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B TECH
(SEM-IV) THEORY EXAMINATION 2018-19
MASS TRANSFER-I

[Time: 3 Hours] ***[Total Marks: 100]***

Note: Attempt all questions.

SECTION-A

1. Attempt **all** parts of the following: [2*7=14]

a. What is Fick's law of diffusion?
b. Define absorption factor and its significance.
c. Discuss the types of dryers.
d. Define Weeping, Loading in packed column.
e. Discuss about WBT & DBT.
f. What do you mean by Mier's supersaturation theory?
g. Differentiate b/w molecular diffusion and knudsen diffusion.

SECTION-B

2. Attempt any **three** parts of the following: [7*3=21]

a. What is the mass transfer coefficient? Derive the relationship between overall mass-transfer coefficient and individual phase mass-transfer coefficient.
b. A coal gas containing 2% by volume of benzene vapour enters a tray absorber at 0.250 m^3/S at 26^0C and $1.07*10^5$ N/m^2 total pressures for 95% removal of the benzene vapour. The solvent containing 0.005 mole fraction of benzene enters at 26 0C and has an average molecular weight of 260. Calculate the circulation rate of solvent if the absorber is to be operated at 1.5 times the minimum rate. Equilibrium data- $\frac{Y^*}{1+Y^*} = 0.125\frac{X}{1+X}$, where X, Y are mole ratio of benzene in solvent and absorber.
c. Calculate the rate of diffusion of methanol at 20 ^0C under unidirectional steady state condition through a 20 mm thick film of water when the concentrations of methanol at the opposite sides of the film are respectively 10% to 4 % methanol by weight. The diffusivity of methanol in water solution is $5.9*10^{-6}$ cm^2/s. The density of 10% & 4% methanol solution at 20 ^0C may be taken as 0.951 and 0.986 g/cc respectively.
d. Explain mass, heat and momentum transfer analogies.
e. Explain selection criteria for choice of solvent for absorption.

SECTION-C

3. Attempt any **one** part of the following: [7x1=7]

a. In an O_2-N_2 gas mixture at 1 std. atm 25^0C, the concentration of O_2 at two planes 2mm apart are 10 and 20 vol% respectively. Calculate the flux of diffusion of the O_2 for the case where-(a) the N_2 is non-diffusing (b) there is equimolar counter diffusion of the two gases. Diffusivity of O_2 in N_2 is $1.81x10^{-5}$ m^2/s. Draw and explain the different types of equilibrium curve which may be encountered in leaching operation.
b. Write the short note of the following –
   (i) Film theory of mass transfer
   (ii) Non-adiabatic humidification

4. Attempt any **one** part of the following: [7x1=7]

a. It is desired to dry sheet material from 58 % to 5 % moisture content. The sheets are 0.131 m by 0.162 m by 0.071 m. The drying rate during constant rate period is 8.9 $kg/m^2.hr$. The critical moisture content is 24.9% and the equilibrium moisture content is 1%. The sheet is to be dried from one side only and has a bone-dry density of 210 kg/m^3. Determine the time required for drying. The falling rate may be assumed linear.

b. Explain the typical rate of drying curve and explain various regions in it. Also explain any one dryer equipment with neat sketch.

5. Attempt any **one** part of the following: [7x1=7]

a. What is the Crystallization? Explain construction and working Swenson-Walker Crystallizer with the help of a neat sketch.

b. A hot solution containing 5000 kg Na_2CO_3 and water with a concentration of 25 % by wt. Na_2CO_3 is cooled to 293 K and crystal of $Na_2CO_3.10H_2O$ are precipitated. At 293 K, the solubility is 21.5 kg anhydrous Na_2CO_3 per 100 kg of total water. Calculate the yield of hydrated Na_2CO_3 crystals obtained if 5 % of the original water in the system evaporates on cooling. Also calculate the quantity of mother liquor.

6. Attempt any **one** part of the following: [7x1=7]

a. A mixture of nitrogen-acetone vapors at 800 mmHg and has percentage saturation of 80%. Calculate- i) absolute molal humidity, ii) absolute humidity (kg acetone/kg nitrogen), iii) partial pressure of acetone, iv) relative humidity, v) volume percentage of acetone. Assume vapor pressure of acetone at 25^0C as 190 mmHg and the Mol. Wt of nitrogen are 28.02 & acetone is 58.06.

b. Differentiate between Packed Tower and Tray Tower.

7. Attempt any **one** part of the following: [7x1=7]

a. 1400 Kg (bone dry) of granular solid is to be dried under constant drying condition from a moisture content of 0.2 Kg/Kg dry solid to a final moisture content of 0.02 Kg/Kg dry solid. The drying surface is given as 0.0615 m^2/Kg. Under the same conditions, the following rates were previously known. Calculate the time required for drying.

X, (kg/kg dry solid)	0.3	0.2	0.14	0.096	0.056	0.046	0.026	0.016
Rate,N ($kg/m^2.h$)	1.71	1.71	1.71	1.46	1.29	0.88	0.54	0.376

b. What is wet bulb temperature? Derive an expression for the wet-bulb depression.