A 1216

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2006.

Fifth Semester

Industrial Biotechnology

IB 333 — MASS TRANSFER AND SEPARATION

Time : Three hours

Maximum : 100 marks

Missing data may be suitably assumed.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Explain how the penetration and film mass theories are used to determine the mass transfer coefficients.

2. Define Permeability and Diffusivity.

3. What is the use of an entrainer in distillation?

4. Differentiate between flash distillation and steam distillation.

5. Discuss the factors to be considered in the choice of solvent for leaching.

6. Sketch the operating line and equilibrium curve for a Counter-current extractor.

7. Define absorption Factor and explain its significance.

8. Explain briefly about break-through curve.

9. Define Concentration Polarization. How do you overcome this problem in membrane separation process?

10. Name the different modules of membranes used in downstream processing.

PART B — (2 × 15 = 30 marks)

11. (i) Uric acid (A) at 37° C is diffusing in an aqueous solution of proteins (P) containing 7.2 g protein/100 mL solution. Uric acid binds to the protein and over the range of concentrations present, 1.0 g mol of acid binds to the proteins for every 3.0 g mol of total acid present in the solution. The diffusivity D_{AB} of uric acid in water is $1.21*10^{-5}$ cm²/sec and diffusivity of protein D_P is 0.091^{-5} cm²/sec.

(1) Assuming no binding, predict the ratio D_{AP}/D_{AB} due to blockage effects only.

(2) Assuming blockage plus binding effects, predict the ratio D_{AP}/D_{AB}.

(3) Predict the flux in g/s.cm² for a concentration of acid is 0.05 g/L at point 1 and 0 g/L at point 2 a distance 1.5 μm away. (8)

(ii) Helium and Nitrogen gas are contained in a conduit 5 mm in diameter and 0.1 m long at 298° k and uniform constant pressure of 1.0 atm abs. The partial pressure of He at one end of the tube is 0.060 atm and 0.020 atm at the other end. The diffusivity of Helium is 0.687 cm²/s.

Calculate the following for steady state equimolar counterdiffusion.

(1) Flux of He in Kgmol/s.m²

(2) Flux of N_2

(3) Pressure of He at a point 0.05 m from either end. (8)

12. (a) A binary mixture of benzene and toluene containing 40 mol percent benzene is to be distilled at atmospheric pressure to recover 95% of the benzene. Estimate the molal percent of the mixture which should be distilled and the composition of the distillate obtained, it the distillate is carried out by

(i) Simple equilibrium distillation

(ii) Differential distillation collecting all distillate together

The average relative volatility of benzene to toluene is 2.5. (16)

Or

(b) A bubble cap fractionating column of 15 plates working at an overall efficiency of 75% is being used to distill 1000 kg/hr of aqueous methanol entering the tower at its bubble point. The feed, overhead product and bottom product are 50 mole%, 90 mole% and 10 mole% 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, check whether the column available is satisfactory. The VLE data are :

x	0.08	0.1	0.2	0.3	0.4	0.5	0.7	0.8	0.95
y	0.365	0.418	0.579	0.665	0.729	0.778	0.87	0.958	0.979

(16)

13. (a) Crushed oilseeds containing 55% oil (by weight) is to be extracted at the rate of 4000 kg/hr using 100 kg/min of n-hexane containing 5% oil (by wt.) as the solvent. A counter current two stage extraction system is employed. The oil seeds will retain 1 kg of solution per kg of oil-free cake. Estimate the percent recovery of oil (based on original feed) obtained under the above conditions : (16)

Or

(b) (i) Explain the working principle and applications of Podbielniak and sieve tray extractor with the aid of neat sketches. (8)

(ii) Write a short notes on :

(1) Selectivity

(2) Distribution coefficient

(3) Plait point. (8)

14. (a) A waste steam of alcohol vapour in air from a process was adsorbed by activated carbon particles in a packed bed having a diameter of 4 cm and length of 14 cm containing 80 g of carbon. The inlet gas stream having a concentration c_o of 500 ppm and a density of 0.0012 g/cm^3 entered the bed at a flow rate of 750 cm^3/s. The breakpoint concentration is set at $c/c_o = 0.01$.

Time (hr)	0	3	3.5	4	4.5	5	5.5	6.0	6.2	6.5	6.8
c/c_o	0	0	0.002	0.03	0.155	0.396	0.658	0.903	0.933	0.975	0.993

(i) Determine the break point time, the fraction of total capacity used up to the break point and the length of the unused bed. Also determine the saturation loading capacity of the carbon. (8)

(ii) If the break-point time required for a new condition is 6.0 hr, what is the new total length of the column required? (8)

Or

(b) (i) Explain the loading and flooding in packed towers. (8)

(ii) List the characteristics of packing in Absorption. (8)

15. (a) (i) Discuss the Complete-mixing model for reverse osmosis. (10)

(ii) A solution containing 0.9 wt% protein is to undergo ultrafilteration using a pressure difference of 5 psi. The membrane permeability is $A_w = 1.37 * 10^{-2}$ kg/s m^2.atm., Predict the flux, assuming no effects of polarization. (6)

Or

(b) Discuss briefly the principle, operation and application of the following processes :

(i) Zone refining

(ii) Hemodialysis. (8 + 8)
