Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-Vth Examination December 2010

Subject code: 150404

Subject Name: Principles of Process Engineering-II

Date: 18 /12 /2010 **Time: 03.00 pm - 05.30 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Notations used have their conventional meanings.**

Q.1 **(a)** Starting from basic principles of diffusion for unidirectional binary gas phase, derive the equation to calculate N_A for steady state molecular diffusion of A through non-diffusing B and for steady state equimolal counter diffusion of gases A and B. **09**

(b) In an O_2-N_2 gas mixture at 1 atm. pressure and 25^oC, the concentrations of oxygen at two planes 2 mm apart are 10 and 20 volume % respectively. Calculate the flux of diffusion of O_2 for the case where, **05**

(i) N_2 is non-diffusing. (ii)There is equimolar counter diffusion of the two gases.

Data: D_{O2-N2} at 25^oC and 1 atm. = 2.065 x 10^{-5} m^2/s

Q.2 **(a)** State and discuss the methods of conducting mass transfer operations with examples of each. **07**

(b) Explain Film theory for mass transfer in fluids past solid surfaces. **07**

OR

(b) Define F and k-type mass transfer coefficients along with their units. Also, mention relationships between them and derive any two. **07**

Q.3 **(a)** Discuss various factors to be considered in making choice of solvent for LLE (liquid-liquid extraction). **07**

(b) Discuss the preparation of solids in leaching and also explain rate of leaching. **07**

OR

Q.3 **(a)** Explain the concept of equilibrium for interphase mass transfer. **07**

(b) Describe Shanks system for counter current leaching with neat sketch. **07**

Q.4 **(a)** Write a short note on absorption factor in case of gas absorption. **04**

(b) Light oil is being absorbed from the mixture of light oil vapor and air by means of absorption oil. The absorber is plate type. The lean oil entering the absorber contains 0.5% by weight of light oil and the rich oil leaving the absorber contains 5% by weight of the light oil. The gas entering the absorber contains 2.25% by volume of light oil and the scrubbed gas leaves the absorber containing 0.18% of light oil by volume. The molecular weight of light oil is 80 and average molecular weight of air is 29. The equilibrium relation is given by equation $Y_i = 0.65\ X_i$ where Y_i is kg of light oil/kg of light oil free air and X_i = kg of light oil/kg of light oil free absorption oil. Calculate the kg of light oil free air to kg of light oil free absorption oil. Also find the number of theoretical plates in the absorber. **10**

OR

Q.4 **(a)** Explain minimum Liquid-Gas ratio for absorbers. **07**

(b) Describe Ternary diagram (Equilateral triangular coordinates) of liquid extraction. **07**

Q.5 **(a)** Classify the equipments used in LLE (liquid-liquid extraction). **05**

(b) A continuous countercurrent multistage system is to be used to leach oil from meal by benzene as a solvent. The process is to treat 2000 kg/h of inert solid meal containing 800 kg of oil and also 50 kg benzene. The inlet flow per hour of fresh solvent mixture contains 1310 kg benzene and 20kg oil. The leached solids are to contain 120kg oil. Settling experiments similar to those in the actual extractor show that the solution retained depends upon the concentration of oil in the solution as shown below: **09**

N, kg inert solid/kg solution	*y_A, kg oil/kg solution*
2	0
1.98	0.1
1.94	0.2
1.89	0.3
1.82	0.4
1.75	0.5
1.68	0.6
1.61	0.7

Calculate the amounts and concentrations of the stream leaving the process and the number of stages required.

OR

Q.5 **(a)** Discuss the theory of mass transfer with chemical reaction in brief. **06**

(b) Acetaldehyde 10% by weight is in solution with toluene and is to be extracted with water in a 5 stage cocurrent unit. If 30 kgs of water are used as solvent per 100 kgs of feed for each stage, calculate the amount of acetaldehyde extracted in percent and the final concentration. The equilibrium relation is $Y^* = 2.20\ X$ where Y^* is kgs of acetaldehyde/kg of water and X is kgs of acetaldehyde/kg of toluene. **08**

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