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Reg. No. :

B.E./B.Tech. DEGREE EXAMINATION, NOV 2019

Sixth Semester

Chemical Engineering

15UCH601 - MASS TRANSFER - II

(Regulation 2015)

Duration: Three hours   Maximum: 100 Marks

Answer All Questions

PART A - (10 x 1 = 10 Marks)

1. The partial pressure of solute in the gas phase_____ as the process
   moves towards equilibrium   CO1- U

   (a) increases   (b) decreases   (c) remains constant   (d) can't say

2. Absorption accompanied by heat evolution results in   CO1- R

   (a) increased solubility of gas in the liquid

   (b) larger number of plates (than that required for isothermal absorption) for the same
       degree of separation

   (c) increased capacity of the absorber

   (d) none of the above

3. The relative volatility   CO2- R
   (a) is independent of pressure   (b) decreases with increasing pressure

   (c) increases with increasing pressure   (d) increases with decreasing pressure

4. When the distillation column at total reflux, its reflux ratio is   CO2- R
   _____

   (a) 0   (b) ∞   (c) <1   (d) >1

5. A solvent employed in a liquid-liquid extraction operation should   CO3 R
   preferably have

   (a) low viscosity and low interfacial tension   (b) high viscosity and low interfacial tension

   (c) low viscosity and high interfacial tension   (d) high viscosity and high interfacial tension

6. The apex of an equilateral triangular co-ordinate (in ternary liquid system) represents a/an   CO3 R
   (a) pure component   (b) binary mixture
   (c) ternary mixture   (d) insoluble binary system

7. For liquids of very small density difference, the most suitable extractor is   CO4 R
   (a) a mixer-settler unit   (b) a rotating disc contactor
   (c) a packed column extractor   (d) a centrifugal extractor

8. With increase in temperature, the leaching rate increases due to   CO4 R
   (a) decreased liquid viscosity   (b) increased diffusivity
   (c) both (a) and (b)   (d) neither (a) nor (b)

9. Adsorption of a gas onto a solid can be conducted most efficiently at   CO5 R
   (a) high pressure and low temperature   (b) low pressure and low temperature
   (c) low pressure and high temperature   (d) high pressure and high temperature

10. Reverse osmosis is also known as   CO5 R
    (a) dialysis   (b) Electrodialysis
    (c) diffusion   (d) ultrafiltration

PART – B (5 x 2= 10Marks)

11. Distinguish between Raoult's law and Henry's law   CO1- R
12. Draw the T-x,y diagram for constant pressure system   CO2- U
13. When do you prefer liquid – liquid extraction? Give the justification   CO3- U
14. When heap leaching is preferred?   CO4- R
15. Provide any two industrial applications of adsorption process   CO5- R

PART – C (5 x 16= 80Marks)

16. (a) A gas absorber is to be designed to handle 900 m³/hr of coal gas containing 2% by volume of benzene. Coal gas enters the tower with temperature of 300 K and 805 mm Hg and 95% of benzene is to be recovered by solvent. The solvent enters the tower at 300K and has 0.005 mole fraction of benzene and average molecular weight of 260. Calculate the circulation rate of solvent per seconds if to be operating 1.5 times of minimum solvent rate. The equilibrium relationship is $y = 0.125 x$ CO1- App   (16)

Or

(b) An effluent gas containing 12% benzene is to be scrubbed in a packed column continuously, operating in counter-current manner at 43°C and 1 atm pressure. The column is to be designed for treating 15 m³ of entering gas per hour per square meter of the column cross section, such that the exit gas will contain 1% benzene. The solvent for scrubbing is mineral oil which will enter the top of the column at a rate of 28 kmol/hr.m² and a benzene content of 1%. Determine the height of the column assuming height of transfer unit to be 0.75 m. The equilibrium concentration at the operating conditions may be estimated as $y^* = 0.263\ x$.   CO1- App (16)

17. (a) (i) Derive Rayleigh's equation for differential distillation.   CO2- App (8)

(ii) A feed of 50 mole % hexane and 50 mole % octane is fed into a pipe still through a pressure reducing valve and then into a flash disengaging chamber. The vapor and liquid leaving the chamber are assumed to be in equilibrium. If the fraction of the feed converted to the vapor is 0.6. Find the compositions of the top and bottom products. the following table gives the equilibrium data for this system.   CO2- App (8)

Mole fractions of hexane in liquid 'x'	1.00	0.69	0.40	0.192	0.045	0.00
Mole fractions of hexane in vapour 'y'	1.00	0.932	0.78	0.538	0.1775	0.00

Or

(b) A mixture of benzene and toluene containing 40 mole% benzene is to be separated to give a product of 90 mole% of benzene at a top and a bottom product with not more than 10 mole% benzene. Using an average value of 2.4 for the volatility of benzene relative to toluene, calculate the number of actual plates required at total reflux condition with plate efficiency 70%. Also calculate the minimum reflux ratio, if the feed is liquid and its bubble point.   CO2- Ana (16)

18. (a) Explain with neat sketch, how the number of theoretical stages can be determined graphically in the case of continuous counter current liquid extraction using partially miscible solvents.   CO3- App (16)

Or

(b)	With neat sketch discuss the construction and working of Rotating Disc Contactor and Pulsed Column Extractor	CO3- Ana	(16)

19. (a) Explain with a neat diagram and constructional features and working principles of equipment used for leaching of oil from oil seeds using a solvent.   CO4- U   (16)

<div align="center">Or</div>

(b) How leaching equipments are classified? Elaborate the methods/equipments you will adopt for the following cases:

(i) When there is a need to extract metallic compounds from low grade ore?   CO4-Ana   (4)

(ii) When there is a requirement for extracting oil from seeds?   CO4- Ana   (12)

20. (a) A solid adsorbent is used to remove the color impurities from an aqueous solution. The original value of color in an arbitrary scale is 48. It is required to reduce this value to 10% of its original value. Using the following data find the quantity of fresh adsorbent used for 1000 kg of a solution for   CO5- U   (16)

(i) Single stage

(ii) Two stage cross current operating with the intermediate color value of 24.

Equilibrium data:

kg adsorbent/kg solution	0	0.001	0.004	0.008	0.02	0.04
Equilibrium color	48	43	31.5	21.5	8.5	3.5

<div align="center">Or</div>

(b) (i) Justify that for cross current two-stage treatment of liquid solution by contact filtration, when the adsorption isotherm is linear, the least total adsorbent results if the amounts used in each stage are equal   CO5- U   (8)

(ii) Explain the principles of ion exchange process.   CO5- U   (8)

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