Register Number: ……..

B.TECH DEGREE EXAMINATIONS: APRIL/MAY 2014

(Regulation 2009)

Fifth Semester

BIOTECHNOLOGY

BTY115 : Mass Transfer Operations

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Type of diffusion where turbulence is involved
   a) Molecular diffusion b) Natural diffusion
   c) Eddy diffusion d) Thermal diffusion
2. Theory of interphase mass transfer which is a steady state model
   a) Two film theory b) Penetration theory
   c) Surface renewal theory d) Surface stretch theory
3. NTU is
   a) Non Transfer Unit b) Number of Transfer Units
   c) Non Thermal Units d) Number of Thermal Units
4. Range of Absorption factor value for an economical operation
   a) 1.2 to 2 b) 12 to 20
   c) 0.12 to 0.2 d) 120 to 200
5. What is the reflux ratio at total Reflux?
   a) 0 b) 1
   c) ∞ d) -1
6. Reboiler is considered as
   a) One theoretical stage. b) Two theoretical stage
   c) Zero theoretical stage d) None of the above
7. When Distribution co-efficient is a larger value then the solvent requirement for extraction is
   a) More b) Less
   c) No chance d) None of the above
8. Extract is
   a) Mixed solvent b) Solvent less phase
   c) Aqueous rich phase d) Solvent rich phase
9. Leaching action depends on

   a) Pressure b) Particle size distribution
   c) Surface tension d) None of the above
10. An example for industrial adsorbent
   a) Activated carbon b) Silica gel
   c) Fullers earth d) All the above

PART B (10 x 2 = 20 Marks)

11. State Fick's law of diffusion.
12. What is the criterion for Knudsen diffusion to occur?
13. State Raoults law.
14. Mention few applications of absorption.
15. Define relative volatility.
16. What is ' binodal Curve' and 'tie line' in ternary diagram?
17. What is selectivity of a solvent?
18. State the assumptions made in McCabe-Thiele method.
19. When double solvent extraction is preferred? Give an example.
20. Differentiate chemi-sorption and physi-sorption.

PART C (5 x 14 = 70 Marks)

21. a) (i) Derive an expression for steady state equimolar counter diffusion. (7)
   (ii) In an oxygen- nitrogen mixture of 1.1 atm and 35ºC, the concentration of oxygen at 2 planes 0.5 cm apart are 20% and 30% respectively by volume. Calculate the amount of oxygen diffused in 3 hrs when equimolar counter diffusion takes place. Diffusivity is 0.185×10^{-4} m^2/ sec. (7)

(OR)

   b) (i) Derive the relationship between individual and overall mass transfer coefficients. (7)
   (ii) Discuss the Penetration Theory of mass transfer in detail. (7)

22. a) A gas absorber is to be designed to handle $900 m^3$ /hr of coal gas containing 2% by volume of benzene. Coal gas enters the tower at a temperature of 300K and 805mm Hg and 95% of benzene are to be recovered by the solvent. The solvent enters the tower at 300K and has 0.005 mole fraction of benzene and an average molecular weight of 260. Calculate the circulation rate of solvent per second if the column is to be operated 1.5 times the minimum solvent rate. The

equilibrium data is {y/ (1+y)} =0.125{x/ (1+x)}.where Y and X represents the mole ratio of benzene in gas phase and liquid phase respectively.

(OR)

b) (i) What are the factors governing the selection of solvent for absorption process? (7)

(ii) An air-benzene mixtrue containing 5% benzene enters into the absorption tower, where it is counter currently contacted with hydrocarbon oil. Take G_s = 600Kmoles/hr. Solubility follows Raoults Law. The system is maintained at 26.7^0C and 1atm.pressure. Average molecular weight of oil is 200. Vapour pressure of benzene at 26.7^0C is 103mmHg. Find $(L_s)_{min}$ to recover 90% entering benzene. (7)

23. a) 1000 kmol/ hr of an ethanol- propanol mixture containing 65 mole percent ethanol is to be separated in a continuous plate column operating at 101.325 kPa total pressure. The distillate and bottom composition in terms of mole fraction of ethanol are X_D =0.92 and X_w =0.07. The feed is saturated vapour and total condenser is used. When the reflux flow rate is four times the amount of top product, find the number of theoretical plates required for the separation. Relative volatility of ethanol – propanol system may be taken as 2.10.

(OR)

b) (i) A binary hydrocarbon mixture of A and B of α=1.5 containing 60% of A is flash vaporized, if 40% of the feed is vaporized. What is the mole fraction of A in the top and bottom products? (7)

(ii) Write a detailed note on azeotropic distillation. (7)

24. a) Discuss in detail about the estimation of number of stages and the solvent requirement for a countercurrent extraction operation for a partially immiscible system.

(OR)

b) Picric acid is to be extracted from a dilute solution contain 0.1 mol picric acid per liter of solution using benzene as a solvent. 80% of the original picric acid is to be recovered. The equilibrium data for benzene-picric acid-water system at 298 K are as follows

C_s x 10^2	0.0932	0.225	1	2	5	10	18
C_s/ C_A	2.23	1.45	1.705	0.505	0.32	0.24	0.187

Where C_s and C_A are the equilibrium concentration of picric acid in mol/lit in benzene and aqueous phase respectively. Determine the quantity of benzene required per 1 litre of aqueous solution for:

(i) Single stage operation

(ii) Three stage cross current operation using equal quantities of fresh solvent in each stage.

25. a) (i) Discuss about the adsorption isotherms. (7)

(ii) Equilibrium isotherm data for adsorption of phenol from an aqueous solution to activated carbon are as follows (7)

C (gm/cc)	0.004	0.0087	0.019	0.027	0.094	0.195
Q (gm/gm)	0.0266	0.053	0.075	0.082	0.123	0.129

Determine the isotherm that fits the data and give the constant of the equation.

(OR)

b) Explain with a neat diagram and constructional features and working of an extractor for the extraction of oil from oil seeds using a solvent.

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