DEPARTMENT OF CIVIL ENGINEERING

Final Assignment / Quiz (Spring 2020)

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Subject:	**Water Demand Supply and Distribution**
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Dept & Semester	**MS (CEM) Final semester**

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

Ans:

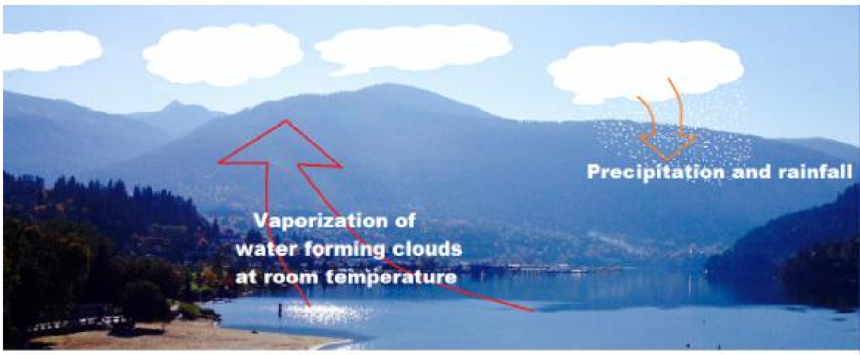
Desalination: Desalination or desalinization refers to any of several processes that remove the excess salt and other minerals from water in order to obtain fresh water suitable for animal consumption or irrigation, and if almost all of the salt is removed, for human consumption, sometimes producing table salt as a by-product.
The basic considerations are…

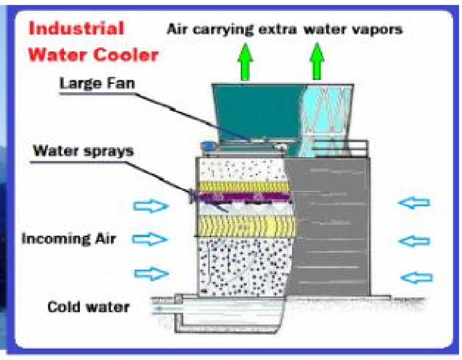
Demandforfreshwater(domesticuse,industry,agricultureetc.)
Lackofconventionalwatersources
Availabilityofsaltwater
AvailabilityofInfrastructure(energy,waterdistributionnetwork)
Interestforfinancing(invest,maintenance,energy,…)

Desalination methods:

NaturalDesalination: Major Stages:

1.Evaporation
2. Condensation
3. Precipitation
4. Collection





PrincipalMethods for Desalination

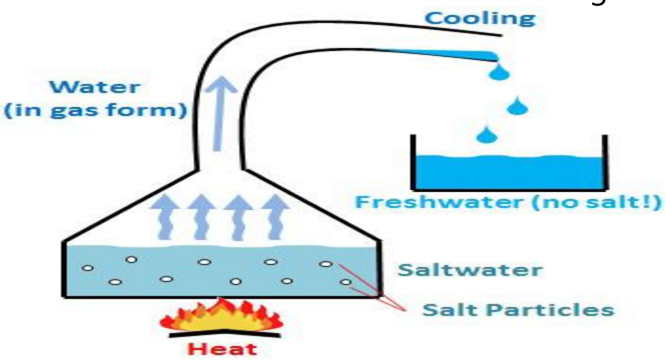
Demand for fresh water (domestic use, industry, agriculture.....)
• Lack of conventional water sources
• Availability of salt water
• Availability of Infrastructure (energy, water distribution network)
• Interest for financing (invest, maintenance, energy,...)

PrincipalMethods for Desalination

Distillation(Evaporation)
Electro dialysis
Freezing
Reverse osmosis

Distillation(Evaporation):

Salt water is heated in one container to make the watere vaporate,leaving the salt behind. The desalinated vaporis 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 vaporis very high.



Electrodialysis: Electrodialysis is a membrane-based process that uses an electric field to filter out the salt. It uses very little energy but is limited to the treatment of low-salinity water.

Freezing Method:
In this method 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 .

ReverseOsmosis(RO):

It is a water purification technology/method that uses asemi-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.

MOST EFFECTIVE METHOD OF DESALINATION:

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.

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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, a5-micron filter isused.The sediments are filtered in order to make sure that no damage is done to the membrane.
The micron f
ilter does not let the separticles pass by and thus they are suspended.

2nd Step–

In the second step **carbonfilter** isused 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.

Extent of Use

The capacity of reverse osmosis desalination plants sold or installed during the 20-year period between 1960 and 1980 was 1 050 600 m^3/day. During the last 15 years, this capacity has continued to increase as a result of cost reductions and technological advances. RO-desalinated water has been used as potable water and for industrial and agricultural purposes.

Potable Water Use: RO technology is currently being used in Argentina and the northeast region of Brazil to desalinate groundwater. New membranes are being designed to operate at higher pressures (7 to 8.5 atm) and with greater efficiencies (removing 60% to 75% of the salt plus nearly all organics, viruses, bacteria, and other chemical pollutants).

Industrial Use: Industrial applications that require pure water, such as the manufacture of electronic parts, speciality foods, and pharmaceuticals, use reverse osmosis as an element of the production process, where the concentration and/or fractionating of a wet process stream is needed.

Operation and Maintenance

Operating experience with reverse osmosis technology has improved over the past 15 years. Fewer plants have had long-term operational problems. Assuming that a properly designed and constructed unit is installed, the major operational elements associated with the use of RO technology will be the day-to-day monitoring of the system and a systematic program of preventive maintenance. Preventive maintenance includes instrument calibration, pump adjustment, chemical feed inspection and adjustment, leak detection and repair, and structural repair of the system on a planned schedule.

The main operational concern related to the use of reverse osmosis units is fouling. Fouling is caused when membrane pores are clogged by salts or obstructed by suspended particulates. It limits the amount of water that can be treated before cleaning is required. Membrane fouling can be corrected by backwashing or cleaning (about every 4 months), and by replacement of the cartridge filter elements (about every 8 weeks). The lifetime of a membrane in Argentina has been reported to be 2 to 3 years, although, in the literature, higher lifespans have been reported.

Operation, maintenance, and monitoring of RO plants require trained engineering staff. Staffing levels are approximately one person for a 200 m^3/day plant, increasing to three persons for a 4 000 m^3/day plant.

Effectiveness of the Technology

Twenty-five years ago, researchers were struggling to separate product waters from 90% of the salt in feedwater at total dissolved solids (TDS) levels of 1 500 mg/1, using pressures of 600 psi and a flux through the membrane of 18 l/m^2/day. Today, typical brackish installations can separate 98% of the salt from feedwater at TDS levels of 2 500 to 3 000 mg/1, using pressures of 13.6 to 17 atm and a flux of 24 l/m^2/day - and guaranteeing to do it for 5 years without having to replace the membrane. Today's state-of-the-art technology uses thin film composite membranes in place of the older cellulose acetate and polyamide membranes. The composite membranes work over a wider range of pH, at higher temperatures, and within broader chemical limits, enabling them to withstand more operational abuse and conditions more commonly found in most industrial applications. In general, the recovery efficiency of RO desalination plants increases with time as long as there is no fouling of the membrane.

Suitability

This technology is suitable for use in regions where seawater or brackish groundwater is readily available.

Advantages

· The processing system is simple; the only complicating factor is finding or producing a clean supply of feedwater to minimize the need for frequent cleaning of the membrane.

· Systems may be assembled from prepackaged modules to produce a supply of product water ranging from a few liters per day to 750 000 l/day for brackish water, and to 400 000 l/day for seawater; the modular system allows for high mobility, making RO plants ideal for emergency water supply use.

· Installation costs are low.

· RO plants have a very high space/production capacity ratio, ranging from 25 000 to 60 000 $l/day/m^2$.

· Low maintenance, nonmetallic materials are used in construction.

· Energy use to process brackish water ranges from 1 to 3 kWh per 1 0001 of product water.

· RO technologies can make use of use an almost unlimited and reliable water source, the sea.

· RO technologies can be used to remove organic and inorganic contaminants.

· Aside from the need to dispose of the brine, RO has a negligible environmental impact.

· The technology makes minimal use of chemicals.

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?

Ans:

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.

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

Ans:

Reservoirs are those water bodies formed or modified by human activity for specific purposes, in order to provide a reliable and controllable resource.

TYPES OF RESERVOIRS:

Reservoirs may be classified according to their function, their relative position with respect to the earth's surface, manner of operation, and the type of material of construction.

1. **Elevated Reservoirs:**

   Reservoirs are constructed in elevated or hilly areas. In case of flat areas, a supporting frame or tower is installed to support the storage tank. This is known as an elevated reservoir. Standpipes are reservoirs with height greater than their diameter.

2. **Ground Level Reservoirs:**

   Ground level reservoirs may be made of reinforced concrete pipe, fiber glass, concrete hollow blocks, steel or ferro-cement. These may be single ground level tanks or multiple type tanks.

Operation of Reservoirs:

Reservoirs may be operated on the following basis:

1. Floating-on-the-Line Reservoir: Water is pumped both into the reservoir and to the consumers; water goes up the tank when the water demand is low or if there is a residual water supply. During peak demand, water goes to the customers directly from the source and from the tank. This system requires fairly continuous pumping at low pumping capacity.

2. **Fill-And-Draw Reservoir:**

Water flows or is pumped directly into the reservoir and from the reservoir, water supply is distributed to the consumers through gravity flow. The tank is usually installed near the water source to minimize head losses due to friction losses. In the fill-and-draw system, however, water is conveyed to the storage tank at high pumping capacity at shorter time duration, and always against the maximum head.

Importance of Reservoirs:

In water supply distribution systems, whether water is obtained by gravity or by pumping,

reservoirs are usually necessary for the following reasons:

• To balance the supply and demand in the system. In small distribution systems, variations in demand may be three or more times the average hourly consumption.

• To maintain adequate and fairly uniform pressure throughout the distribution system.

• To avoid the total interruption of water service when repairing pipes between the source of supply and the reservoir.

• To allow pumps to be operated uniformly throughout the day. Such pumps may be much smaller than would otherwise be required.

Storage Capacity of reservoir: As a rule of thumb, the storage Reservoir volume should be at least equal to one-fourth (25%) of average day demand of the community.

The formula is:

$$Cr = (1/4)\,(ADD)$$

Where:

Cr=Reservoir capacity in liters

ADD= Average Day Demand in liters per day

Q 4. Why pumps are used in water supply schemes and how to calculate pump curve to meet water demand?

Ans:

The reasons why we use pumps in water supply system are ....

Pumps and equipments are used for pumping fluids from one place to another. They are used for a variety of infrastructure systems, such as the supply of water to canals, the drainage of lowlying land, and the removal of sewage to processing sites. A pumping station is, by

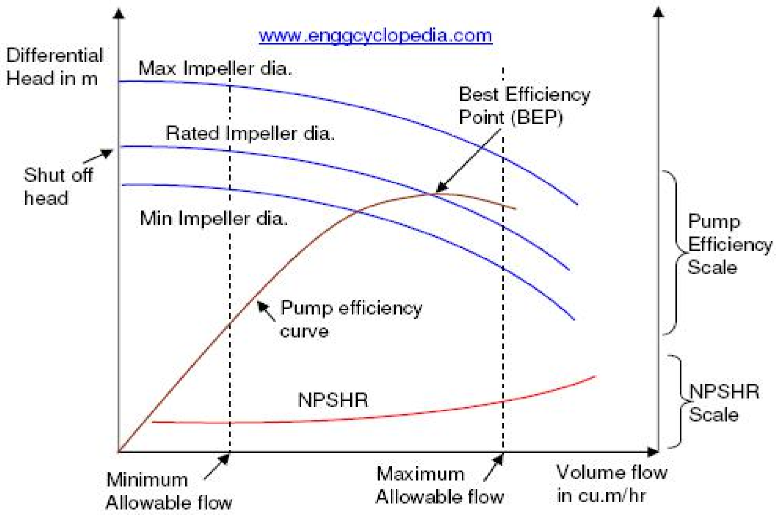
definition, an integral part of a pumped-storage hydroelectricity installation.

In countries with canal systems, pumping stations are also frequent. Because of the way the system of canal locks work, water is lost from the upper part of a canal each time a vessel passes through. Also, most lock gates are not watertight, so some water leaks from the higher levels of the canal to those lower down. Obviously, the water has to be replaced or eventually the upper levels of the canal would not hold enough water to be navigable.

Canals are usually fed by diverting water from streams and rivers into the upper parts of the canal, but if no suitable source is available, a pumping station can be used to maintain the water level.

Calculation of Pump Curve:

Pump curves are primarily used to predict the variation of the differential head across the pump, as the flow is changed. But in addition variation of efficiency, power etc, as the flow is changed, can also be represented on the pump performance curves by the manufacturer.



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- Curve of differential head for Rated Impeller Diameter represents the variation of differential head with volumetric flow for the impeller with rated diameter which will actually be provided with the pump.

- Variation of differential head with volumetric flow for Maximum Impeller Diameter is plotted for the impeller with the maximum diameter that can be accommodated within the pump. This impeller can be used in case flow through the pump is increased or if more differential head is required in the future, with the same pump.

- Variation of differential head with volumetric flow for Minimum Impeller Diameter is plotted for the impeller with minimum possible diameter. If the flow or differential head requirement is reduced in future, this impeller can be used with lower power consumption

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.It should be note that the pump curves for differential head Vs. volumetric flow rate are plotted for a particular liquid density. If in the future the process liquid or even just liquid density is changed,that effect has to be considered to finally determine the differential pressure. In such as case, revised volumetric flow should be calculated and located on the pump curve and corresponding differential head should be then determined from the curve for the appropriate impeller diameter. This differential head should then be

used along with the changed liquid density to determine the differential pressure across the pump.

THE END

THANK YOU SIR