IQRA NATIONAL UNIVERSITY

DEPARTMENT OF CIVIL ENGINEERING

M.S TRANSPORTATION

FINAL TERM ASSESSMENT

Submitted To:

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Course:

Water Demand Supply & Distribution

Course Code: CE-562

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

Answer:

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.

Beside natural desalination i.e Evaporation, Condensation, Precipitation and collection

The following most important methods for Desalination.

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

Distillation (Evaporation) Method:

In this method salt water is heated in one container to make the water evaporate, leaving the salt behind.

Then desalinated vapor is then condensed to form water in a separate container.

Drawback of this method:

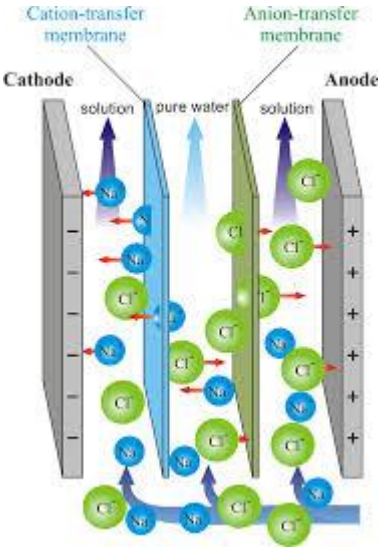
Although long known, it has found limited applications in water supply because of the fuel costs involved in converting salt water to vapor is very high.

Electro Dialysis:

In this method i.e Electro Dialysis utilizes a membrane and sends an electric charge 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.

This method mostly used in Russia for drinking water where saline water exist.

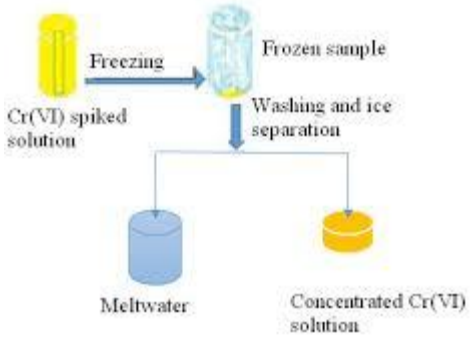


Freezing:

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

Its involves three steps

- Ice Formation
- Ice Washing
- Ice Melting to obtain Fresh Water by removal of contaminants.



Effective Method:

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

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.

5 th 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.

Q2: Briefly describe merits and demerits of 4 types of water distribution layouts? Which layout will you recommend for newly proposed township in hilly are? Support your answer with justification?

Answer:

Merits & demerits of 4 types of water system:

There are four types of Water Distribution layouts.

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

Merits and demerits of above system

Dead End System

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.

Radial System:

Merits:

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

Demerits:

Water pressure low being more connection from center.

Grid Iron System:

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.

Ring System:

Merits:

- Water can be supplied to any point from at least two directions.

Demerits:

- Pressure and supply to Sub Mains will be Low/less.

System recommended for New Town Ship for Hill Area:

I will recommend Grid Iron system for new town ship in Hill areas. Because water is kept in good circulation due to the absence of dead end. Furthermore in the cases of breakdown in some section water is available from some other direction. Although its design is difficult but being township proper designing for each items water, sewerage etc. is mandatory so water is essential part which to be design carefully and good pipes layouts to be adopted.
In Mohmand Marble City (Mohmand Agency) now merged area which is located at Hill area , the Grid Irion system for water supply distribution adopted.

Q3: what are different types of reservoir used in water supply system Briefly describe its importance and how its storage capacity be calculated

Answer:

There are two types of reservoirs used in water supply system.

1. **Surface Reservoirs**
2. **Elevated Storage Reservoirs**

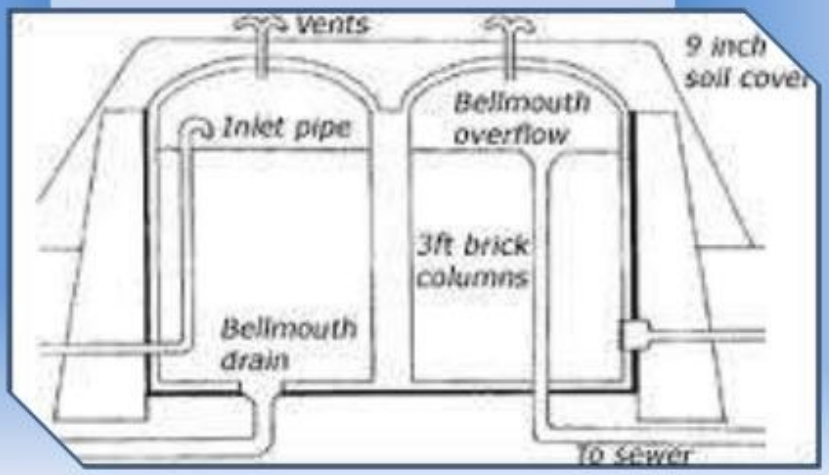
Surface Reservoirs:

These are also called ground reservoir.

- Mostly Circuler or rectangular Tank
- Under Ground 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 od stones, bricks, plain or reinforced cement concrete.

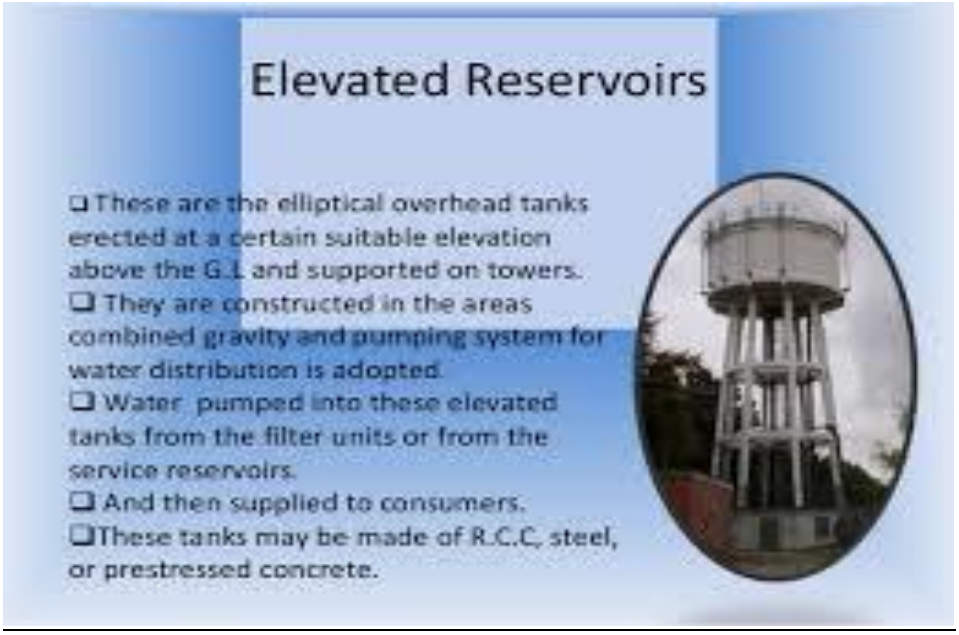
- The side walls are designed to take up the pressure of the water, when the reservoir is full and the earth pressure when it si empty.
- The position of ground water table is also considered while designing these reservoirs.
- The floors of these reservoirs may be constructed with RCC slab or stone blocks with sufficient water proofing.
- To obtain water tightness bitumen compounds are used at all construction joint.
- For aeration of water and inspection. Manholes, ventilation pipes and stairs are provided.

- Ladders to reach the top of the reservoir and then upto the bottom of the reservoir for inspection.
- Manholes for providing entry into the tank for inspection purpose.
- Ventilator for freh air circulation



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.



Importance:
In many cases domestic drinking and industrial water supply at the current level of development of the national economy can be provided only by reservoirs. Large reservoirs, other conditions being equal, improve the quality of river water and adjust it seasonally. The development of reservoirs usually requires relocation of water intakes and outfall sewers and the accomplishment of many sanitary measures. It is necessary to find means to combat bluegreen algae and to utilize more fully the potentialities created by reservoirs for recreation.

The storage capacity can be calculated by summation of

Balance Storage + Breakdown Storage + Fire storage

Balance 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).

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.

- 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 m^3/d
A = Area of all stories of buildings under consideration (m^2)
C = Constant depending on the type of Construction

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

Answer:

Pumping system is used for water supply is more reliable and timely provided the demand for drinking , irrigation and sewerage purpose.

- 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.
- Also called pumping without storage system.
- Depending upon the demand, high lift pumps are required.
- Pressure in the distribution system reduces along the length of flow and depends on area topography as well.
- If power supply fails, complete stoppage of water supply occurs.
- Operational cost of this system is much higher than gravity system.

The term water supply pump refers to all **centrifugal pumps** which transport drinking or service water either directly to a supply network or through long-distance pipes to a supply area.

Requirements to be met by water supply pumps:

- High **efficiency** (continuous operation)
- Reliable bearing arrangement which does not impair the water quality
- Low noise level

Various **types of pumps** are used depending on the **flow rate** (Q), **head** (H) and installation conditions.

Types of pumps and their operating ranges

- **Submersible borehole pumps** are installed in wells. They pump the water directly to the network if no water treatment is required:
  Q up to 3,000 m^3/h, H up to 1,400 m
- Vertical, wet-installed **deep-well turbine pumps** (see **Vertical pump**; see **Wet well installation**):
  Q up to 2,800 m^3/h, H up to 160 m
- Vertical, wet-installed, multistage **tubular casing pumps** (see **Mixed flow pump**; see **Multistage pump**):
  Q 800 to 30,000 m^3/h, H up to 140 m
- Single-stage, single-entry **volute casing pumps**:
  Q up to 36,000 m^3/h, H up to 140 m

- Single-stage, single-entry volute casing pumps with **diffuser**: Q = 500 to 10,000 m^3/h, H up to 210 m
- Multistage pumps: Q = 20 to 500 m3/h, H up to 500 m; Q = 500 to 3,500 m^3/h, H up to 350 m
- Double-suction, single-stage volute casing pumps (see **Double-suction pump**): Q = 100 to 30,000 m^3/h, H up to 500 m
- Double-suction, single-stage volute casing pumps with diffuser: Q = 800 to 20,000 m^3/h, H up to 700 m

  - This system is suitable in areas where high residual pressure and continuous flow is demanded.
  - Normally electricity or solar energy is used for pumping.

Pump Curve:

A pump performance curve is simply a graph or chart that represents the performance capabilities of a given water pump. A pump manufacturer conducts a variety of tests and the findings are then reflected on a graph, which we refer to as the pump curve. A pump curve will typically show not just the maximum capabilities of the pump, but just as important, many pump curves will give information helpful in determining the best efficiency point (BEP) for flow rates as well as reflecting the preferred operating range (POR) of the water pump. Once you know how to read a pump curve you will be able to determine **what to expect from your water pump:** how many feet is it capable of pumping, how many gallons per minute, and what will be the ideal operating performance for efficiency, as well as other important information.

The Most Common Information a Pump Curve Provides

- Total Dynamic Head

  Total dynamic pump head, most commonly referred to as total head, concisely stated is **the height that a water pump is capable of raising a liquid**. It is the total vertical distance that the pump is capable of 'pumping'. It answers the question, "How

high can it pump?" **The greater the pressure, the higher the head. The lower the pressure, the lower the head**.

- Flow Rate
  Flow rate, or rate of flow, is the **total maximum amount of liquid flow that a pump can produce during a specified period of time**. It is almost always **measured per minute** and most pump curves will show either gallons per minute (GPM) or liters per minute (LPM), or commonly both. Flow rate answers the question, "How many gallons can I expect?" The greater the pressure, the higher the flow rate. The lower the pressure, the lower the flow rate.
- NPSHr (Net Positive Suction Head Required)
  Net positive suction head required is the **minimum amount of pressure or force of energy that is required at the suction port (inlet) to overcome the losses from friction** that are caused between the suction head/nozzle (inlet) and the eye of the impeller, without causing vaporization (cavitation) of the liquid being pumped.
- Best Efficiency Point
  Every pump has a best efficiency point (BEP) and many pump curves will clearly show the BEP. BEP is the **rate of flow and the total head at which a pump efficiency is at a maximum** at a given motor speed and impeller diameter.
  BEP is a combination of the head/flow rate as it corresponds to the highest efficiency. BEP directly corresponds to the input horsepower of the motor required to drive the pump and the horsepower created by the flow of water created by the pump.

  For a pump to be 100% efficient the input horsepower needed would be equal to the water horsepower being created. No pump is capable of 100% efficiency and as a result every pump will require more horsepower input from the motor than it is capable of generating in water horsepower.

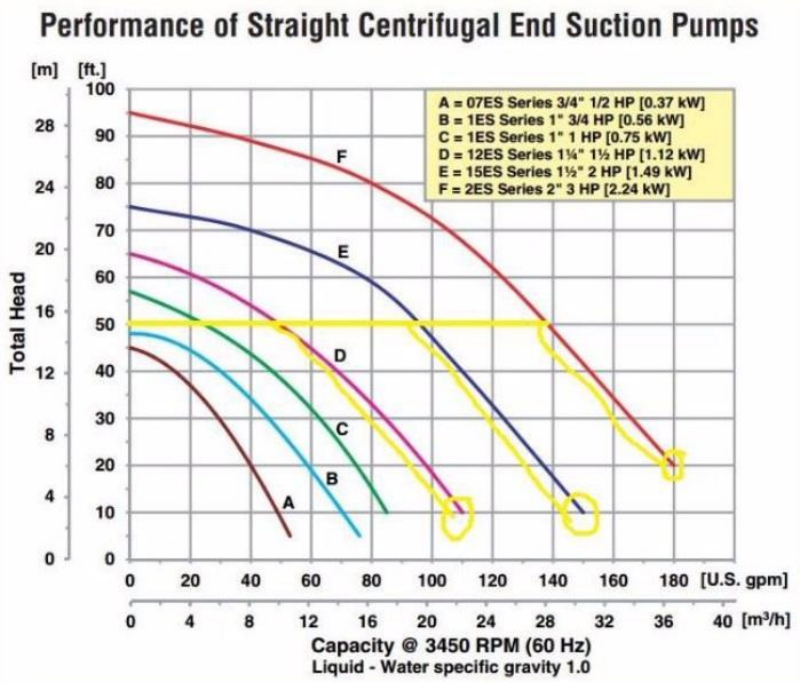
  Think of the BEP as what a baseball player would refer to as the "sweet spot" of the bat! Studies have shown that by operating within the BEP, the pump/motor life is extended. This not only minimizes the cost of repairs, maintenance, and replacement, but also the costs incurred during a down time of production for a pump that is no longer operational.

- Preferred Operating Range (POR)
  Referred to as the preferred operating range or preferred operating region. A pump will run best the closer it is to the BEP. For this reason, The Hydraulic Institute has determined that the preferred operation range as it pertains to water flow is between 70%-120%. Most manufactures will recommend a POR that is between 80% and 110% as operation in the POR has direct implications on the life of the pump as well as power consumption.
  Pump manufactures give a variety of information on their pump curves. Some are more detailed than others. However, most manufacturers will offer more detailed specs,

requirements, additional curves, etc. in their product manuals. But the most basic information that the average consumer needs typically boils down to 2 items: **Total Pump Head & Gallons Per Minute**

Reading a Pump Curve

Let's look at an example situation to help you pick out the right pump for your application using just pump head and gallons per minute to help us come to a decision on the right pump.



<u>Situation #1</u>: You are replacing an old pump that already has the pipes in place that are 2" going into the pump and 2" going out. The old pump is pumping water from a 5,000 gallon tank and pumping the water to a second tank that is 50 feet above the first tank. Your old pump was pumping approximately 100gpm (gallons per minute) and you would like to try to get a pump that will perhaps get you to 150gpm due to increased production demands.

So we can determine the following:

- You need a pump with a 2" inlet diameter and a 2" outlet diameter
- You have a minimum pump head of 50 feet
- You would like a pump that will give at least 150gpm

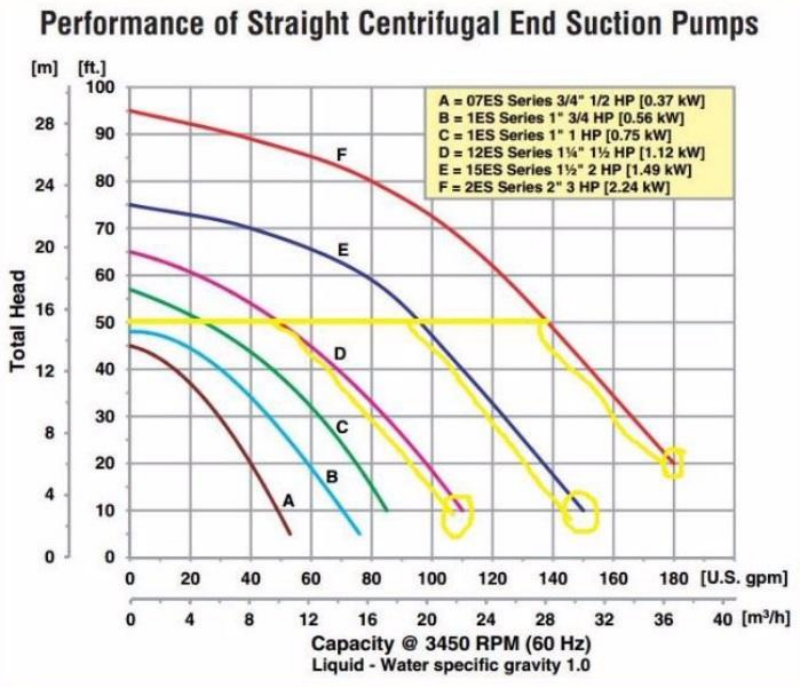
Looking at the pump curve below, which of the following 2" pumps will work for your application?

Step #1: Start with your required pump head (50 feet) on the left-hand side of the curve

- We can see that pumps A & B are below our required head, so we can rule them out.
- We now have 3 pumps on this curve that meet our total pump head requirement of 50ft.

Step #2: Determine which pump is capable of 125gpm or more

- From the left of the curve, starting at 50ft, draw an imaginary line to the right.
- Then follow each pump curve down towards the GPM.
- We can see that pump D will give us the 50 feet of head we require but will only give us 110gpm. It's probably similar to the pump you are replacing.
- Pump E will meet our 50ft head requirement (it's capable up to 75ft) and at 50ft head it will give us 145gpm. Pump F at 50ft of head will give us 180gpm.



Step #3: Decision Time!
You have 3 pumps to choose from that meet your requirements but you still have a few things to consider:

- Pump D:
  - Pro: similar to the pump you are replacing
  - Con: no real increase in performance in GPM (110gpm total)
  - Pro: guaranteed to be lower cost than pumps E & F
- Pump E:
  - Pro: increase of 45gpm compared to your old pump (145gpm total)
  - Pro: gets you close to your desire of 150gpm
  - Con: 5gpm lower than your 150gpm goal
  - Con: higher price than pump D
- Pump F:
  - Pro: increase of 80gpm compared to your old pump
  - Pro: 35gpm greater than pump E
  - Pro: gets beyond your desire of 150gpm (180gpm total)
  - Con: higher price than pumps D & E

Conclusion

As you can see there are many considerations to look at when picking out a pump. And we only looked at one example and a simple one at that!

While there is a lot of information available to you, the consumer, finding the most basic information is not as hard as one would think. Just remember, the best thing to do is to ask an expert if you are not sure! But now that you know the most basic details as you look at a pump curve, you will be better prepared to make the best decision on the right pump.