

III B.Tech. II Semester Regular Examinations, April/May -2005
MASS TRANSFER OPERATIONS-II
(Chemical Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
 All Questions carry equal marks

1. (a) A liquid mixture of 50 mole% n-heptane
 i. and 50 mole% n-octane
 ii. were subjected to differential distillation at atmospheric pressure with 70 mole% of the liquid distilled. Compute the composition of the composite distillate and the residue.

x	1.00	0.50	0.46	0.42	0.38	0.34	0.32	0.00
y	1.00	0.689	0.648	0.608	0.567	0.523	0.497	0.00

- (b) What is relative volatility? How is it computed?
2. Pertinent data on a binary system heptane ethyl benzene are as follows

x_H	0	0.08	0.185	0.25	0.335	0.487	0.651	0.788	0.914
y_H	0	0.233	0.428	0.514	0.608	0.729	0.834	0.904	0.963

- A feed containing 42 mole % heptane (H) and 58 mole percent ethyl benzene is to be fractionated at 760 mmHg to produce a distillate containing 97% mole % heptane and a residue containing 99 mole % ethyl benzene.
- (a) Determine the minimum number of equilibrium stages.
- (b) Using a reflux ratio equal to 2.5 times minimum reflux ratio, determine the number of equilibrium stages needed for a liquid feed at its boiling point.
3. (a) What is an azeotrope? Give example.
- (b) What is the importance of extractive distillation.
- (c) With neat figure explain the process of extractive distillation. Mention its application in the industries.
4. If 100 kg of a solution of acetic acid (C) and water (A) containing 30% acid is to be extracted three times with isopropyl ether (B) at 20°C, using 40 kg of solvent in each stage, determine the quantities and compositions of the various streams. How much solvent would be required if the same final raffinate concentration were to be obtained with one stage?

The equilibrium data at 20°C are listed below.

Water layer, wt %			Isopropyl ether layer wt%		
Wt% acetic acid 100x	Water	Isopropylether	Acetic acid 100y*	Water	Isopropylether
0.69	98.1	1.2	0.18	0.5	99.3
1.41	97.1	1.5	0.37	0.7	98.9
2.89	95.5	1.6	0.79	0.8	98.4
6.42	91.7	1.9	1.93	1.0	97.1
13.30	84.4	2.3	4.82	1.9	93.3
25.50	71.1	3.4	11.40	3.9	84.7
36.70	58.9	4.4	21.60	6.9	71.5
44.30	45.1	10.6	31.1	10.8	58.1
46.40	37.1	16.5	36.2	15.1	48.7

5. Discuss about continuous contact tower with a neat sketch and derive equations to calculate height of the tower
6. (a) Define Leaching.
 (b) What is lixiviation?
 (c) What is decoction?
 (d) Explain the applications of leaching operation with suitable examples.
7. (a) Explain about the theories of adsorption
 (b) Discuss about the nature and characteristics of adsorbents used in industry.
 List at least four industrial absorbents.
 (c) What is absorption hysteresis?
8. (a) State the principles of ion exchange.
 (b) Derive the equation to calculate the length of used bed.

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1. (a) Write about the construction of enthalpy concentration diagram for a binary liquid mixture
(b) Give the characteristics of an enthalpy-concentration diagram
(c) Explain, how the enthalpy-concentration diagram and x-y diagram are related.
2. A methanol(A)-water(B) solution containing 50 wt% methanol at 27.6°C is to be continuously rectified at 1 std. atm. Pressure at a rate of 5000 kg/h to provide a distillate containing 95 % methanol and a residue containing 1 % methanol by weight. The feed is to be preheated by heat exchange with the residue, which will leave the system at 37.8°C. The distillate is to be totally condensed to a liquid and the reflux returned to the bubble point. The with drawn distillate will be separately cooled before storage. A reflux ratio of 1.5 times the minimum will be used. Determine the quantity of the products.
3. (a) Describe thermosyphon reboilers with neat diagrams.
(b) What do you understand by plate efficiency? Explain.
4. (a) What are the different coordinate by which liquid - liquid equilibrium can be represented?
(b) Discuss cross current multistage extraction operation of insoluble liquids?
5. If 8000 kg/h of an acetic acid (C)-water (A) solution, containing 30 % acid, is to be counter currently extracted with isopropyl ether (B) to reduce the acid concentration to 2 % in the solvent free raffinate product,
(a) The minimum amount of solvent which can be used and
(b) The number of theoretical stages if 20,000 kg/h of solvent is used.

The equilibrium data are given below.

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Wt% acetic acid 100x	Water	Isopropylether	Acetic acid 100y*	Water	Isopropylether
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6. (a) What is Shanks system of leaching?
 (b) Explain countercurrent multiple contact shanks system.
 (c) Explain briefly about extraction battery.
7. (a) Draw a graph showing different types of adsorption isotherms for vapors and explain
 (b) Explain in detail about single stage adsorption
8. (a) What is the role of adsorption in waste water treatment? Explain
 (b) What will be the effect of feed concentration on the break through curve

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1. (a) A binary Mixture of A and B components have the following temperature and vapour pressure characteristics (vapour pressure in mm Hg)

$T^{\circ}\text{C}$	38.5	42	46	50	54	58	62
Vapour pressure A	400	458	532	615	708	812	948
Vapour pressure B	160	185	217	254	295	342	400

Calculate the T-x-y diagrams for the above system at 400mm Hg total pressure.

- (b) Explain the p-x-y characteristics of binary liquid system with a neat schematic diagram.
2. Explain in detail the Ponchon-Savarit method to calculate the number of theoretical plates in a distillation column. What are the advantages of this method over McCabe-Thiele method?
3. Discuss the use of OPEN STEAM in separation processes and write the material and enthalpy balances pertinent to the use of open steam.
4. A feed solution containing 4000 kg of water and 20 kg of acetic acid is to be extracted with benzene solvent to recover 80% acetic acid by weight. The equilibrium data is :

gm acetic acid per kg water	0.920	1.140	1.525	2.04	3.29	5.23
gm acetic acid per kg benzene	1.020	1.620	2.910	5.35	20.10	36.0

Calculate:

- (a) the number of cross-current stages required, if 1000 kg of benzene per stage is used and
- (b) the concentration of acetic acid in the combined extract.
5. (a) Describe the mixer settler cascading system with a neat flow sheet of three stage counter mixer settler extraction to cascade.
- (b) Discuss about Podbielniak extractor with a neat sketch
6. (a) With a neat sketch explain the construction and operation of Kennedy extractor.
- (b) Explain the method of calculation of stage efficiency in leaching.

- (c) In practice, stage efficiency is always less than 100 percent. Why?
7. Write short notes on:
- (a) Contact filtration of liquids.
 - (b) Adsorption isotherm of concentrated solutions.
8. Write short notes on:
- (a) The heatless adsorber
 - (b) Percolation in adsorption of liquids.

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Calculate the T-x-y diagrams for the above system at 400mm Hg total pressure.

- (b) Explain the p-x-y characteristics of binary liquid system with a neat schematic diagram.
2. (a) Define reflux and reflux ratio
 (b) Explain the importance of reflux in a distillation column.
 (c) How will you calculate the optimum reflux ratio?
3. Explain fractionation in a packed tower with a neat sketch. Derive the equation to calculate the height of the enriching section.
4. (a) Draw a neat sketch of multistage cross current extraction unit and make the material balance by using solvent free coordinates ?
 (b) How do you estimate the quantity of extract by using single stage extraction?
5. Write short notes on the following equipment for liquid extraction:
- (a) Spray towers
 (b) Packed towers
6. (a) Explain percolation method of leaching.
 (b) Describe the different types of tanks used in percolation operation.
 (c) Describe the sequence of procedures to be followed in percolation tank operation.
7. (a) Discuss about integral heat of adsorption
 (b) An aqueous solution is colored by small amount of impurities which can be removed by adsorption on carbon. A series of laboratory tests yield the equilibrium data represented by the equation. $y = 8.91 \times 10^{-5} x^{1.66}$, where y = equilibrium color units/kg solution and x is units of color adsorbed/kg carbon.

It is desired to reduce the color of the solution from 9.6 units to 10% of the value. Determine the quantity of fresh carbon required per 1000kg of solution for a single stage operation.

8. Write short notes on:

- (a) Ion exchange equilibria.
- (b) Adsorption wave.

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