Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/BT (O)/SEM-5/BT (CHE)-514/2012-13

2012
TRANSFER OPERATION – 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) The diffusivity has the same dimension as

a) absolute viscosity

b) kinematic viscosity

c) density

d) concentrations.

ii) According to the film theory the mass transfer coefficient is directly proportional to

a) $D_{AB}^{0.3}$ b) $D_{AB}^{0.5}$

c) D_{AB} d) D_{AB}^{2}.

iii) For distillation if the feed entered is cold liquid then the q value will be

a) $q = 0$ b) $q = 1$

c) $q > 1.0$ d) $q < 0$.

iv) Stripping column distillation means

a) feed to be distilled is supplied at an intermediate point of the column

b) feed is an azeotropic mixture

c) the feed to be distilled is supplied at the bottom of the collumn

d) feed to distilled is added to the top of the clumn.

v) Relative volatility α_{AB} stands for

a) x_a/y_a b) P_B^{sat}/PA^{sat}

c) y_a/x_a d) $(y_A/x_A)/(y_B/x_B)$.

vi) Which of the following operations does not involve leaching ?

a) dissolving pharmaceuticals products from bark or roots

b) removing nicotine from water solution of kerosene

c) dissolving sugars from cells of beet

d) dissolving gold from ores.

vii) Schmidt number in analogous to

a) Prandtl number b) Sherwood number

c) Nusselt number d) Froude number.

viii) Fenske equation is applicable for

a) Minimum reflux condition in distillation

b) total reflux condition in distillation

c) absorption, when equilibrium and operating lies are parallel

d) stripping.

ix) Membrane used for reverse osmosis is

a) symmetric b) isotopic

c) asymmetric d) semi-permeable.

x) In azeotropic mixture, the equilibrium vapor composition is

a) more than liquid composition

b) less than liquid composition

c) same as liquid composition

d) none of these.

xi) During drying of a solid, the lowest moisture content is denoted as

a) critical moisture content

b) equilibrium moisture content

c) free moisture content

d) bound moisture content.

GROUP – B

(Short Answer Type Questions)

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

2. Deduce Rayleigh's equation for batch distillation operation 5

3. What is membrane fouling ? How is it controlled ? 5

4. Define the following

   a) Free moisture

   b) Bound moisture

   c) Unbound moisture

   d) Equilibrium moisture

   e) Relative humidity. 5

5. Oxygen (A) is diffusing through carbon monoxide (B) under steady-state conditions, with the carbon monoxide nondiffusing. The total pressure is 1×10^5 N/m^2, and the temperature 0°C. The partial pressure of oxygen at two planes 2.0 mm apart is, respectively, 13000 and 6500 N/m^2. The diffusivity for the mixture is 1.87×10^{-5} m^2/s. Calculate the rate of diffusion of oxygen in kmol/s, through each square meter of the two planes. 5

6. Describe the operating principle of reverse osmosis and its application in industry. 5

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Define reflux ratio. Write down the basic assumptions of McCabe-Thiele method for calculations of number of ideal plates in a distillation operation.

   b) A liquid feed at the boiling point of 400 kgmol/h containing 70 mol % benzene (A) and 30 mol % tolune (B) is fed to a stripping tower at 101.3kPa pressure. The battoms product flow is to be 60 kg mol/h containing only 10 mol % A and the rest B. Calculate the kgmol/h overhead vapor, its composition, and the number of theoretical steps required.

   The equilibrium data for Benzene- Tolune system.

   Mole fraction of Benzene at 101.325 k Pa

x_A	1.000	0.780	0.581	0.411	0.258	0.130	0
y_A	1.000	0.900	0.777	0.632	0.456	0.261	0

2 + 4 + 9

8. a) Describe Fick's first law.

   b) Derive the expression of steady-state diffusion of A through nondiffusing B.

   c) Describe briefly the types of solid diffusion.

   d) Prove that $1/K_y \approx 1/k_y$ (In local overall Mass Transfer Coefficients). 2 + 3 + 5 + 5

9. a) Define Henry's law.

   b) It is desired to absorb 90 % of the acetone in a gas containing 1.0 mol % acetone in air in a countercurrent stage tower. The total inlet gas flow to the tower is 30.0 kg mol/h, and the total inlet pure water flow to be used to absorb the acetone is 90 kgmol H20/h. The process is to operate isothermally at 300 K and a total pressure of 101.3Kpa. The equilibrium relation for the acetone (A) in the gas-liquid is $y_A = 2.53\ x_A$. Determine the number of theoretical stages required for this separation. 2 + 13

10. a) Describe briefly the types of leaching equipment.

    b) In a single stage leaching of soybean oil from flaked soybeans with hexane, 100kg of soybeans containing 20 wt% oil is leached with 100 kg of fresh hexane solvent. The value of N for the slurry underflow is essentially constant at 1.5kg insoluble solid/kg solution retained. Calculate the amounts and compositions of the overflow and the underflow slurry leaving the stage. 6 + 9

11. a) A salt solution weighing 10000 kg with 30 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 21.5 kg anhydrous Na_2CO_3/100 kg of total water ? Do this for the following cases.

    i) Assume that no water is evaporated.

    ii) Assume that 3% of the total weight of the solution is lost by evaporation of water in cooling.

b) Calculate the flux and the rate of removal of urea at steady state in g/h from blood in a cuprophane membrane dialyzer at 37°C. The membrane is 0.025 mm thick and has an area of 2.0m^2. The mass transfer coefficient on the blood side is estimated as $k_{cl} = 1.25 \times 10^{-5}$ m/s and that on the aqueous side is 3.33×10^{-5} m/s. The permeability of the membrane is 8.73×10^{-6} m/s. The concentration of urea in the blood is 0.02 g urea 100 mL and that in the dialyzing fluid will be assumed as 0. 4 + 4 + 7