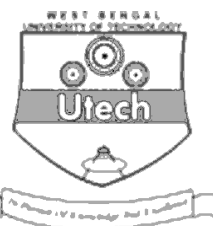




- iv) Example of maximum boiling azeotrop is
- a) acetone + chloroform
 - b) ethanol + water
 - c) carbon disulfide-acetone
 - d) benzene + water.
- v) In a binary gas mixture of A and B , diffusivity of A is
- a) equal to diffusivity of B
 - b) greater than diffusivity of B
 - c) less than diffusivity of B
 - d) none of these.
- vi) Which of the following is NOT a mass transfer unit operation ?
- a) Diffusion
 - b) Drying
 - c) Crystallization
 - d) Conduction.
- vii) Fenske equation is used for finding
- a) No. of plates required in absorption
 - b) No. of plates required for extraction
 - c) No. of plates in distillation with minimum reflux
 - d) No. of plates in distillation for total reflux.
- viii) The slope of operating line for the stripping section of distillation column is
- a) 0
 - b) ∞
 - c) < 1
 - d) > 1 .



- ix) Flux is *not* given by
- a) mole/time.area
 - b) volume/time.area
 - c) mass/time.area
 - d) density/time.area.
- x) For a gas, volume fraction is equal to
- a) mass fraction
 - b) mole fraction
 - c) both of these
 - d) none of these.
- xi) Which of the following conditions favours formation of large crystals ?
- a) A high temperature
 - b) A low nucleation rate
 - c) A high magma density
 - d) A high degree of supersaturation.
- xii) A membrane for reverse osmosis is
- a) microporous
 - b) dense
 - c) porous with a dense skin
 - d) any membrane.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. Derive the equation of rectification line in continuous distillation.
3. Define Overall, Murphree and Local plate efficiencies. Write the difference between minimum and maximum boiling azeotrop.
3 + 2
4. Explain diffusion operation in the light of Penetration theory. State Fick's first law of diffusion.
3 + 2
5. Calculate the rate of diffusion of Acetic acid across a film on non-diffusing water through a film of 2 mm thickness at 17°C, when the concentrations on the opposite side of the film are 10% and 4% acid. The diffusivity of acetic acid is $0.000095 \text{ m}^2/\text{s}$. Density of 10% and 4% acid by weight are 1013 kg/m^3 and 1004 kg/m^3 respectively.
6. Define the following terms :
5 × 1
 - a) Relative humidity
 - b) Equilibrium moisture content
 - c) free moisture
 - d) Drying
 - e) Humid volume.

**GROUP – C****(Long Answer Type Questions)**Answer any *three* of the following. $3 \times 15 = 45$

7. a) A mixture of 100 mol containing 50 mol% *n*-penten and 50% mol% *n*-heptane is distilled under differential condition until 40 mol is distilled. What is the average composition of the vapour distilled and liquid left ? If the same operation is carried out by flash distillation system, then find out the composition of vapour and liquid left. The equilibrium data is given as :

$x :$	1	0.867	0.594	0.398	0.254	0.145	0.059	0
$y :$	1	0.984	0.925	0.836	0.701	0.521	0.271	0

- b) Explain how cost of distillation regulates the optimum reflux ratio to be selected for a distillation operation.

 $(6 + 6) + 3$

8. It is desired to absorb 90% of the acetone in a gas containing 1.0 mol % acetone in air in a counter current stage tower. The total inlet gas flow to the tower is 30 kg mol/h and the total inlet pure water flow to be used to absorb the acetone is 90 kmol water/hr. The process is to operate isothermally at 300 K and a total pressure of 101.3 kPa. 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.



9. Laboratory tests of a pervaporation membrane exposed to liquid with 90 wt% ethanol (B) and 10% water (A) at 60°C showed a flux of 0.2 kg/m².h and a permeate composition of 71% ethanol when the downstream pressure was 15 mm Hg.

Calculate the permeability of the membrane to ethanol and the water at the test conditions and the selectivity for water.

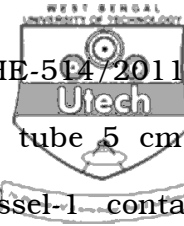
(Use Margule's equation :

for water, $\ln \gamma_A = (0.7947 + 1.615 x_A) x_B^2$ and

for ethanol, $\ln \gamma_B = (1.6022 - 1.615 x_B) x_A^2$).

10. A granular wet solid is taken on a tray and dried in a stream of hot air (120°C, humidity = 0.02 kg per kg dry air, velocity, $u = 4.5$ m/s, pressure = 1 atm). The initial moisture content of 28% (dry basis) is to be reduced to 0.5%. The critical moisture content is 12% and the equilibrium moisture is negligible. The falling rate of drying is linear in the moisture content. If the solid loading (dry basis) is 35 kg/m², calculate the drying time.

The convective heat transfer co-efficient, h_c may be estimated from the gas flow rate G' as $h_c = 0.0204 (G')^{0.8}$, where G' is in kg/h.m². mol. wt of air and water vapour are 29 and 18, respectively, The wet bulb temperature of air, $T_w = 41.5^\circ\text{C}$, latent heat of vaporization of water is 2400 kJ/kg, $R = 0.0821$ m³.atm/kmol.K.



11. a) Two large vessels are connected by a tube 5 cm in diameter and 15 cm in length. Vessel-1 contains 80% N_2 (A) and 20% O_2 (B), vessel-2 contains 20% N_2 and 80% O_2 . The temperature is 20°C and the total pressure is 2 atm. The diffusivity ($D_{N_2-O_2}$) of nitrogen-oxygen mixture is $0.23 \text{ cm}^2/\text{s}$ at 43°C and 1 atm. Calculate (i) the steady state flux and (ii) the rate of transport of N_2 from vessel-1 to vessel-2.
- b) Describe film theory of mass transfer.
- c) What is the physical significance of Schmidt number ?

8 + 5 + 2

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