Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (CHE-N)/SEM-6/CHE-601/2011

2011

SEPARATION PROCESSES – II

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) For Air-water system wet bulb temperature and adiabatic saturation temperature are almost same because

      a) Thermal diffusivity equals to mass diffusivity

      b) Schimdt number equals to Prandtl number

      c) Lewis number equals to 1·0

      d) All of these.

   ii) For an effective extraction operation, the selectivity of the solvent for the solute should be

      a) much greater than 1·0 b) less than 1·0

      c) equal to 1·0 d) equal to 0.

iii) Can a cooling tower cool water below the wet bulb temperature of inlet air ?

a) Yes

b) No

c) Yes, but height of the tower will be prohibitively high

d) No, but the air flow rate should be excessively high.

iv) In adiabatic humidifier

a) enthalpy of air and temperature of liquid remain constant

b) temperature of air decreases

c) temperature of air increases

d) both (a) and (b).

v) Selectivity of a solvent used in extraction should be

a) 1 b) > 1

c) < 1 d) 0.

vi) In liquid-liquid extraction, the number of phases at plait point is

a) 1 b) 2

c) 3 d) 4.

vii) An unstable product is to be recovered by extraction, and the contact time in the extractor should not be more than 30 s. The interfacial tension for the system is low. What kind of extractor appears to be suitable ?

a) Karr extractor b) Scheibel column

c) Podbielniak extractor d) Bollman extractor.

viii) If the solute concentration (on sold-free basis) in the overflow and the underflow are equal, the tie lines are

a) vertical b) horizontal

c) of varying slope d) none of these.

ix) Ultrafiltration employs membrane having pore sizes

a) 1 to 100 nm b) 0·1 to 10 μm

c) 0·1 to 1 nm d) none of these.

x) Allowable pH range for cellulose acetate membrane is

a) 4 – 11 b) 2 – 10

c) 4·5 – 7·5 d) 1 – 14.

xi) Dense membrane separates species based on

a) Solution diffusion mechanism

b) Sieving mechanism

c) Knudsen diffusion mechanism

d) Viscous flow mechanism.

xii) Tea percolation employs

a) liquid-liquid extraction

b) leaching

c) absorption

d) none of these.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Calculate the flux and the rate of removal of urea at steady state in gm/hr from blood in a membrane dialyzer at 37° C. The membrane is 0·021 mm thick and has an area $1 \cdot 8\ m^2$. The mass transfer co-efficient on the blood side is estimated as $KCl = 1 \cdot 32 \times 10^{-5}$ m/s and on the aqueous side is $3 \cdot 38 \times 10^{-5}$ m/s. The permeance of the membrane is $9 \cdot 22 \times 10^{-6}$ m/s. The concentration of urea in the blood is 0·06 gm urea/100 ml and that in the dialyzing fluid will be assumed as zero.

3. a) What are the advantages and problems of carrying out extraction of a solid at an elevated temperature ?

   b) Can two tie lines intersect within the two-phase region of an LLE diagram ? Explain qualitatively. 2 + 3

4. Discuss the advantages and limitations of forced draft and induced draft cooling towers.

5. a) Write down the sequence of stages in the evolution of a crystal.

   b) What are the parameters controlling the crystal size distribution in a crystallizer ? Explain them briefly. 2 + 3

6. a) What is accepted definition of molecular weight cut-off (MWCO) ?

   b) Mention the three major negative effects of concentration polarization on desalination by RO. 2 + 3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Explain the procedure need to be followed to determine by suitable sketches the following for the mixture of air and water vapour of given dry and wet bulb temperatures.

   i) Per cent saturation and absolute humidity.

   ii) Dew point.

   b) Define the terms 'wet bulb depression', 'psychrometric' ratio and 'Lewis number'.

   c) A salt solution weighing 8000 kg with 25 wt% Na_2CO_3 is cooled to 293 K. The salt crystallizes as the decahydrate. What will be the yield of Na_2CO_3, $10\,H_2O$ crystals if the solubility is 20 kg anhydrous Na_2CO_3/100 kg of total water ? Do these for the following cases :

   i) Assume that 10% water is evaporated.

   ii) Assume that 5% of the total weight of the solution is lost by evaporation of water. 5 + 3 + 7

8. Pure solvent isopropyl ether at a rate of 850 kg/h is being used to extract an aqueous solution flowing at a rate of 275 kg/h containing 38 wt% acetic acid by counter-current multistage extraction. The desired exist acid concentration in the aqueous phase is 4 wt%. Calculate the compositions and amounts of the either extract and aqueous raffinate.

The equilibrium data is given below :

Water layer (wt%)			**Isopropyl ether layer**		
Acetic acid	Water	Isopropyl ether	Acetic acid	Water	Isopropyl ether
0	98·8	1·2	0	0·6	99·4
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
13·3	84·4	2·3	4·82	1·9	93·3
25·5	71·1	3·4	11·4	3·9	84·7
36·7	58·9	4·4	21·6	6·9	71·5
44·3	45·1	10·6	31·1	10·8	58·1
46·4	37·1	16·5	36·2	15·1	48·7

9. a) Define the following :

   i) Percentage humidity

   ii) Relative humidity

   iii) Wet bulb temperature.

   b) A continuous contercurrent dryer is being used to dry 453·6 kg dry solid/h containing 0·04 kg total moisture/kg dry solid to a value of 0·002 kg total moisture/kg dry solid. The granular solid enters at 27° C and is to be discharged at 63° C. The dry solid has a heat capacity of 1·46 kJ/kg K, which is assumed to be constant. Heating air enters at 90° C, having a humidity of 0·010 kg water/kg dry air, and is to leave at 38° C. The latent heat of vaporization of water may be taken as 2500 kJ/kg

   Calculate the air flow rate and the outlet humidity, assuming no heat losses in the dryer. 5 + 10

10. a) How can the commercial extractors be broadly classified ?

   b) Write short notes on spray dryer and rotary dryer.

   c) Discuss the factors which govern the selection of solvents to be used for liquid-liquid extraction. 5 + 5 + 5

11. Answer any *three* of the following : 3×5

a) Discuss Electrodialysis process with a neat sketch.

b) Discuss the application of membrane separation processes.

c) Define : bound moisture, unbound moisture, critical moisture, equilibrium moisture, free moisture.

d) Write short note on Crystallizer.

e) Draw typical rate of drying curve under constant drying conditions and explain constant rate period and falling rate period.