

Department: Chemical engineering

level: 5th level

Semester: Summer semester

Course title: Water desalination

Subject Code: Chem. 416



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Date: 28/7/2018

Day: Saturday

Time allowed: 1.5 hours

Full marks: 20 marks

Question 1(10 marks):

1- Define the following terms: (2marks)

MED,

(1) Evaporation occurs on the external surface of a tube bundle which is heated by motive steam condensing inside the tubes.

(2) Vapor produced in one effect is then used as motive steam in the following effect, which operates at lower pressure.

water desalination

Desalination processes make freshwater from the separation of salt from seawater or brackish water.

2- Give the reason why: (3marks)

a- **The single-effect evaporation system for seawater desalination has no practical use on an industrial scale.**

Because the system has a thermal performance ratio of less than 1, the mass of water produced is less than the mass of heating steam used to operate the system.

b- **The horizontal falling film arrangement necessitates operation at temperatures below 70°C.**

To limit the scaling rate of the outside surface of the tubes and to reduce the frequency of chemical cleaning.

3- Explain pretreatment of seawater when we used MED and MSF in desalination process?

(3marks)

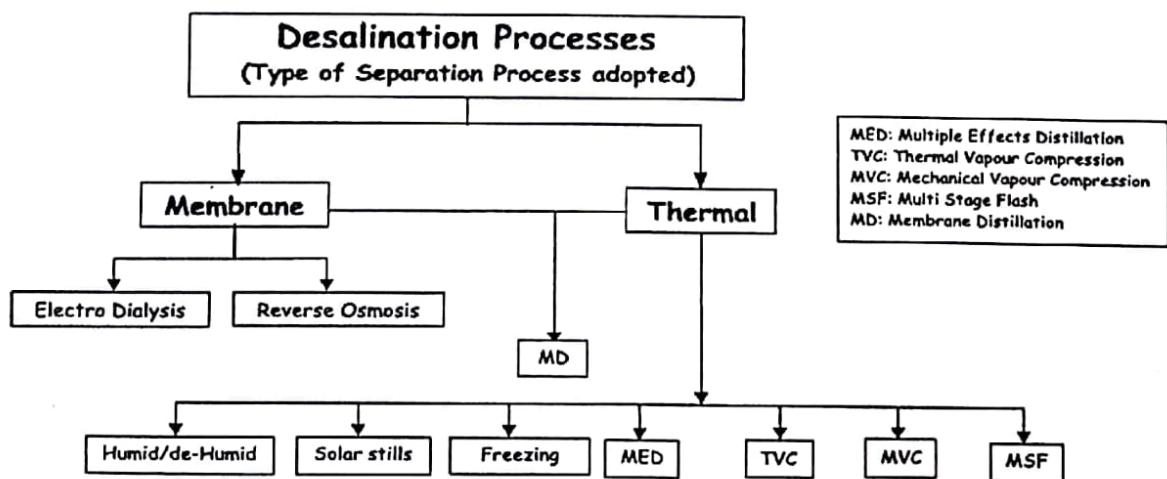


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- (1) Grid filtration and suspended solids settling, in order to reduce the concentration of suspended matter in the feed stream.
- (2) Disinfection, usually through the addition of common disinfectants such as hypochlorite, chlorine, etc., in order to reduce the formation of algae and biofouling.
- (3) De-aeration, with the double aim of:
 - (i) Reducing the quantity of CO₂, bi-carbonates and carbonates which can lead to scaling.
 - (ii) Reducing non condensable gases which could then prevent the achievement and keeping of vacuum conditions within evaporation stages.
- (4) Addition of anti-scaling chemicals, usually consisting of dimeric or polymeric organic acids or chelating agents, able to reduce the formation of Calcium Carbonate and Sulphate.
- (5) Addition of anti-foaming chemicals, for example consisting of polyglycols, which reduce the formation of foam during the evaporation process.

4- Classify desalination processes according to type of separation processes?

(2marks)





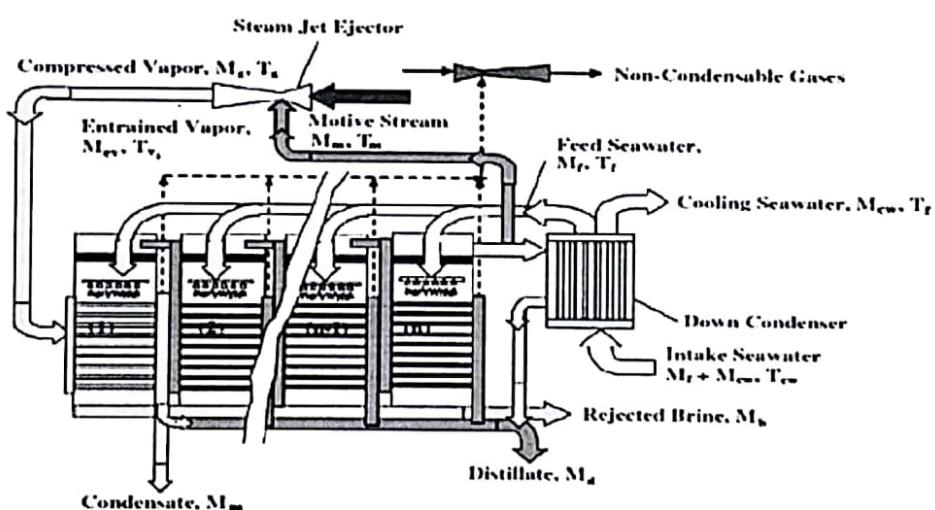
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Question2 (10marks):

1-Compare by sketching between MED/MVC and MED/TVC techniques? (5marks)

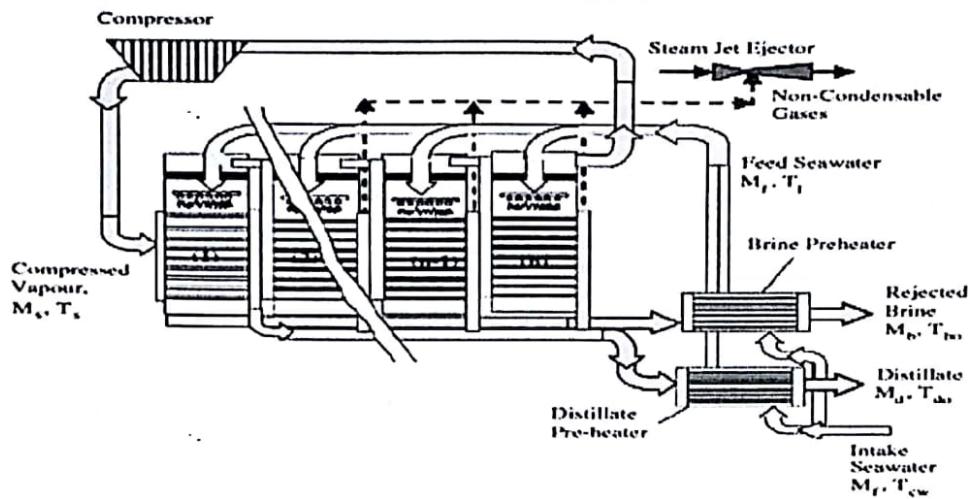
MED/MVC systems, have similar layouts to thermal vapour compression processes.

- The main differences are the absence of a down condenser and the use of a mechanical compressor, to compress the entire vapour formed in the last effect to the desired heating steam temperature.
- In addition, the outlet brine and distillate streams exchange heat with the feed stream in two pre-heaters.





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2-Draw schematic chart which demonstrate plate and horizontal evaporators with explanation?

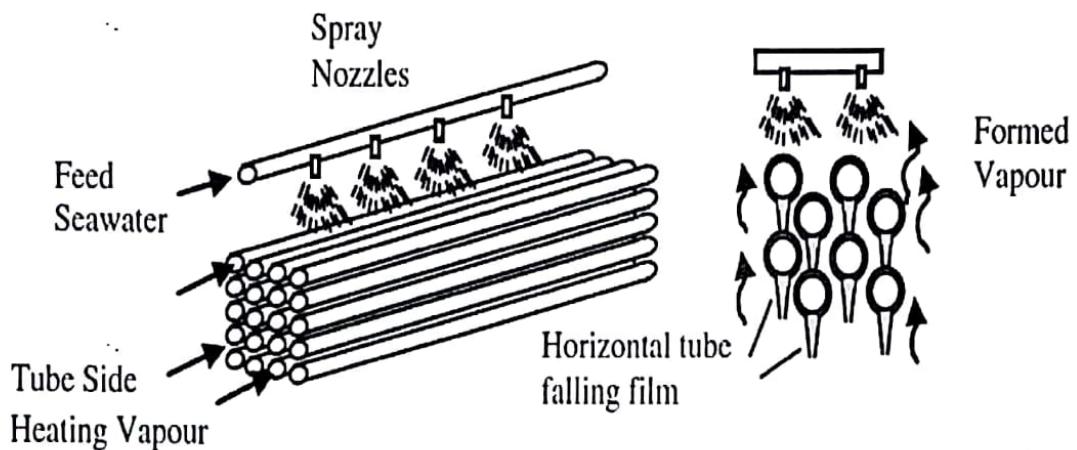
(5marks)

The horizontal falling film evaporator:

1. eliminates the static pressure effect on the evaporating surface, and as a result, higher overall heat transfer coefficients are obtained.
2. Necessitates operation at temperatures below 70°C, to limit the scaling rate of the outside surface of the tubes and to reduce the frequency of chemical cleaning.
3. The horizontal falling film configuration is the industry standard and is used in most MED and MVC systems.

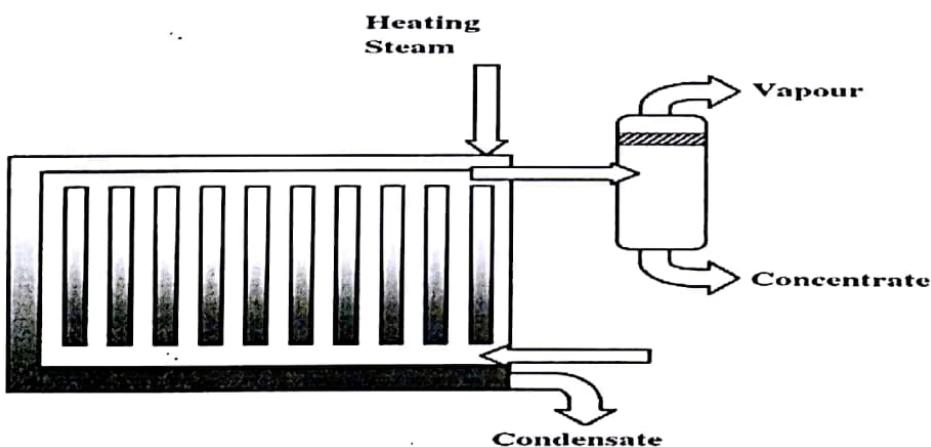


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2- Plate

- The heating steam condenses on one side of the plate, and water evaporates on the other.
- Plate evaporators can be manufactured using metal, plastic or polymer-coated metal.
- These plate heat exchangers have lower hold-up volumes, closer temperature approaches, lighter weights, smaller space requirements, higher heat transfer coefficients and lower fouling resistances.
- They remain limited to experimental and prototype units.





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With my best wishes

Dr:Hend Gadow