Code No: 07A60802 | R07 | Set No. 2

III B.Tech II Semester Examinations,December 2010
MASS TRANSFER OPERATIONS-II
Chemical Engineering

Time: 3 hours | Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks
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1. (a) What is differential distillation? Derive Rayleigh equation and mention the assumption involved during derivation.
   (b) Give the characteristics of an enthalpy-concentration diagram. [10+6]

2. Discuss about the following equipment for liquid-liquid extraction with neat diagrams.
   (a) Sieve tray tower.
   (b) Pulsed column. [8+8]

3. (a) Explain briefly how to estimate minimum reflux ratio using Ponchon - Savarit method.
   (b) Write short notes on optimal reflux ratio. [8+8]

4. (a) For adsorption from dilute liquid solutions in stagewise counter current operations, where the Freundlich equation describes the adsorption equilibrium, derive analytical expression interms of n,m,Y0 and Yn, for the minimum adsorbent/solvent ratio when fresh adsorbent used.
   (b) Apply Freundlich equation for multistage cross current adsorption operation and derive
   $(Y_1/Y_2)^{1/n}$ - 1/n (Y_0/Y_1) = 1-Y_n. [8+8]

5. (a) Explain briefly the process of elution in a fixed bed.
   (b) Explain the process of vacuum swing adsorption with examples. [8+8]

6. The mutual solubility and the tie-line data for the MEK (A)-ethylene glycol(C)-water (B) system at 30^{0}C are given below:

Extract (MEK phase)

y_A	y_B	y_C
0.884	0.111	0.005
0.849	0.113	0.038
0.871	0.112	0.017
0.827	0.116	0.057
0.806	0.118	0.076
0.50	0.205	0.295

Raffinate (water)

x_A	x_B	x_C
0.208	0.697	0.095
0.21	0656	0.134
0.221	0.583	0.196
0.236	0.524	0.240
0.261	0.461	0.278
Plait point		

500 kg/h solution of ethylene glycol in water (30% glycol, 70% water) is extracted with pure MEK at a rate of 500 kg/h. Determine the flow rate and compositions of the raffinate and the extract phases. [16]

7. A saturated liquid feed containing 40 mole % chloroform and 60 mole% benzene is fed to a continuous fractionating column to yield a distillate and residue product with 95 mole % chloroform and 95 moe benzene respectively. The VLE data may be represented by the following relationship.
   Y = 1.29x + 0.25x^2 -0.54x^3.
   x,y-mole fractions of chloroform in the liquid and vapor. Determine:
   (a) The minimum number of plates.
   (b) The number of plates when the reflux ratio is such as to make the operating line slope = 1.18. [16]

8. A solid having 20% solute, 2% water and the rest is to be leached with water at a rate of 2 tons/h. The overflow leaving the counter current leaching cascade has 15% solute and no solid. The underflow carries 0.5 kg solution per kg inerts independent of the solution concentration. If 97% of the solids is to be recovered, determine the number of stages required. [16]

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Code No: 07A60802 **R07** **Set No. 4**

III B.Tech II Semester Examinations,December 2010
MASS TRANSFER OPERATIONS-II
Chemical Engineering

Time: 3 hours Max Marks: 80

Answer any FIVE Questions
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1. (a) An ethanol- water mixture containing 36% by weight of ethanol is differentially distilled at 1 atm, pressure and the mixture is reduced to a maximum ethanol concentration of 6 mole %. Determine the quantity and composition of the distillate. Molecular weight of Ethanol = 46. The VLE data are:

Mole frac.of Ethanol in Liquid (x)	0.18	0.16	0.14	0.12	0.10	0.08	0.06
Mole frac.of Ethanol in Vapour(y)	0.517	0.502	0.485	0.464	0.438	0.405	0.353

   (b) Write the applications of distillation. [8+8]

2. A saturated equimolar mixture of vapours of A and B enters a partial condenser at a rate of 1 kmol/h. The vapour leaves the condenser at a rate of 0.6 kmol/h. If the relative volatility of B with respect to A is 0.3, calculate the composition of the vapour and the liquid leaving the partial condenser. [16]

3. (a) Explain different types of agitated vessels with neat sketches.
   (b) With a neat sketch explain the working of Pachuca tank. [8+8]

4. (a) Discuss the advantages of supercritical fluid extraction. Name a few supercritical solvents.
   (b) Write the practical applications of supercritical fluid extraction. [8+8]

5. (a) For adsorption from dilute liquid solutions in stagewise counter current operations, where the Freundlich equation describes the adsorption equilibrium, derive analytical expression interms of n,m,Y0 and Yn, for the minimum adsorbent/solvent ratio when fresh adsorbent used.
   (b) Apply Freundlich equation for multistage cross current adsorption operation and derive
   $(Y_1/Y_2)^{1/n}$ - 1/n (Y_0/Y_1) = 1-Y_n. [8+8]

6. (a) Explain briefly the process of elution in a fixed bed.
   (b) Explain the process of vacuum swing adsorption with examples. [8+8]

7. Benzene and trimethylamine (TMA) are to be separated in a three-stage liquid-liquid extraction column using water as the solvent. If the solvent free extract and raffinate products are to contain, respectively, 70 and 3 wt% TMA, find the original feed composition and the water-to-feed ratio with a right-triangle diagram. There is no reflux and the solvent is pure water. Equilibrium data are as follows:

Extract, wt%			Raffinate, wt%		
TMA	H20	Benzene	TMA	H20	Benzene
5.0	94.6	0.04	5.0	0.0	95.0
10.0	89.4	0.06	10.0	0.0	90.0
15.0	84.0	1.0	15.0	1.0	84.0
20.0	78.0	2.0	20.0	2.0	78.0
25.0	72.0	3.0	25.0	4.0	71.0
30.0	66.4	3.6	30.0	7.0	63.0
35.0	58.0	7.0	35.0	15.0	50.0
40.0	47.0	13.0	40.0	34.0	26.0

The tie-line data are:

Extract, wt% TMA	Raffinater, wt% TMA
39.5	31.0
21.5	14.5
13.0	9.0
8.3	6.8
4.0	3.5

[16]

8. A mixture of methyl alcohol and water containing 32mol % of the alcohol is being fractionated in a plate rectification column using indirect steam as the source of heat. The fractionation is being carried out at 1atm pressure to obtain an overhead product containing 97mol % of the alcohol. The bottom product may contain upto 1.5mol% of alcohol. Calculate minimum reflux ratio and number of stages if actual reflux ratio is .1.3 times minimum is used. The VLE data for methanol is:

x	y
0	0
0.02	0.134
0.04	0.23
0.06	0.304
0.1	0.418
0.2	0.579
0.3	0.665
0.4	0.729
0.5	0.779
0.6	0.825
0.7	0.87
0.8	0.915
0.9	0.958

[16]

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Code No: 07A60802 **R07** **Set No. 1**

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MASS TRANSFER OPERATIONS-II
Chemical Engineering

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

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1. (a) One mole of a solution of A and B (enthalpy = 900 kcal/kmol; x = 0.4) is mixed with two moles of another solution of the components (enthalpy = 1200 kcal/kmol, x = 0.8). Calculate the enthalpy and composition of the mixture.
   (b) Draw and explain T-x-y and P-x-y diagrams. [6+10]

2. Calculate the number of theoretical stages required to distill 1000 kg/hr of aqueous Methanol at its boiling point enters the tower. The feed, overhead product and bottom product contains 50 mole% , 90 mole %, and 10 mole % of Methanol respectively. A total condenser is provided. The reflux is sent at its saturation temperature. If the reflux ratio is 1.7 times the minimum reflux ratio.
   VLE data are

x	y
0.1	0.418
0.2	0.579
0.3	0.665
0.4	0.729
0.5	0.778
0.7	0.87
0.8	0.958
0.9	0.979
1.0	1.0

[16]

3. With suitable figures explain the working principle of
   (a) Dorr agitator.
   (b) Bollman extractor. [16]

4. It is required to extract picric acid from a dilute aqueous solution containing 0.1 mole picric acid per litre of solution using benzene as solvent with a recovery of 80% of the picric acid originally present. Determine the quantity of benzene required per litre of aqueous solution by employing:
   (a) Single stage extraction and
   (b) Three stage extraction (cross current) using equal amounts of fresh solvent in each stage. The equilibrium data for benzene picric acid water system at 25^0C is given by:

C_Bx10^2	0.0932	0.225	1	2	5	10	18
m= C_B/C_A	2.23	1.45	1.705	0.505	0.32	0.24	

0.187
where C_B, C_A are the equilibrium concentrations of picric acid in benzene and aqueous phases respectively in mole per litre. Assume benzene-water are completely immiscible. [16]

5. (a) Explain briefly the simulation of moving bed adsorbers.
   (b) write few applications of fixed bed adsorbers.
   (c) Explain the term hypersorber. [8+4+4]

6. (a) In adsorption, why are adsorbents having a microporous structure desirable?
   (b) What is absorption hysterisis?
   (c) What is an adsorption isotherm? Does it have anything to do with phase equilibrium? [5+5+6]

7. In order to extract acetic acid from dilute aqueous solution with isopropyl ether, the two immiscible phases are passed counter currently through a packed column 3.05 m in height and 7.6 cm in diameter. It is found that if 1950 kg/hr m^2 of pure ether is used to extract 975 kg/hr m^2 of 4% acid by weight then the ether phase leaves the column with a concentration of 1% acid by weight. Calculate the number of overall transfer units based on raffinate phase. It is given that, wt% of acid in ether phase = 0.3 x wt% acid in water phase. [16]

8. A dilute aqueous solution of ethanol is to be concentrated from 20 mass% to 85 mass% alcohol in a tray tower at 1 atm pressure. The feed rate is 8000 kg/h at its bubble point. The bottom product must not contain more than 3.5 mass% of ethanol. Determine:
   (a) The minimum reflux ratio,
   (b) The number of ideal trays if 1.2 times minimum reflux ratio is used. The enthalpy and concentration diagram is as follows:

x,y	H_L	H_v
0	7540	48150
0.0417	7125	48250
0.1436	6915	48328
0.207	7097	48436
0.37	7750	48450
0.477	8105	48631
0.61	8471	48694
0.779	8945	48950
1	9523	

x	0.00792	0.0202	0.0891	0.1436	0.281	0.37	0.477	0.61	0.706	0.86	0.95
y	0.0850	0.191	0.427	0.493	0.568	0.603	0.644	0.703	0.756	0.864	0.9456

The enthalpies are given in kJ/kmol and reference state is pure liquids at 0^0C. [16]

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Chemical Engineering

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1. (a) Explain briefly how to observe the adsorption from liquid solution.
   (b) Explain briefly heat of wetting.
   (c) Write short notes on Freundlich equation. [6+4+6]

2. (a) Explain the terms break point and break through curve.
   (b) Explain various parameters which will influence the shape of break through curve.
   (c) Explain the term hypersorber. [8+4+4]

3. (a) Explain the term heteroazeotropes with suitable examples.
   (b) Write the modified Rayleighs equation applicable for binary system and mention the important assumption made to convert Rayleighs into modified Rayleighs equation.
   (c) Show that the relative volatility is the ratio of vapor pressures for ideal solution.
   [6+4+6]

4. (a) Soybeen flakes containing 22wt% oil are to be leached in a single stage extraction with pure hexane as solvent. Calculate the amount of solvent per every kg of feed mixture to recovery 80% of the oil present in the flakes. The equilibrium data is as follows:

y_a	0	0.2	0.3
N_y	1.73	1.52	1.43

   Where y_a the weight fraction of oil in the hexane solution and N_y is kg inert solid per kg of solution retained. Assume that the tie lines are vertical and there is no presence of flakes in the hexane.
   (b) In leaching, why does the underflow contain liquid? [12+4]

5. What is open steam and write the material and energy balance equations around distillation column Using Ponchon - Savarit method. Also explain how to estimate the number of stages. [16]

6. (a) For distillation of an equimolar binary mixture of A and B, the equations of the operating lines are: Rectifying section: y = 0.663x + 0.32. Stripping section: y = 1.329x - 0.01317. What is the condition of the feed?
   (b) Write short notes on partial condensers. [8+8]

7. A mixture containing 40% p-chloronitrobenzene (B) and 60% o-chloronitrobenzene (C) is to be separated at the rate of 100kg/h into products containing 80 and 15%, respectively, of the Para isomer after removal of solvents. The insoluble solvents to be used are 2400 kg/h heptane (A) and 2760 kg/h aqueous methanol (D). The distribution coefficients are constant and independent, y/*B / x/B = 1.35 and y/*C / x/C = 0.835. Determine the number of theoretical stages required and the position of the feed stage. [16]

8. 500 kg /hr of a solution containing 35% by weight of components A dissolved in B is treated in a counter current extraction process with 270 kg/hr of solvents S. The components S and B are insoluble. Compute:

   (a) How many stages will be required to reduce the concentration of A in B to 5% and what is the percentage recovery.

   (b) What would be the percentage recovery when the same amount of solvent is employed equally divided among the same number of stages obtained in cross current operation.
   The equilibrium data:

X'=kg of A/kg of B:	0.05	0.2	0.3	0.45	0.50	0.54
Y=kg of A/kg of S:	0.25	0.40	0.50	0.65	0.70	0.74

[16]

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