Code No: 07A60802 R07 Set No. 2

III B.Tech II Semester Examinations,APRIL 2011
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) Discuss briefly the difference between van der waals"adsorption and chemisorption.

    (b) Explain the method of calculation for multi-stage countercurrent adsorption assuming that equilibrium data follows the Freundlich equation.   [8+8]

2. Determine steam distillation temperature for Aniline _ Water system for which vapour pressure components at different temperatures are given below:
Vapor pressure of Aniline

Temperature	V.P of Aniline (in mm of Hg)
40	1.9
50	3.632
60	5.912
70	10.476
80	18.413
90	30.4885

Water vapor pressure

Temperature ^0C	P_B sat mm Hg
63.6	114.94
68	212.89
74	275.59
78	325.49
82	382.784
90	522.9
92	563.947
98.8	728.9

Mass of distillate =112.309gram
Mass of residue=1117.430gram
Mass of organic layer in the distillate=25.803gram
And also determine composition of the distillate &, steam distillation efficiency at steam distillation temperature.   [16]

3. (a) Explain rotating fixed bed adsorber with neat sketch and show various parts in it.

    (b) Write short notes on percolation.   [8+8]

4. (a) How to estimate minimum reflux ratio for the case of continuous counter current extraction with reflux.

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(b) Write the advantage of continuous counter current extraction with reflux over continuous counter current extraction with out reflux. [8+8]

5. (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]

6. 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]

7. Oil from fish livers is to be continuously and counter current extracted using ethyl ether as solvent. The quantity of solution retained by the granulated livers is given below

Kg oil/kg soln	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.070
Kg soln/ kg oil-free liver	0.205	0.242	0.286	0.339	0.0405	0.489	0.672	0.810

The liver contains 0.257 mass fraction oil. If 95% of the oil is be extracted and the strong solution obtained from the system is to contain 0.70 mass fraction of oil, determine:

   i) The quantity and composition of the discharge soilds
   ii) Kg of oil free ether required per 100 kg of fresh liver
   iii) The number of ideal stages required. [16]

8. Acetic acid (c) is to be extracted from a 45% aqueous solution using isopropyl (B) as the solvent at 20^0C in a counter current extraction unit. The feed rate is 1500 kg/h and the raffinate must not contain more than 2.5% acid. If the solvent supplied to the extractor has 0.5% acetic acid in it, calculate the minimum solvent rate. Also calculate the number of stages if 1.5 times minimum solvent is used. The liquid-liquid equilibrium data at 20^0C are given below.
Water layer (raffinate), mass%

A	B	C
0.981	0.012	0.0069
0.971	0.015	0.0141
0.955	0.016	0.0289
0.917	0.019	0.0642
0.844	0.023	0.133
0.711	0.034	0.255
0.589	0.044	0.367
0.451	0.106	0.443
0.371	0.165	0.464

Ether layer (extract), mass%

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A	B	C
0.005	0.993	0.0018
0.007	0.989	0.0037
0.008	0.984	0.079
0.01	0.971	0.0193
0.019	0.933	0.0482
0.039	0.847	0.114
0.069	0.715	0.216
0.108	0.581	0.311
0.151	0.487	0.362

[16]

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MASS TRANSFER OPERATIONS-II
Chemical Engineering

Time: 3 hours   Max Marks: 80

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1. (a) Write short notes on external reboilers.

   (b) Write advantages and disadvantages of jacketed kettle reboilers.   [8+8]

2. (a) Explain the method of leaching of vegetable oil seeds for extraction of oil.

   (b) Explain the principle of thickening and describe of any thickener.   [6+10]

3. (a) A feed mixture of benzene and toluene containing 30 mole % of benzene is to be distilled in a batch still by differential distillation process. A distillate product having an average composition of 45 mole % benzene is to be obtained. Calculate the quantity of residue if 100 moles are taken in the batch initially. The equilibrium data is given below:

x	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y	0.21	0.35	0.51	0.64	0.72	0.79	0.86	0.91	0.96

   (b) Explain the principle of flash vaporization.   [10+6]

4. (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]

5. A mixture weighing 1000 kg contains 23.5 wt% acetone and 76.5 wt% is to be extracted by 500 kg methyl isobutyl ketone in a single stage extraction. Determine the amounts and compositions of the extract and raffinate phases. Equilibrium Data:

Composition data (wt%)			Acetone distribution data (wt%)	
MIK	Acetone	water	Water phase	MIK phase
98.0	0	2.00	2.5	4.5
93.2	4.6	2.33	5.5	10.0
77.3	18.95	3.86	7.5	13.5
71.0	24.4	4.66	10.0	17.5
65.5	28.9	5.53	12.5	21.3
54.7	37.6	5.53	12.5	21.3
46.2	43.2	10.7	17.5	28.2
12.4	42.7	45.0	20.0	31.2
5.01	30.9	64.2	22.5	34.0
3.23	20.9	75.8	25.0	36.5
2.12	3.73	94.2	26.0	37.5
2.20	0	97.8		

                                                                    [16]

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6. (a) Apply the Freundlich equation for two stage cross current operation and derive the equation to estimate intermediate concentration of the liquid stream.

   (b) What is the effect of temperature on adsorption isotherms for binary gas mixtures.

   [10+6]

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 mixture containing 40% p-chloronitrobenzene (B) and 60% o-chloronitrobenzene (C) is to be separated at the rate of 100kg/h into products containing 85% 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]

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MASS TRANSFER OPERATIONS-II
Chemical Engineering

Time: 3 hours   Max Marks: 80

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1. (a) Write short notes on applications of fixed bed adsorber.

   (b) Explain the term breakpoint in adsorption wave curve.

   (c) Write short notes on Ion exchange equilibria.   [5+6+5]

2. (a) Describe thermosyphon reboilers with neat diagrams.

   (b) What does the Fenske equation compute? Be precise! Is it a theoretical or empirical equation? Is it an exact equation? If not, what assumptions are made in its derivation?

   (c) What is the difference between extractive distillation and azeotropic distillation?

   [5+5+6]

3. (a) A feed mixture of benzene and toluene containing 30 mole % of benzene is to be distilled in a batch still by differential distillation process. A distillate product having an average composition of 45-mole % benzene is to be obtained. Calculate the quantity of residue if 100 moles are taken in the batch initially. The equilibrium data is given below:

x	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y	0.21	0.35	0.51	0.64	0.72	0.79	0.86	0.91	0.96

   (b) Explain the principle of flash vaporization.   [10+6]

4. (a) How to estimate minimum reflux ratio for the case of continuous counter current extraction with reflux.

   (b) Write the advantage of continuous counter current extraction with reflux over continuous counter current extraction with out reflux.   [8+8]

5. 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	0.50	0.32	0.24	0.187

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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]

6. (a) For a multistage counter current leaching operation, explain how to estimate composition of raffinate, extract obtained along with number of stages by graphical method.

   (b) Write note on various types of equilibrium diagrams for a solid liquid systems for leaching operation. [10+6]

7. A mixture of 60 mole%A and 40 mole% B is separated in a column to yield 96 mole % A as the top product. Also, 97% of A entering the tower must be recovered in the distillate. The feed is a saturated vapour. The following concentrations have been measured by analyzing the liquid and vapour samples around the 6 th tray $x_6 = 0.55$, $y_6 = 0.72$, $y_7 = 0.63$.

   (a) What is the local value of the relative volatility of A with respect to B?

   (b) How many ideal trays does the column have? Assume that the relative volatility remains constant. [16]

8. The equilibrium partial pressure of water in contact with a certain silica gel on which water is adsorbed at 25^0C is as follows

Partial Pressure of water, mmHg	0	2.14	4.74	7.13	9.05	10.9	12.6	14.3	16.7
Kg water/ 100 kg dry gel	0	5	10	15	20	25	30	35	40

When 4.5 kg of silica gel containing 5 wt% adsorbed water is placed in a following air stream containing a partial pressure of water vapor = 12 mmHg, the total pressure 1 std atm and the temperature is 25^0C. When equilibrium is reached, what mass of additional water will the gel have adsorbed? Air is not adsorbed. [16]

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MASS TRANSFER OPERATIONS-II
Chemical Engineering

Time: 3 hours   Max Marks: 80

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1. An equimolar mixture of A and B is to be separated in a tray tower. A top product having 95 mol% A is acceptable. However, a very pure bottom product having not more then 0.1 mol % A is required. The feed is liquid at its bubble point. A reflux ratio of 2.0 is suggested. The relative volatility of A with respect to B is $\alpha_{AB} = 2.2$. Determine the number of ideal stages. [16]

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) Write about the use of equilateral coordinates to describe the concentrations in ternary systems.

   (b) What is mixture rule? Explain how it is used to determine mixture composition on a triangular graph. [8+8]

4. 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]

5. (a) A given mixture of n-pentane and n-octane is heated and flashed when one mole liquid having a mole fraction x= 0.15 of n-pentane and two moles of vapour are generated. At the temperature of the flash drum, the relative volatility of n-octane with respect to n-pentane is 0.216. The solution is ideal. Calculate the composition of the original mixture.

   (b) What are the important factors that determine the selection of a batch distillation column for the separation of a liquid mixture?

   (c) Explain P-x-y diagram. [6+6+4]

6. (a) Prove that for cross current two stage treatment of liquid solutions by contact filtration, when the adsorption isotherm is linear, the least total adsorbent results if the amount used in the two stages are equal.

   (b) What is an adsorption isotherm? How can the heat of adsorption be determined from a series of isotherms? [10+6]

7. 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]

8. 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]

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