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B TECH
(SEM-VI) THEORY EXAMINATION 2018-19
MASS TRANSFER OPERATIONS

Time: 3 Hours   *Total Marks: 100*
Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1.   **Attempt *all* questions in brief.**   **2 x 10 = 20**
   a) Gas absorption
   b) Dew point.
   c) Eqilibrium moisture content.
   d) Absolute humidity.
   e) Relative volatility.
   f) Vapour pressure.
   g) Knudsen diffusion.
   h) Freeze drying,
   i) Flooding.
   j) Reflux ratio.

SECTION B

2.   **Attempt any *three* of the following:**   **10 x 3 = 30**
   a) Methane diffuses at steady state through a tube containing Helium. At point 1, the partial pressure of methane is P_{A1}=55kpa and at point 2, 0.03m apart, P_{A2}=15kpa.The total pressure is 101.32kpa and the temperature is 298k.At this pressure and temperature, the value of diffusity is 6.75 x10^{-5} m^2/s.
        i.   Calculate the flux of CH_4 at steady state for equimolar counter-diffusion.
        ii.   Calculate the partial pressure at appoint 0.02m apart from point 1.
   b) calculate the amount of diffusion of acetic acid (A) in 2 hours a film on non-diffusing water(B) solution 1mm thick at 17C when the concentration on opposite side of the film are respectively 9 and 3 wt% acid. The diffusivity of acetic acid in solution is 0.95x10^{-9} m^2/s. At 17C, Density of 9 %solution=1012 kg/m^3, Density of 3 %solution=1013.2 kg/m^3.
   c) Define azeotropes and write a note on types of azeotropes. Distinguish between minimum and maximum boiling azeotropes with examples of each.
   d) Describe the method of estimation of the number of theoretical plates using panchan savarit method.
   e) Explain the mechanism of batch drying and continuous drying? Explain all types of moisture content with the help of an equilibrium diagram (wet solid -air equilibria).

SECTION C

3.   **Attempt any *one* part of the following:**   **10 x 1 = 10**

   a) Define molecular and eddy diffusivity. Explain Fick's First law and concept of N & J Flux.
   b) Derive the expression for binary mixture $D_{AB} = D_{BA}$.

4. **Attempt any *one* part of the following:** **10 x 1 = 10**

a) Derive the expression for Gas absorption Countercurrent and co-current contact operation.

b) A packed tower is designed to recover 98% CO_2 from a gas mixture containing 10% CO_2 and 90% air using water. A relation $y = 14x$ can be used for equilibrium conditions where, y = kg CO_2/ kg dry air and x = kg CO_2/ kg water. The water to gas rate is kept 30% more than the minimum value. Calculate the height of the tower if (HTU) OG is 1 meter.

5. **Attempt any *one* part of the following:** **10 x 1 = 10**

a) A continuous fractionating column operating at atmospheric pressure is to separate a feed containing 30% CS_2 and 70% $CC1_4$ into an overhead product of 95 % CS_2 and a bottom product of 95 mole % $CC1_4$. The feed enters as a liquid at its boiling point. Assuming an overall plate efficiency of 70% and a reflux ratio of 3:1 estimate the number of plates needed. All the compositions are in mole %.

x	0.0296	0.0615	0.258	0.39	0.532	0.663	0.758	0.86
y	0.0823	0.1555	0.494	0.634	0.747	0.830	0.880	0.932

b) Derive operating line for Rectification and Stripping sections of distillation column with neat figure. Discuss differential distillation and derive Rayleigh's equation.

6. **Attempt any *one* part of the following:** **10 x 1 = 10**

a) A granular wet solid is dried on a tray dryer under cross flow of hot air from 30% initial moisture to 1 % final moisture. The solid loading is 35 kg dry solid per m^3 tray area. The constant drying rate is 4.5 kg/ m^2 hr. the critical moisture is 10 % and the equilibrium moisture is 0.2%. Calculate the total drying time, if the falling rate is linear in moisture content. What is the drying rate when the moisture content is 5%? All moisture concentration is expressed on dry basis.

b) Write the different types of drying equipments and with the neat sketch explain one of them.

7. **Attempt any *one* part of the following:** **10 x 1 = 10**

a) Discuss the concept of HETP and HTU & NTU. How the height of absorption column is determined?

b) Write short notes on:
  i. Steam Distillation.
  ii. Extractive distillation.
  iii. Minimum reflux ratio.
  iv. Vacuum distillation.