

III B.Tech I Semester Regular Examinations, November 2006
MASS TRANSFER AND SEPARATION
(Bio-Technology)

Time: 3 hours**Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Calculate the rate of diffusion of hydrogen through Non diffusing Methane at 25°C and 101 KN/m^2 Pressure ($D_{AB} = 6.6 \times 10^{-5} \text{ m}^2/\text{sec}$).
 The diffusional path is 5mm long and the concentration of Hydrogen at the two ends of the path in terms of partial pressure is 12 KN/m^2 and 8.4 KN/m^2 respectively.

[16]

2. (a) Distinguish between Eddy and Molecular Diffusion?
 (b) Explain Penetration Theory versus Two Film Theory?

[8+8]

3. Discuss briefly about the following:

(a) Constant pressure vapour liquid equilibrium.

(b) Equilibrium distillation.

[8+8]

4. A feed of 2000 kgs/hr of Ammonia water solution is to be continuously distilled in a column having composition of 30 weight percent Ammonia. The bottom product should be 99.5 mol% Ammonia. Calculate if the operating reflux ratio is 1.2 times of the minimum reflux ratio.

(a) Heat required in the boiler.

(b) Heat rejected in condenser.

(c) Number of Actual plates.

(d) Feed plate number

(e) Minimum number of plates.

Enthalpy data

X, wt fraction	0	0.2	0.40	0.50	0.80	0.90	1.0
H_L , K cal /kg	111.1	77.8	55.6	44.4	38.8	-	25
Y wt fraction	0	0.55	0.75	0.83	0.88	0.95	1.0
H_y , K cal /kg	155.5	150	144.4	133.3	116.7	-	77.8

[4+3+3+3+3]

5. Explain how the number of stages can be determined for immiscible solvents in cross current extraction?

[16]

6. With the help of a neat sketch explain the working of Bollmann extractor? [16]
7. (a) Explain in detail break through curve and its significance?
(b) Indicate how rate of adsorption in fixed beds is estimated. [8+8]
8. A liquid containing solute A at a concentration $C_1 = 3 \times 10^{-2} \text{ kg mol/m}^3$ is flowing rapidly by a membrane of thickness $L = 3.0 \times 10^{-5} \text{ m}$. The distribution coefficient $K' = 1.5$ and $D_{AB} = 7.0 \times 10^{-11} \text{ m}^2/\text{s}$ in the membrane. The solute diffuses through the membrane and its concentration on the other side is $C_2 = 0.50 \times 10^{-2} \text{ kgmol/m}^3$. The mass transfer coefficient K_{C1} is large and can be considered as infinite and $K_{C2} = 2.02 \times 10^{-5} \text{ kmol/m}^2\text{s mol fraction}$. Calculate the flux and the concentrations at the membrane interfaces? [16]

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1. Obtain an expression for the steady state Equimolar counter diffusion of two gases starting from fundamentals? [16]
2. (a) Distinguish between Eddy and Molecular Diffusion?
 (b) Explain Penetration Theory versus Two Film Theory? [8+8]
3. A liquid mixture containing 50 mole percent n-heptane and 50 mole percent n-octane is subjected to a differential distillation at atmospheric pressure until the residual liquid contains 35 mole percent n-heptane. Using the equilibriums data determine the percentage of feed that is left over as residue.

X	0.50	0.46	0.42	0.38	0.34	0.32
Y	0.689	0.648	0.608	0.567	0.523	0.49

Where x = mole fraction n-heptane in liquid.

Y = mole fraction n-heptane in vapour. [16]

4. Discuss the steps involved in the determination of theoretical number of plates by Panchon Savarit method? What is Reflux? Explain the method for determining minimum Reflux by using the above method? [8+8=16]
5. Describe the solubility characteristics of a ternary liquid system with one pair partially soluble. Indicate the tie lines if the system forms solutrope. [16]
6. (a) Write a short notes on types of adsorption and distinguish between physical adsorption and chemisorption?
 (b) Explain the different industrial adsorbents used and enumerate their applications? [8+8]
7. Write on:
 - (a) Adsorption wave and break through curve and
 - (b) Pressure solving and thermal solving methods. BET Isotherm. [8+8]
8. A liquid containing solute A at a concentration $C_1 = 3 \times 10^{-2} \text{ kg mol/m}^3$ is flowing rapidly by a membrane of thickness $L = 3.0 \times 10^{-5} \text{ m}$. The distribution coefficient $K' = 1.5$ and $D_{AB} = 7.0 \times 10^{-11} \text{ m}^2/\text{s}$ in the membrane. The solute diffuses through the membrane and its concentration on the other side is $C_2 = 0.50 \times 10^{-2} \text{ kgmol/m}^3$. The mass transfer coefficient K_{C1} is large and can be considered as infinite and $K_{C2} = 2.02 \times 10^{-5} \text{ kmol/m}^2\text{s mol fraction}$. Calculate the flux and the concentrations at the membrane interfaces? [16]

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1. Obtain an expression for the steady state Equimolar counter diffusion of two gases starting from fundamentals? [16]
2. (a) Distinguish between Eddy and Molecular Diffusion?
 (b) Explain Penetration Theory versus Two Film Theory? [8+8]
3. A liquid feed consisting of 1200 kg moles of mixture containing 30% Naphthalene and 70% Dipropylene Glycol is differentially distilled at 100 mm Hg pressure and final distillate contains 55% of Naphthalene. The VLE data are

X	8.4	11.6	2.8	50.6	68.7	80.6	88
Y	22.3	41.1	62.9	74.8	80.2	84.4	88

- (a) Determine the amount of distillate.
- (b) Determine the concentration of Naphthalene in residue and distillate? [8+8]
4. (a) Explain the terms: minimum reflux ratio optimum reflux ratio and total reflux.
 (b) Differentiate between flash distillation, differential distillation and rectification? [8+8]
5. A 25% (weight%) solution of dioxane in water is to be continuously extracted in counter current fashion with Benzene to remove 95% of the dioxane in feed. If the feed rate is 1000 kg/hr estimate the
 - (a) Minimum solvent required and
 - (b) Theoretical stages needed if 900 kg/hr of solvent is used

Wt% Dioxane in water	5.1	18.9	25.2
Wt% Dioxane in Benzene	5.2	22.5	32.0

[8+8]

6. (a) Write a short notes on types of adsorption and distinguish between physical adsorption and chemisorption?
 (b) Explain the different industrial adsorbents used and enumerate their applications? [8+8]

7. Batch tests were performed in the laboratory using solution of Phenol in water and particles of granular activated carbon. The equilibrium data at room temperature are shown in the following table. Determine the isotherm that fits the data.

C kg Phenol / m ³ solution	0.3222	0.117	0.039	0.0061	0.0011
Q Kg Phenol / Kg carbon	0.150	0.122	0.094	0.059	0.045

[16]

8. Discuss gas permeation through membranes with suitable examples. [4+12=16]

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1. (a) Write the Fick's law of diffusion for 'Z' direction. What is the significance of Diffusion coefficient?
 (b) Derive the equation for steady state diffusion of gas (A) through the wall of a hollow cylinder? [8+8]
2. (a) Distinguish between Eddy and Molecular Diffusion?
 (b) Explain Penetration Theory versus Two Film Theory? [8+8]
3. (a) Write and Explain Rayleigh's equation?
 (b) A binary mixture containing 15 mole percent n-Butane and 85 percent n-Pentane is subjected to simple Batch distillation at atmospheric pressure. If 80 percent of the Butane is removed by distillation process, how much Pentane would be removed? What would be the composition of the remaining liquid? Average relative volatility=3.5 [6+10]
4. A saturated liquid feed of 200 mol/h at the boiling point containing 42 mol% heptane and 58% ethyl Benzene is to be fractionated at 101.32 kpa abs to give a distillate containing 97 mol% heptane and a bottoms containing 1.1 mol% heptane. The reflux ratio used is 2.5:1. Calculate the mol/h distillate mol/h bottoms, theoretical number of trays and the feed tray chamber. Equilibrium data are given below at 101.32 kpa abs pressure for the mole fraction n-heptane x_H and y_H .

Temperature				Temperature			
K	$^{\circ}\text{C}$	x_H	x_Y	K	$^{\circ}\text{C}$	x_H	x_Y
409.3	136.1	0	0	383.3	110.6	0.485	0.730
402.6	129.4	0.08	0.230	376.0	102.8	0.790	0.904
392.6	119.4	0.250	0.514	371.5	98.3	1.0	1.0

[16]

5. (a) What is a plait point?
 (b) Draw the flow diagram for continuous counter current multistage extraction operation. [6+10]
6. Acetaldehyde (5%) is in solution in Toluene and is to be extracted with water in a five stage co-current unit. If 25 kg of water is used per 100 kg feed, find the amount of acetaldehyde extracted and the final concentration. If $Y = \text{Kg Acetaldehyde/Kg water}$ and $X = \text{Kg Acetaldehyde / Kg Toluene}$ then $Y_e = 2.20 X$ represents the equilibrium relation [16]

7. (a) Explain in detail break through curve and its significance?
(b) Indicate how rate of adsorption in fixed beds is estimated. [8+8]
8. Discuss in brief about principles of Ion exchange? [4+12=16]

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