



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.TECH (CHE)/SEM-6/CHE-601/2010  
2010**

**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 )**

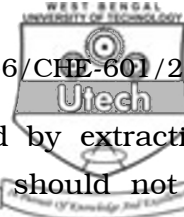
1. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

- i) In extraction, as the temperature increases, the area covered by binodal curve
- a) decreases                      b) increases
- c) remains unchanged      d) none of these.
- ii) Extraction of coffee from its seed is done by
- a) liquid-liquid extraction
- b) leaching
- c) extractive distillation
- d) steam distillation.



- iii) The apex of an equilateral triangular coordinate ( in ternary liquid system ) represented a/an
- a) pure component
  - b) binary mixture
  - c) ternary mixture
  - d) insoluble binary system.
- iv) Leaching of sugar from sugar beets is done by
- a) hot water
  - b) hexane
  - c) dilute  $H_2SO_4$
  - d) lime water.
- v) For all humidities other than 0% and 100%, the percentage humidity is
- a) higher than relative humidity
  - b) equal to relative humidity
  - c) less than relative humidity
  - d) any of these.
- vi) Dry bulb temperature is equal to wet bulb temperature at
- a) 0% humidity
  - b) 50% humidity
  - c) 100% humidity
  - d) none of these.



- vii) An unstable product is to be recovered by extraction, and the contact time in the extractor should not be more than 30s. 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) 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).
- ix) All moisture in a non-hygroscopic material is
- a) free moisture  
b) equilibrium moisture  
c) unbound moisture  
d) bound moisture.
- x) How does the swelling of membrane affect diffusion of molecules through it ?
- a) Increases  
b) Decreases  
c) No influence  
d) May increase or decrease depending upon the situations.



- xi) A membrane for reverse osmosis is
- a) microporous
  - b) dense
  - c) porous with a dense skin
  - d) macroporous.
- xii) A hollow-fibre membrane with isotropic dense wall is suitable for
- a) microfiltration
  - b) RO
  - c) UF
  - d) pervaporation.

**GROUP – B**

**( Short Answer Type Questions )**

Answer any *three* of the following.  $3 \times 5 = 15$

2. 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.  $3 + 2$
3. What are the different types of cooling towers used in industries ? Compare the advantages and disadvantages of induced draft and natural draft cooling towers.  $2 + 3$
4. a) Give a few examples of applications / potential applications of solvent extraction for waste water treatment.
- b) Describe two common types of liquid membranes.  $2 + 3$
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. 1000 kg of an aqueous solution containing 35 mass % trimethyl amine ( TMA ) and 65 mass % water is to be extracted using benzene as the solvent. A three-stage cross-current extraction scheme is suggested. The amounts of solvent ( 98 mass % benzene, 2 mass % TMA ) to be used in successive stages are 815 kg, 950 kg and 2625 kg. Determine the fraction of the solute removed if the stages are ideal. The compositions of the raffinate and the extract as well as the tie-line data are given below ( water : A, benzene : B, TMA : C ).

Water-rich phase,

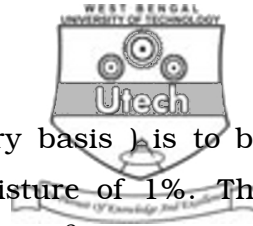
$x_B$	0.004	0.006	0.01	0.02	0.03	0.036	0.07	0.13
$x_C$	0.05	0.10	0.15	0.20	0.35	0.30	0.35	0.40

Benzene-rich phase :

$y_B$	0.95	0.90	0.84	0.78	0.71	0.63	0.50	0.26
$y_C$	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40

Equilibrium data for solute distribution :

$x_C$	0.04	0.083	0.13	0.215	0.395
$y_C$	0.035	0.068	0.09	0.145	0.31



8. a) A wet solid having 32% moisture ( dry basis ) is to be dried on a tray dryer to a final moisture of 1%. The solid loading is 30 kg dry solid per  $m^2$  tray area. There are two critical moisture values  $X_{C_1} = 0.183$  and  $X_{C_2} = 0.097$ . A laboratory test gives a drying rate of  $4 \text{ kg}/m^2 \cdot \text{h}$  in the constant rate period. In the first falling rate period, the drying flux is linear in the moisture content, in the second falling rate, the drying flux varies as the square of the moisture content. The equilibrium moisture is negligible. Calculate the drying time if the drying conditions are the same as in the laboratory test. Mention any assumption made.
- b) Write a short note on spray dryer. 10 + 5
9. It is required to design an RO module for production of  $1500 \text{ m}^3$  /day potable water containing not more than 250 p.p.m. salt from sea water containing 34 g salt per litre. A proprietary asymmetric cellulose acetate membrane with an inherent salt rejection ability of 98% is to be used. The water permeation coefficient is  $0.043 \text{ m}^3 /m^2 \cdot \text{day} \cdot \text{atm}$ . The recovery of the feed water should be 35% and an operating pressure of 70 atm gauge is suggested. The permeate side is at essentially atmospheric pressure. If spiral wound modules of  $5 \text{ m}^2$  effective membrane area each is used, how many modules in parallel are required ? What fraction of the input power can be recovered from the retantate if a turbine of 70% efficiency is used for energy recovery ? The osmotic pressure of 5% brine ( linear in concentration ) is 39.5 atm.



10. a) Derive a mathematical expression for the steady-state flux  $N_A$  and overall resistances for dialysis.
- b) A liquid containing dilute solute A at a concentration  $c_1 = 3 \times 10^{-2}$  kg-mol/m<sup>3</sup> is flowing rapidly past a membrane of thickness  $L = 3.0 \times 10^{-5}$  m. The distribution coefficient  $K' = 1.5$  and  $D_{AB} = 7 \times 10^{-11}$  m<sup>2</sup>/s in the membrane. The solute diffuses through the membrane and its concentration on the other side is  $c_2 = 0.5 \times 10^{-2}$  kg-mol/m<sup>3</sup>. The mass transfer coefficient  $K_{c_1}$  is infinitely large and  $K_{c_2} = 2.02 \times 10^{-5}$  m/s. Calculate (i) the steady-state flux  $N_A$  and (ii) the concentrations at membrane interfaces and the flux through the membrane. 5 + 10
11. Write short notes on any *three* of the following : 3 × 5
- Packed extraction tower
  - Homogeneous crystallization
  - Pervaporation
  - Freeze drying.

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