Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (CHE-OLD)/SEM-6/CHE-601/2013

2013

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 Prandlt 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 remains constant

b) temperature of air decreases

c) temperature of air increases

d) both (a) & (b).

v) If the solute concentrations (on 'solid-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.

vi) Percentage saturation is ..... the relative saturation.

a) always smaller than

b) always greater than

c) not related to

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) All moisture in a non-hygroscopic material is

a) free moisture b) equilibrium moisture

c) unbound moisture d) bound moisture.

ix) A hollow-fibre membrane with isotropic dense wall is suitable for

a) Microfiltration b) RO

c) UF d) Pervaporation.

x) A UF membrane has a pore-size range of

a) 1-100 Å b) 1-100 μm

c) 1-100 nm d) 1-100 mm.

xi) The caking of crystals can be prevented by

a) maintaining high critical humidity

b) maintaining low critical humidity

c) coating te product with inert material

d) both (a) & (c).

GROUP – B

(Short Answer Type Questions)

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

2. What are the different types of cooling towers used in industries ? Compare the advantages and disadvantages of mechanical draft and natural draft cooling towers. 2 + 3

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. A material is dried in a tray-type batch dryer using constant-drying conditions. When the initial free moisture content was 0·28 kg free moisture/kg dry solid, 6·0 hrs was required to dry the material to a free moisture content of 0·08 kg free moisture/kg dry solid. The critical free moisture content is 0·14. Assuming a drying rate I the falling-rate region, where the rate is straight line from the critical point to the origin, predict the time to dry a sample from a free moisture content of 0·33 to 0·04 kg free moisture/kg dry solid.

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 followings for the mixture of air and water vapour of given dry and wet bulb temperature.

      i) Percent saturation and absolute humidity.

      ii) Dew point.

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

c) A plant requires 15 kg/s of cooling water to flow through a condenser. It is planned to cool the water for reuse by contact with air in an induced-draft cooling tower. Entering and leaving temperature of water through the cooling tower are 45°C and 29°C. Hardness of makeup water is 500 ppm dissolved solids. The circulating water is not to contain more than 2000 ppm hardness. Compute the make-up water requirement. Latent heat of vaporization of water may be taken as 2260 kJ/kg. 5 + 3 + 7

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 $X_{C1} = 0{\cdot}183$ and $X_{C2} = 0{\cdot}097$. A laboratory test gives a drying rate of 4 kg/m^2h 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 short note on spray dryer. 12 + 3

9. a) An aqueous feed of 200 kg/h containing 25 wt% acetic acid is being extracted by pure iso-propyl ether at the rate of 600 kg/h in a counter current multistage system. The exit acid concentration in the aqueous phase is to contain 3 wt% acetic acid. Calculate the compositions and amounts of the extract and raffinate streams.

Water layer (wt %)			Ether layer (wt %)		
Acetic acid	Water	Isopropyl ether	Acetic acid	Water	Isopropyl ether
0·0	98·8	1·2	0·0	0·6	99·4
1·41	97·1	1·5	0·37	0·7	98·9
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
46·4	37·1	16·5	36·2	15·7	48·7

b) Discuss the factors which govern the selection of solvents to be used for liquid-liquid extractions.

c) Differentiate between distillation and extraction process.

10 + 2 + 3

10. a) Briefly describe the solid preparation steps in leaching.

b) A continuous countercurrent multistage system is to be used to leach oil from meal by benzene solvent. The process is to treat 2000 kg/hr of inert solid meal containing 800 kg oil and also 50 kg benzene. The inlet flow per hr. is fresh solvent mixture containing 1310 kg benzene and 20 kg oil. The leached solids are to contain 120 kg oil. The value of N (kg inert solid/kg solution) for the slurry underflow is essentially constant at 1·85. Calculate the exit flows and compositions and the number of stages required. 3 + 12

11. a) A liquid containing dilute solute A at concentration $C_1 = 3 \times 10^{-2}$ kg mol/m^3 is flowing rapidly, passed a membrane of thickness $L = 3{\cdot}0 \times 10^{-5}$ m. The distribution coefficient $k = 1{\cdot}5$ & $D_{AB} = 7{\cdot}0 \times 10^{-11}$ m^2/sec in the membrane and its concentration on the other side is $C_2 = 0{\cdot}5 \times 10^{-2}$ kg mol/m^3. The mass transfer coefficient k_{c1} is large and can be considered as infinite and $k_{c2} = 2{\cdot}02 \times 10^{-5}$ m/sec. Calculate the flux & the concentrations at the membrane interfaces.

b) It is desired to use ultrafiltration for 800 kg of a solution containing 0·05 wt % of a protein to obtain a solution of 1·1 wt %. The feed is recirculated by the membrane with a surface area of 9·9 m^2. The permeability of the membrane is $A_w = 2{\cdot}5 \times 10^{-2}$ kg/s.m^2 atm. Neglecting the effects of concentration polarization if any, calculate the final amount of solution and the time to perform this using a pressure difference of 0·5 atm.

7 + 8