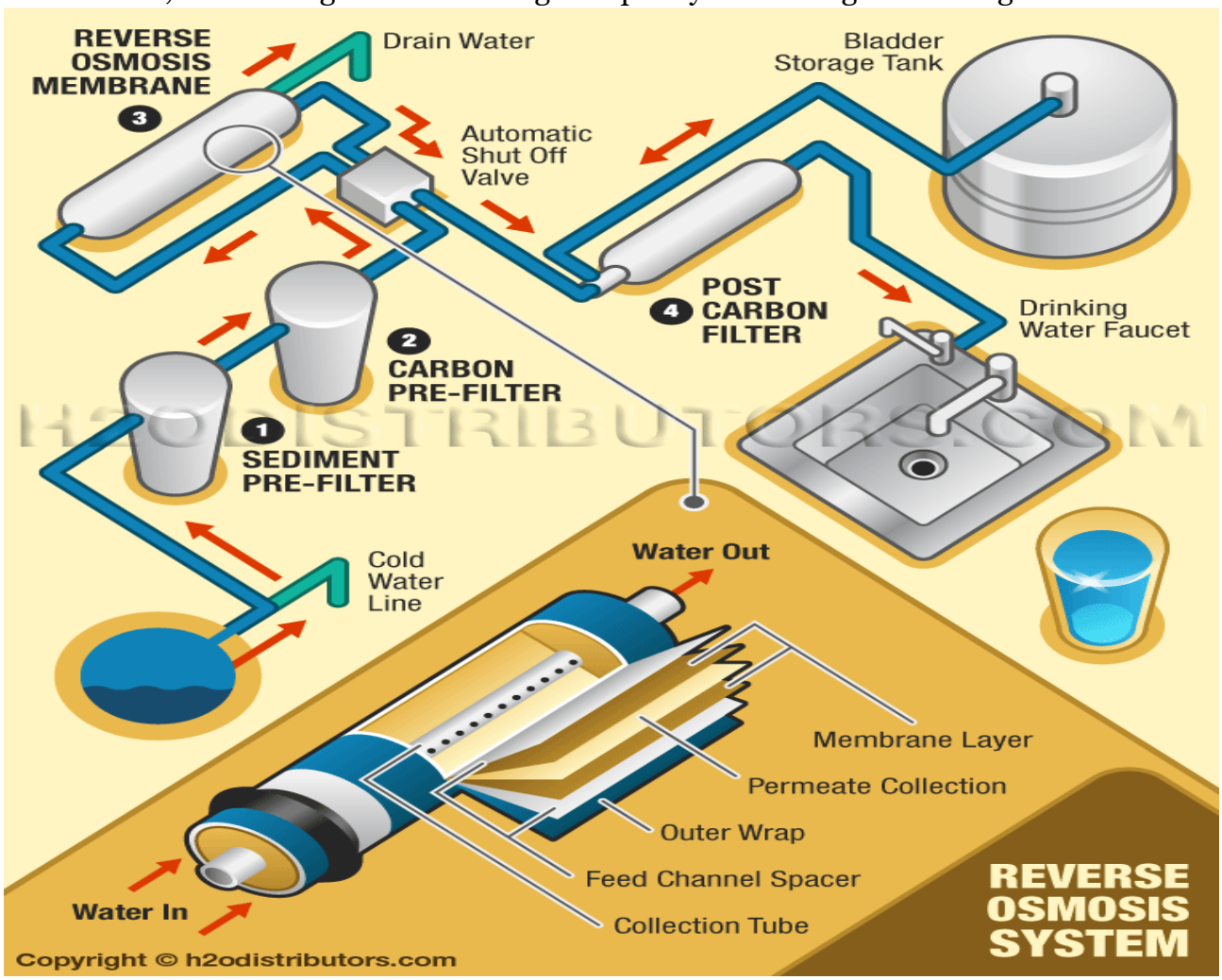


REVERSE OSMOSIS

Reverse osmosis 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 are as follows:

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

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 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.

Reverse Osmosis is the most effective method of desalination, the various reasons to elaborate the above statement is as follows:

Basically there are two main processes i.e. distillation process and membrane process. Distillation process has less capital cost but high operating cost while membrane process is opposite of it. Reverse Osmosis is the more popular membrane process used. In both cases, per unit cost of fresh water varies inversely with the ecomics of scale. Again In each case per unit water cost depends on the salinity level in feeding water. Overall distillation process is 2 time costly than reverse osmosis. Distillation process with solar energy may also be used in areas having sufficient radiation. Both types of plants may be provided at decentralized level. Purifying quality should be properly assessed depending upon feeding salinity level. RO can be adjusted with variations in demand but difficult in distillation. In case of distillation number of stages are adjusted to get the desired purification level. Overall RO is preferred.

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? (15 Marks).

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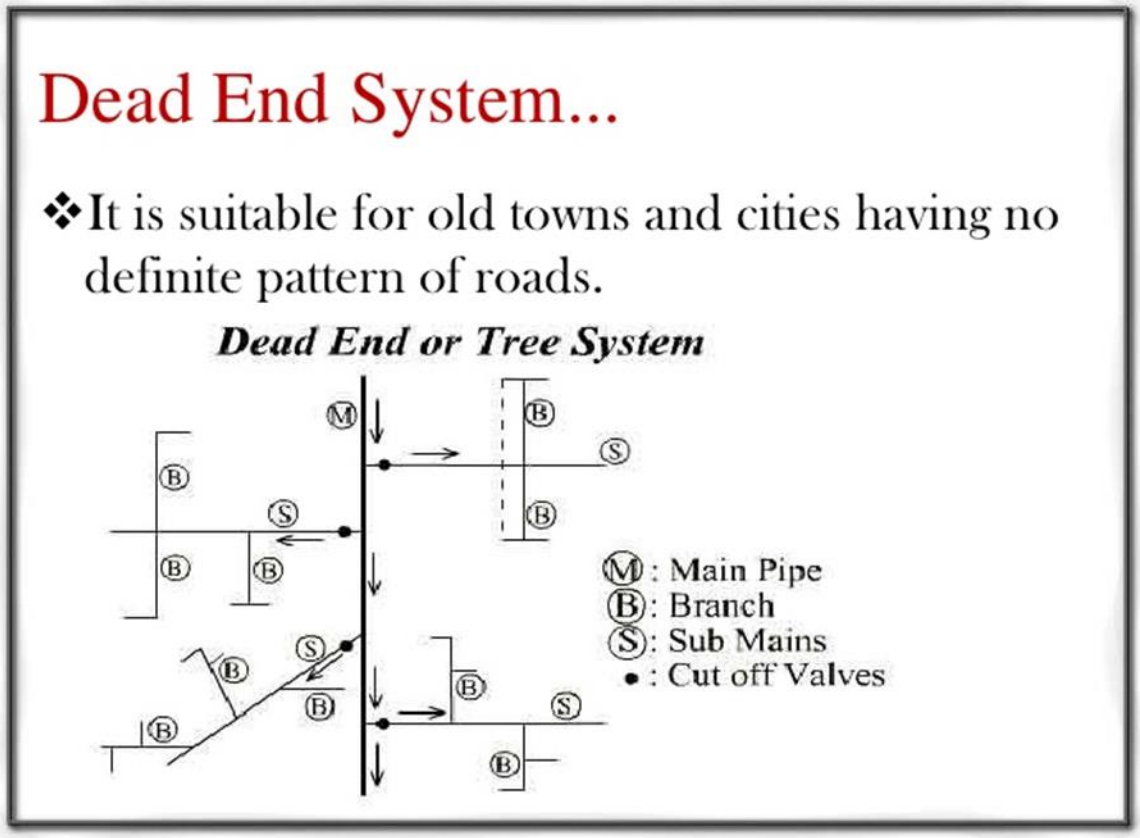
Ans.2.

There are four types of water distribution layouts, namely:

1. Dead End System
2. Radial System
3. Grid Iron System
4. Ring System

Merits and Demerits of 4 types of water distribution layouts:

1. **Dead End System**



Tahir Kamran, Student ID: 15505, Discipline: MS Civil Engineering, Course Title: Water Demand Supply & Distribution, Course Code: CE-562, Instructor: Nadeem Ullah, Date: 25.06.2020

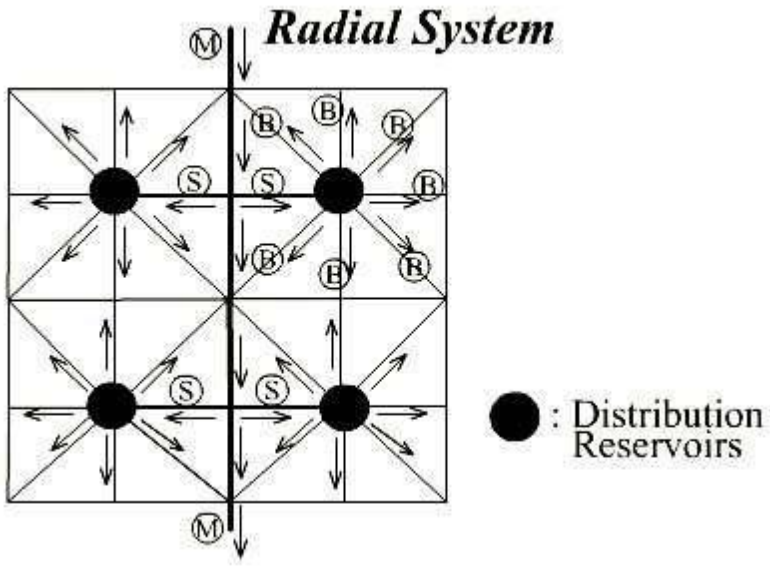
MERITS:

- Determination of discharges and pressure easier due to less number of valves**.**
- Relatively cheap
- This type of system is easy to construct.
- The diameters of pipes of main, sub mains and branches can be designed based on the required demand of population. So, cost of the project can be reduced

DEMERITS:

- Due to many dead ends, stagnation of water occurs in pipes.
- The supply pipes are laid radially ending towards the periphery.
- Large areas are cut off during repairing
- In this system, Limited discharge is available for firefighting

2. Radial System



Tahir Kamran, Student ID: 15505, Discipline: MS Civil Engineering, Course Title: Water Demand Supply & Distribution, Course Code: CE-562, Instructor: Nadeem Ullah, Date: 25.06.2020

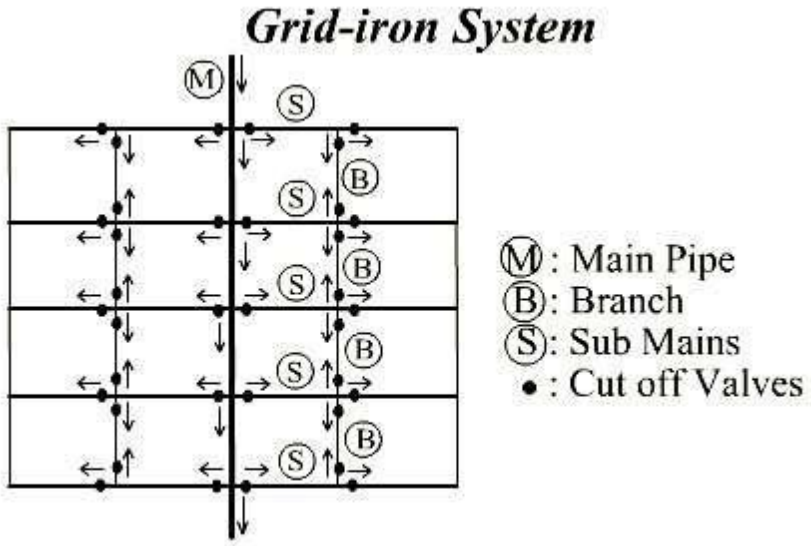
MERITS:

- It gives quick service.
- Stagnation does not occur.
- Repair works can be done without affecting larger network.
- Large quantity of water is available for firefighting

DEMERITS:

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

3. Grid Iron layout



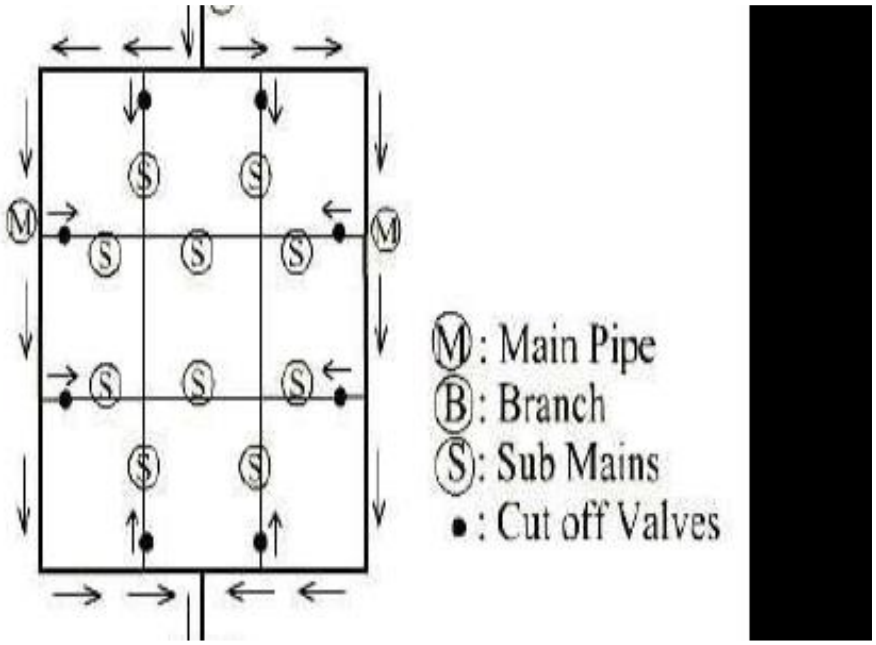
MERITS:

- Water will flow continuously without any dead ends or sediment deposits.
- Head loss is minimum in this case because of interconnection of pipes.
- The discharge will meet the required discharge for firefighting.
- Repair works can be easily done just by closing cutoff valve in that line which do not affect the other users.

DEMERITS:

- Because of circulating flow from all directions, the pipes used in this system should be of large diameters and longer lengths.
- We cannot determine the accurate discharge, velocity or pressure in a particular pipe. So, design is difficult.
- Laying of pipes will be done by skilled workers which consume more cost.
- Cutoff valves required should be more in this system.

4. Ring System



MERITS:

- Water can be supplied to any point from at least two directions.
- Provision of air valves are not required as the house or the township is at higher elevation than the distribution system.

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

DEMERITS:

- Longer length and large diameter pipes are required.
- More number of cutoff valves are necessary.
- Skilled workers are necessary while laying pipes.
- Construction cost is also more compare to other water distribution systems.

Recommendations for choosing the type of layout in Hilly Areas new township:

Having studied the different types of water distribution layouts, it is highly recommended to use the **RADIAL WATER DISTRIBUTION LAYOUT** in townships in hilly areas. The basis for the recommendation are summarized as follows:

- Water distribution systems in hilly areas are always divided into several zones due to the undulating terrain.
- It introduces two indicators – pressure limitation and pressure variation to enable the automatic division of the water supply pipe network.
- It prioritizes economic index as the objective function in the evaluation of the division of water distribution systems in hilly areas townships, and then selects the optimal division scheme by generic algorithm in a large number of candidates.
- This procedure is easier to operate time-saving by staff and is more automatic.
- It gives quick service.
- Stagnation does not occur.
- Repair works can be done without affecting larger network.
- Large quantity of water is available for firefighting

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.

Types of Water Reservoirs:

The water reservoirs are classified into two types, according to their elevation with respect to ground.

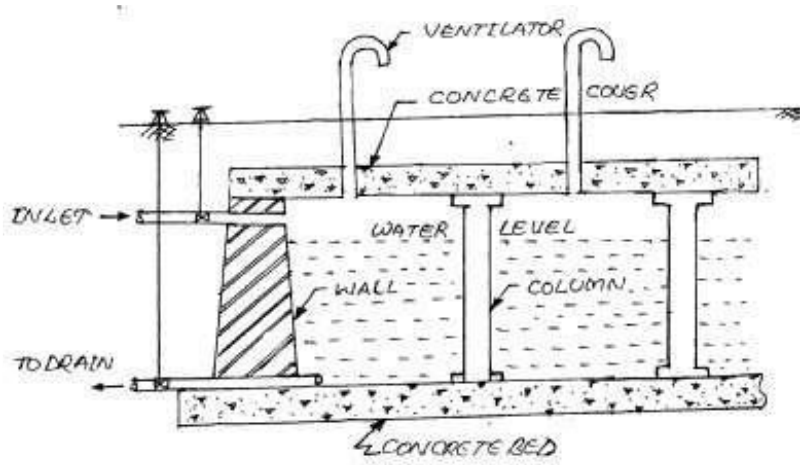
Tahir Kamran, Student ID: 15505, Discipline: MS Civil Engineering, Course Title: Water Demand Supply & Distribution, Course Code: CE-562, Instructor: Nadeem Ullah, Date: 25.06.2020

1. Surface Reservoirs
2. Elevated Reservoirs

1. Surface Reservoirs:

Surface reservoirs are also termed as ground reservoir. Usually they are constructed circular or rectangular in shape. Keeping in view the huge storage capacity underground reservoirs are preferred and are generally constructed on high natural grounds. Construction material such as stones, bricks, PCC and RCC are used. To obtain water tightness and proofing, bitumen compounds are used at all construction joints and floor slab.
While designing these reservoirs, position of ground water table is important for consideration. The side walls are properly designed to take up the pressure of the water, when the reservoir is full and the earth pressure when it is empty.
For aeration of water and inspection, manholes, ventilation pipes and stairs are provided.

Diagram of Surface Reservoir



2. Elevated Storage Reservoir:

Elevated Storage Reservoirs (ESRs) or Overhead Tanks are used to provid sufficient pressure head, if the topography for distribution areas is not suitable for gravity system of distribution. These are rectangular or circular in shape. They are constructed where combine gravity and pumping system of water distribution is adopted.

Diagram of Elevated Reservoir

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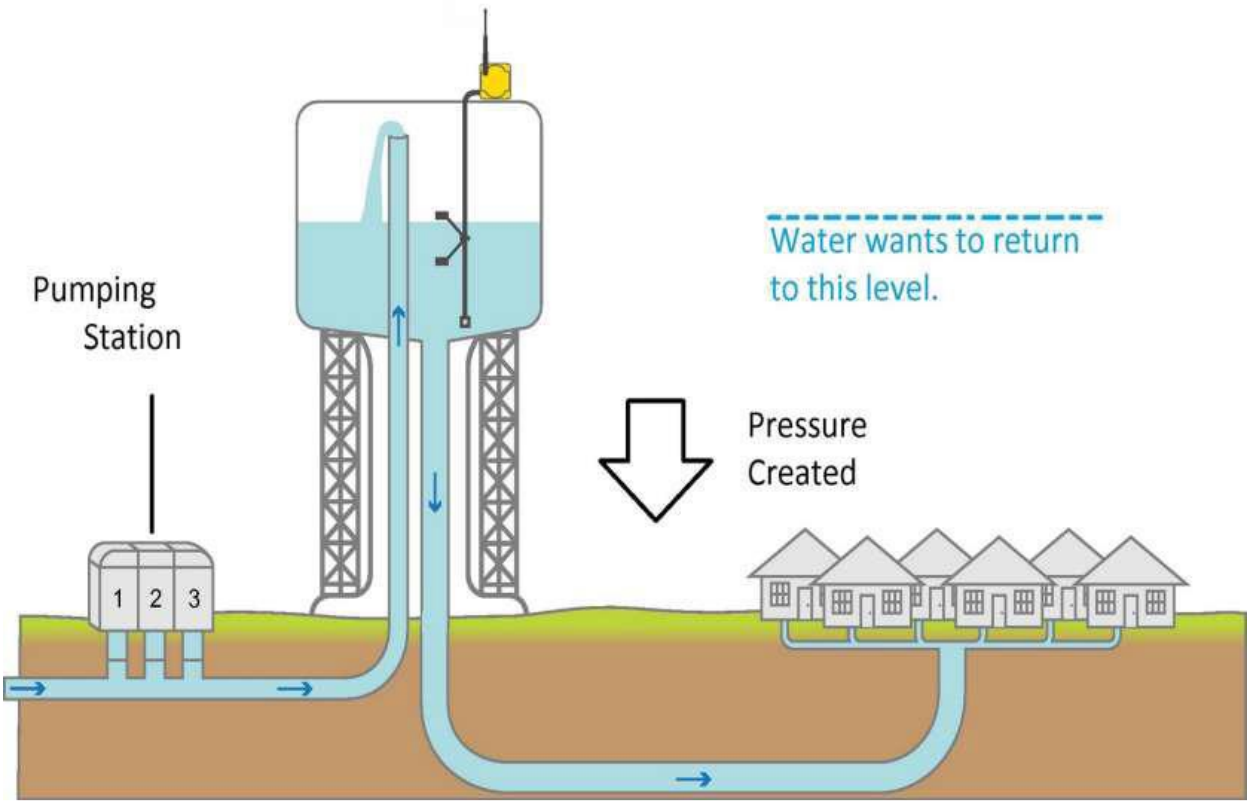

Importance of Distribution Reservoirs:

Distribution/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. Water level in the reservoir must be at a sufficient elevation to permit gravity flow at an adequate pressure.

Storage Capacity of Reservoir:

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

A) **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).

B) **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.

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C) 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;

Total Storage Capacity = Balancing Storage + Breakdown Storage + Fire Storage

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

Ans. 4.

Pumping system is used to:

- Transfer water and/or liquid from source to destination
- Circulate water and/ or liquid around a system
- Move water from treatment plant to distribution system or reservoirs
- Maintain pressure in the distribution system

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 / min etc.

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

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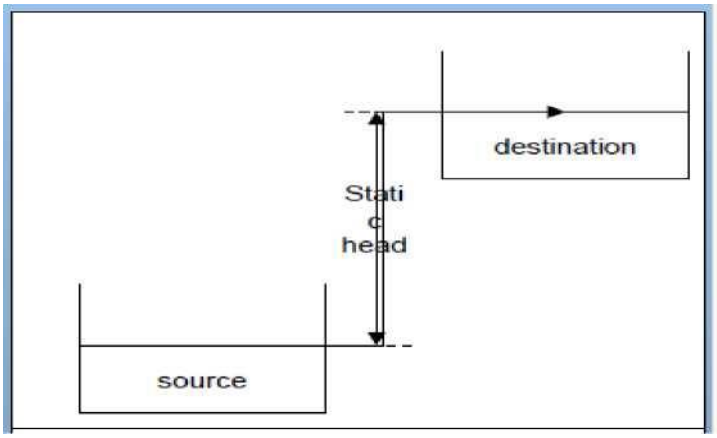
Head is of two types:

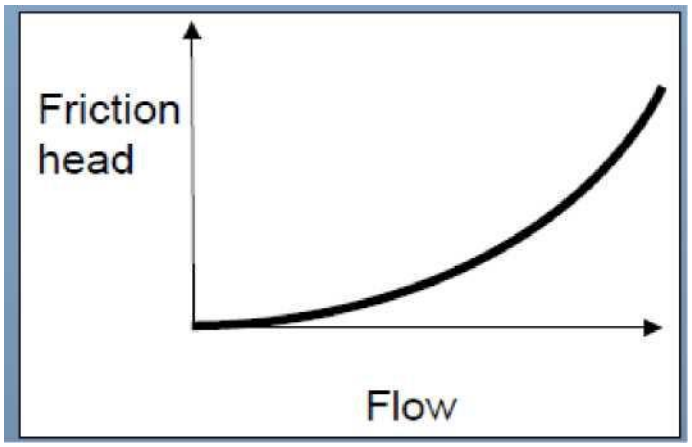
1) Static Head:

- 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).



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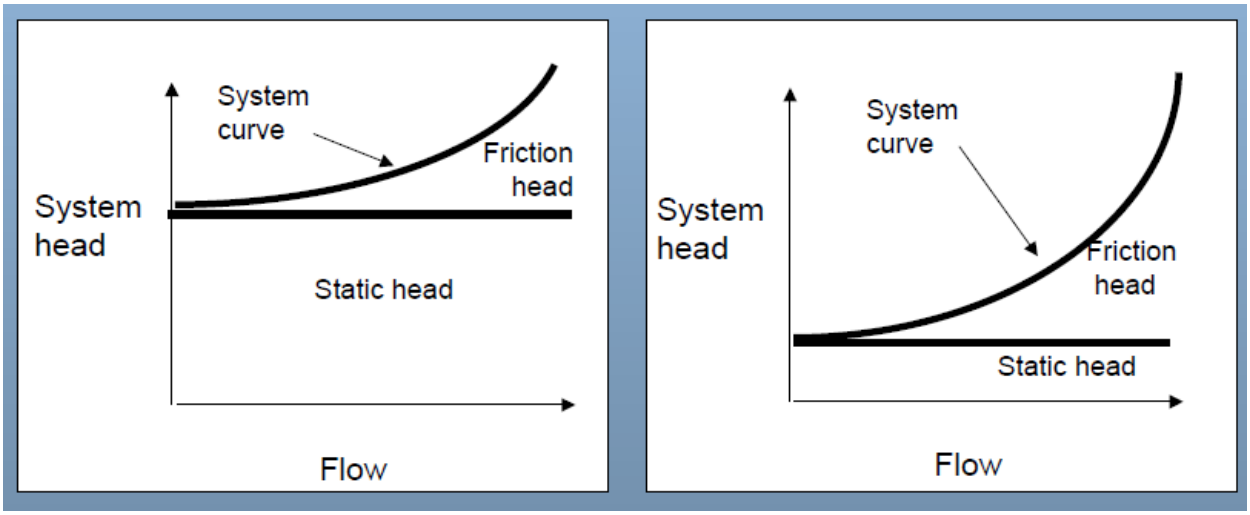
System Head is the sum of static head and friction head



Static Head at any pressure is given as

Head (in feet) = Pressure (in psi) x 2.31/Specific gravity

From the above discussion it is clear that the pump curves are calculated by combining static and friction heads.