

III B.Tech II Semester Supplementary Examinations, Apr/May 2008
MASS TRANSFER OPERATIONS-II
(Chemical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

1. (a) What is differential distillation? Derive Rayleigh equation.
(b) Explain the T-x, y diagram with a neat sketch. [10+6]
2. (a) Derive Fenske's equation for determining the number of plates at total reflux in the case of a binary system and write the assumptions involved in it.
(b) A binary liquid mixture containing 3.5 mole % of A is to be rectified to give a product of 95% A. Calculate the minimum number of plates required assuming ideal system with a constant relative volatility of 1.10. [10+6]
3. (a) Compare azeotropic and extractive distillation.
(b) What are the requirements of a satisfactory extractive distillation solvent? [8+8]
4. Water and dioxane form a maximum boiling azeotrope. Hence to recover dioxane completely from an aqueous solution, benzene is used as a solvent for the extraction operation. The equilibrium distribution of dioxane between benzene and water layer at 25°C is given below.

Dioxane in water Layer, wt%	5.1	18.9	25.2
Dioxane in benzene Layer, wt%	5.2	22.5	32.0

500 kg of 20 wt % dioxane solutions in water is to be treated to recover 95% dioxane present in the feed. The solvent is dioxane free.

Calculate:

- (a) the amount of solvent required if the operation is carried out in a single batch equipment, and
- (b) the amount of solvent per stage, if the extraction carried out in two cross flow cascade system using equal amounts of solvent in each stage. [16]
5. (a) Describe the rotating disk contactor with a neat sketch.
(b) Discuss packed extraction tower with a neat sketch. [8+8]
6. (a) Explain different types of agitated vessels with neat sketches.
(b) With a neat sketch explain the working of Pachuca tank. [7+9]
7. (a) Write briefly about van der Waals adsorption.

- (b) The equilibrium adsorption of acetone vapor on an activated carbon at 30° C is given by the following data:

gm adsorbed / gm carbon:	0	0.1	0.2	0.3	0.35
Partial pressure acetone, mmHg:	0	2	12	42	92

The partial pressure of acetone vapor at 1 standard atmosphere and 30° C is 100mmHg

A 1-liter flask contains air and acetone vapor at 1 standard atmosphere and 30° C after 2gm of fresh activated carbon has been introduced into the flask, the flask is sealed. Compute the final vapor concentration at 30°C and the final pressure. Neglect the adsorption of air. [4+12]

8. (a) Discuss about rate of adsorption in fixed beds.
- (b) The rate of ion exchange depends upon the rates of certain individual processes. What are they? [8+8]

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1. (a) 200 kgmole/hour of a mixture containing A, B and C with a composition of 20%, 50% and 30% (mole) respectively is flash vaporised at 120°C. If 90% of C is to be recovered in liquid, calculate vapour flow rate and vapour composition.

Component	A	B	C
Relative volatility	3.9	1.96	1.0

- (b) Describe how vapour-liquid equilibrium data may be generated for a binary solution in the laboratory. Draw the schematic of the set-up to be used. [10+6]
2. Explain with figure the effect of different feed conditions in a distillation column. Write about the importance of q-line. Also write short notes on feed tray location. [16]
3. (a) What is an azeotrope? Give few examples.
 (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+4+8]
4. Nicotine (C) in a water (A) solution containing 1% nicotine is to be extracted with kerosene (B) at 20°C. Water and kerosene are essentially insoluble.
- (a) Determine the percentage extraction of nicotine if 100 kg of feed solution is extracted once with 150 kg solvent.
 (b) Repeat for three theoretical extractions using 50 kg solvent each.

Equilibrium data are as follows, expressed as kg nicotine/kg liquid:

x' (kg nicotine/kg water)	0	0.001011	0.002460	0.00502	0.00751	0.00998	0.0204
y^* (kg nicotine/kg kerosene)	0	0.000807	0.001961	0.00456	0.00686	0.00913	0.0187

[16]

5. Discuss continuous countercurrent multistage extraction and explain how it is shown on a triangular chart. Indicate how the quantities and compositions of extract and raffinate are computed. For a given separation indicate how the number of equilibrium stages required is found. [16]
6. With suitable figures explain the working principle of

(a) Dorr agitator.

(b) Bollman extractor.

[8+8]

7. (a) Discuss the properties of a good adsorbent.

(b) Raw sugar solution containing 48% by weight is colored by impurities. The impurities are to be removed by activated carbon in a contact filtration unit. The equilibrium data are as follows:

kg carbon/g of dry sugar:	0	0.005	0.01	0.015	0.02	0.03
% color removed :	0	47	70	83	90	95

The original solution has a color concentration of 20% and it has to be reduced to 2%. Calculate the amount of carbon required to treat 500kg of solution in a single stage operation.

[12+4]

8. (a) Derive the rate of adsorption in fixed beds?

(b) What are the factors determining rate of ion exchange?

[10+6]

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1. An equimolal mixture of benzene and toluene is subjected to a simple batch distillation at atmospheric pressure. Assume relative volatility for the system as 2.55. If the distillation is discontinued, when moles of distillate amount to 60% of moles charged calculate:
Concentration of distillate
Concentration of liquid left in the still
The amount of the benzene in the distillate expressed as a percentage of the amount of benzene in the charge. [5+5+6]
2. Write short notes on
 - (a) Feed Tray location
 - (b) Optimum reflux ratio
 - (c) Stripping section in the distillation column
 - (d) Simple distillation. [4×4]
3. An equimolar binary mixture of completely miscible components is to be separated in a packed distillation column operated at atmospheric pressure. The relative volatility is 1.2. The distillate product to be obtained should contain 95 mole% of the more volatile component bottom product contains 5 mole % of the mole volatile component. Compute for this case, the number of transfer units required if the column is operated at total reflux. [16]
4.
 - (a) Discuss about the applications of liquid extraction.
 - (b) Write about the notation scheme used to describe the concentration and amounts of ternary mixtures for the purpose of discussing both equilibrium and material balances. [6+10]
5. 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.m² of pure ether is used to extract 975 kg/hr.m² of 4% acid by weight then the ether phase leaves the column with a concentration of 1% acid by weight. Calculate
 - (a) the number of overall transfer units based on raffinate phase
 - (b) overall extraction coefficient based on raffinate phase.

The equilibrium relationship is given by Wt% acid in ether phase = 0.3 times the wt% acid in water phase. [16]

6.
 - (a) Compare percolation with agitation.
 - (b) Write briefly about the importance of grinding in leaching.
 - (c) Explain the different mechanisms involved in leaching.
 - (d) Describe briefly about rate of leaching. [4×4]
7.
 - (a) Apply the Freundlich equation for two stage counter current operation and derive the equation to estimate intermediate concentration of the fluid stream.
 - (b) What is the effect of pressure on adsorption isotherms for binary gas mixtures? [10+6]
8. Write short notes on:
 - (a) Hypersorber
 - (b) Principles of ion exchange. [8+8]

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1. A binary mixture of benzene and toluene containing 40 mole % benzene is to be distilled at atmospheric pressure to recover 95% of the benzene. Estimate the molal percent of the mixture that should be distilled and the composition of the distillate obtained, if the distillation is carried out by

- (a) Simple equilibrium distillation
- (b) Differential distillation collecting all the distillate together

The average relative volatility of benzene to toluene in the temperature range involved is 2.5. [8+8]

2. A distillation column is to be designed to separate A and B continuously. The feed is 35 % A and 65 % B at its dew point. The distillate and the residue compositions are 0.95 and 0.025 respectively.

- (a) Find the quantities of distillate and bottoms per hour.
- (b) Find the number of equilibrium stages required in the column if the reflux ratio is 2.5.

Assume the relative volatility as 2.25. [16]

3. (a) What is a partial condenser? Represent graphically. Write the material balance equations.

- (b) What is the effect of cold reflux in distillation operation with the help of mathematical equating. [8+8]

4. Write about the use of rectangular coordinates to describe the concentrations in ternary systems. Also show how they can be used on solvent-free basis for two partly miscible liquid pairs. [16]

5. (a) Describe the rotating disk contactor with a neat sketch.

- (b) Discuss packed extraction tower with a neat sketch. [8+8]

6. (a) What are cossettes?

- (b) Explain the preparation of vegetable and animal bodies for leaching operation with specific examples.

- (c) What is the effect of temperature on leaching? [2+10+4]

7. (a) What is irreversible adsorption? Explain in detail.

(b) Write short notes on one component and two component adsorption isotherm. [10+6]

8. (a) Explain about gas drying equipment?

(b) What are hypersorbents? Explain in detail. [8+8]
