C 3092

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Fifth Semester

Biotechnology

BT 1304 — MASS TRANSFER OPERATIONS

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Any missing data may suitably be assumed.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Explain Molar flux and diffusivity.

2. Explain when molecular diffusion and Knudsen diffusion occur in solids.

3. Explain : HTU and NTU.

4. Define Absorption factor and indicate its significance.

5. Explain the principle of steam distillation.

6. Explain how azeotropic mixtures are separated.

7. What is meant by a solutropic system?

8. Explain Tie lines and Plait point.

9. Discuss the factors, which affect the rate of dying.

10. Define differential heat of adsorption.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Obtain an expression for the mass flux under equimolar counter diffusion.

(ii) An open circular tank, 6.0 m in dia. contains benzene at 25°C which is exposed to the atm. in such a manner that the liquid is covered with a stagnant air film having an estimated thickness of 5.0 mm. The concentration of benzene beyond the stagnant film is negligible. The vapour pressure of benzene at 25°C is 100 mm Hg. If benzene is worth one rupee a litre, what is the value of the loss of benzene from this tank in rupees per day? Molar diffusivity of benzene in air at 25°C and 1.0 atm pressure is 277.7 cm^2/hr. Density of benzene at 25°C is 0.88 gm/ml. (6 + 10)

Or

(b) (i) Explain briefly the different types of diffusion in solids.

(ii) Explain how mass transfer coefficients are determined in a wetted wall column.

(iii) Explain the usefulness of analogies (5 + 6 + 5)

12. (a) (i) What are the essential properties for a good tower packing used in gas liquid contact operation?

(ii) NH_3 is absorbed from a gas by water in a scrubber under atmospheric pressure. The initial NH_3 content in the gas is 0.04 k mole/k mole of inert gas. The recovery of NH_3 by absorption is 90 %. The water enters the tower free from NH_3. Estimate (1) Concentration of NH_3 in the exiting liquid if the actual water used is 1.5 times minimum. (2) Number of theoretical stages required (3) If the height of a transfer unit is 0.5 m estimate the height of column.

x :	0.005	0.01	0.0125	0.015	0.02	0.023
y :	0.0045	0.0102	0.0138	0.0183	0.0273	0.0327

where x and y are mole ratios. (5 + 11)

Or

(b) (i) Explain the phenomena of loading and flooding in absorbers.

(ii) Explain the differences between packed towers and plate towers.

(iii) Write briefly on Absorption with chemical reaction. (5 + 6 + 5)

13. (a) (i) The vapour pressure data for n — Hexane — n — Octane system is given below. Compute the equilibrium data and relative volatility for the system at a total pressure of 101.32 kPa.

T°C	n – Hexane	n – Octane
	P_A, kPa (A)	P_B, kPb (B)
68.7	101.32	16.1
79.4	136.7	23.1
93.3	197.3	37.1
107.2	284.0	57.9
125.7	456.0	101.32

(ii) Explain briefly the different types of distillation. (10 + 6)

Or

(b) (i) Explain : External, Internal, Minimum and Total reflux ratios.

(ii) Discuss briefly the features of a sieve plate and a bubble cap distillation column with neat sketches (8 + 8)

14. (a) (i) Discuss the effect of temperature on LLE diagrams with sketch.

(ii) What are the influencing factors on solvent selection in Extraction?

(iii) Explain with a neat sketch the construction and working of an extractor for the extraction of oil from oil seeds. (4 + 4 + 8)

Or

(b) (i) Explain constant and variable underflow systems.

(ii) A 25% (weight) solution of dioxane in water is to be continuously extracted with 200 Kg/hr of pure benzene in each stage in a cross current extraction battery. The feed rate is 100 Kg/hr and if the extraction is carried out in 3 stages, estimate the % recovery.

Equilibrium data:

Dioxane in water wt. %	5.1	18.9	25.2
Dioxane in Benzene wt. %	5.2	22.5	32.0

(4 + 12)

15. (a) (i) Obtain an expression for the drying time in the case of a substance having both falling rate and constant rate drying periods.

(ii) 1000 kg dry weight of non-porous solid is dried under constant drying conditions with an air velocity of 0.75 m/s, so that the area of surface drying is 55 m^2. The critical moisture content of the material may be taken as 0.125 kg water / kg dry solids.

(1) If the initial rate of drying is 0.3 g / m^2.s. How long will it take to dry the material from 0.15 to 0.025 kg water per kg dry solid?

(2) If the air velocity were increased to 4.0 m/s. What would be the anticipated saving in time if surface evaporation is controlling? (6 + 10)

Or

(b) (i) Explain the working of a continuous adsorber for the removal of oil vapour from a gas mixture.

(ii) Explain briefly (1) the different adsorption isotherms (2) Adsorption Hysterisis. (10 + 6)
