Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E SEM-V Examination-Nov/Dec.-2011

Subject code: 150404 **Date: 29/11/2011**

Subject Name: Principles of Process Engineering-II

Time: 02.30 pm-05.00 pm **Total marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Differentiate between direct and indirect mass transfer operations in detail with examples of each. **07**

(b) Define liquid-liquid extraction (LLE). Give the usefulness of LLE in comparison with distillation. **07**

Q.2 **(a)** Write a short note on countercurrent multiple contact for leaching, the Shank's system. Compare different methods of conducting a leaching operation. **07**

(b) What is diffusion in fluids? Explain types of diffusion with examples starting from Fick's first law of diffusion for unidirectional diffusion in binary system and types of fluxes. Prove that $J_A = -J_B$. **07**

OR

(b) Starting from the equation of molar flux N_A for gases, derive equations to calculate molar flux N_A for steady state diffusion of gas A through non-diffusing gas B and for steady state equimolal counter diffusion for gases A and B. **07**

Q.3 **(a)** Calculate the rate of diffusion of acetic acid (A) across a film of non diffusing water (B) solution 1mm thick at 17°C when the concentrations on opposite sides of the film are respectively 9 and 3 wt% acid. The diffusivity of acetic acid in the solution is 0.95×10^{-9} m^2/s. Density of 9 and 3 wt% aqueous solutions is 1012 and 1003.2 kg/m^3 respectively. $M_A=60$ and $M_B=18$. **07**

(b) Explain film theory for mass transfer in fluids past solid surface. Discuss assumptions, failures and usefulness of it in brief. **07**

OR

Q.3 **(a)** Define F and k type mass transfer co-efficients. Mention units and relationships between them. Also, for gas phase, derive, **07**

$F = K_G \overline{P}_{B,lm} = Ky \overline{P}_{B,lm} / P_t = K'_c C = K'y$

(b) Explain the fundamentals of phase equilibrium for interphase mass transfer. Also, state the common principles of equilibrium of all systems involving the distribution of substances between two insoluble phases. **07**

Q.4 **(a)** Discuss in detail comparison of tray towers and packed towers. **07**

(b) Derive an equation for height of tower packed section for concentrated solutions. **07**

OR

Q.4 **(a)** Determine the height of the absorption tower required to recover 95% ethylene oxide from 3mole% of ethylene oxide-air mixture. There is evidence to believe that the gas film offers the controlling resistance. The gas rate is 488.4kgmole/hr.sq.m and the liquid rate to be used is twice the theoretical minimum. The tower will operate at 20°C, employing 0.5% by wt. of sulphuric acid in water as the liquor for absorption. The tower is packed with rasching rings for which the absorption coefficient is K_{Ga} = 298 kg moles/hr/cu.m.atm. The total pressure is 1 atmosphere. The solubility of ethylene oxide in 0.5% H_2SO_4 solution at 20°C may be represented by the equation, p = 200x, where p= partial pressure in mmHg, x= mole fraction of ethylene oxide dissolved in water. **07**

(b) Discuss the properties required for a solvent to be used for gas absorption operation. **07**

Q.5 **(a)** Discuss LLE for system of three liquids- one pair partially soluble and effect of temperature on it. **07**

(b) What is leaching? What is the industrial application of leaching? Describe the working mechanism of the Percolation tank in leaching. **07**

OR

Q.5 **(a)** A continous countercurrent multistage system is to be used to leach oil from meal by benzene solvent. The process is to treat 200kg/h of inert solid meal containing 800kg oil and also 50kg benzene. The inlet flow per hour of fresh solvent mixture contains 1310kg benzene and 20 kg oil. The leached solids are to contain 120kg oil. Calculate the amounts and concentration of the stream leaving the process and the number of stages required. **07**

N, kg inert solid/kg solution	y, 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

(b) Describe in brief different multistage equipments used for liquid-liquid extraction. Draw a neat sketch of any one indicating in all internals in it. **07**

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