



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 .

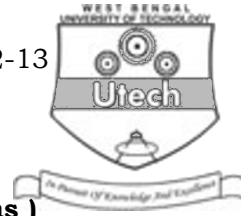
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- viii) Fenske equation is applicable for
- Minimum reflux condition in distillation
 - total reflux condition in distillation
 - absorption, when equilibrium and operating lines are parallel
 - stripping.
- ix) Membrane used for reverse osmosis is
- symmetric
 - isotropic
 - asymmetric
 - semi-permeable.
- x) In azeotropic mixture, the equilibrium vapor composition is
- more than liquid composition
 - less than liquid composition
 - same as liquid composition
 - none of these.
- xi) During drying of a solid, the lowest moisture content is denoted as
- critical moisture content
 - equilibrium moisture content
 - free moisture content
 - 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/m², and the temperature 0°C. The partial pressure of oxygen at two planes 2.0 mm apart is, respectively, 13000 and 6500 N/m². The diffusivity for the mixture is 1.87×10^{-5} m²/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 % toluene (B) is fed to a stripping tower at 101.3kPa pressure. The bottoms 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- Toluene 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 |

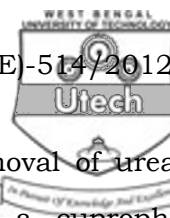
2 + 4 + 9

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 H₂O/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% Na₂CO₃ is cooled to 293 K. The salt crystallizes as the decahydrate. What will be the yield of Na₂CO₃ · 10 H₂O crystals if the solubility is 21.5 kg anhydrous Na₂CO₃/100 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 2.0m². 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
