Code: R7222301 **R7**

B.Tech II Year II Semester (R07) Supplementary Examinations, April/May 2013

MASS TRANSFER AND SEPARATION

(Biotechnology)

Time: 3 hours Max Marks: 80

Answer any FIVE questions
All questions carry equal marks
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1 (a) Write Fick's first law of diffusion. Prove that in molecular diffusion of gases, $N_A = \frac{D_{AB}.P_t}{RTZ\,\overline{P}_{B,M}}(\overline{P}_{A1} - \overline{P}_{A2})$ for steady- state diffusion of A through non diffusing B.

(b) The diffusivity of carbon dioxide in helium is reported to be 5.31 x 10^{-5} m^2/s at 1 std atm, 3.2 ^0C. Estimate the diffusivity at 1 std atm, 225 ^0C

2 (a) What are the three eddy diffusivities? Discuss how they can be computed?

(b) Explain Higbie's penetration theory with the help of neat schematic diagram.

3 (a) Prove that the relationship between individual- phase transfer coefficients and the overall coefficient takes the form of addition of resistances.

(b) In a certain apparatus used for the absorption of SO_2 from air, by means of water, at one point in the equipment the gas contained 10% SO_2 by volume and was in contact with the liquid containing 0.4% $S0_2$ ($\rho = 990\ kg/m^3$). The temperature was 50^0 C and the total pressure 1 std atm. The overall mass-transfer coefficient based on gas concentrations was $K_g = 7.36\ x\ 10^{-10}\ Kmol/m^2$.S.(N/$m^2$). Of the total diffusional resistance 47% lay in the gas phase, 53% in the liquid.

Equilibrium data at 50^0 C are:

Kg $S0_2$/100 Kg water	0.2	0.3	0.5	0.7
Partial pressure $S0_2$, mm Hg	29	46	83	119

Calculate the overall coefficient based on liquid concentrations in terms of mol/vol, and individual mass transfer coefficients for the gas and for the liquid. Also determine the interfacial compositions in both the phases.

4 (a) Discuss the important properties that have to be considered for choice of solvent for absorption.

(b) Ammonia is to be removed from a gas mixture of 20% NH_3 and 80% air by countercurrent scrubbing with water at 1 atm pressure, 20^0 C. The scrubber is designed to remove 99% NH_3. Evaluate the minimum water rate and theoretical number of stages, for actual absorption with 1.2 times minimum water rate. The gas flow rate is 3500 Kg/hr.

Equilibrium data:

Partial pressure of NH_3 in mm Hg	12	18	32	50	70	106
gm NH_3/10 gm H_2O	0.2	0.3	0.5	0.75	1.0	2.0

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5 (a) Discuss the method of Mc Cabe and Thiele for finding the number of ideal trays in multistage tray towers used for separating a binary mixture behaving ideally.

(b) Suppose a liquid of composition 50 mole% n-heptane, 50 mol% n- octane were subjected to differential distillation at atmospheric pressure, with 60 mol% of the liquid distilled. Compute the composition of the composited distillate and the residue.

Equilibrium data:

x^*	0.50	0.46	0.42	0.38	0.34	0.32
y^*	0.689	0.648	0.608	0.567	0.523	0.497

6 (a) Explain the different liquid equalibria with the help of equilateral-triangular co ordinates.

(b) Nicotine in water solution containing 1% nicotine is to be extracted with kerosene at 20^0 C. Water and kerosene one essentially insoluble. Determine the percentage extraction of nicotine if 100 Kg of feed solution is extracted once with 150 Kg solvent. Repeat for three theoretical extractions using 50 Kg solvent each.

$x^1 Kg$ nicotine/Kg water	0	0.001011	0.00246	0.00502	0.00751	0.00998	0.0204
y^{1*} Kg nicotine/Kg kerosene	0	0.000807	0.001961	0.00456	0.00686	0.00913	0.01870

7 (a) Distinguish between two types of adsorption phenomena.

(b) 90% of an undesirable impurity A contained in a stream of fluid is to be removed by using an adsorbent. The equilibrium data is represented by the equation $Y^* = (8.91\,X10^{-5})X^{1.66}$ where $Y^* = gm$ A/Kg solvent, X = gm A/Kg solid in the fluid and solid respectively. Entering fluid has A = 96 gm/Kg solution. Evaluate the quantity of fresh adsorbent required per 100 Kg solution for single stage operation and two stages cross current operation.

8 (a) Explain the process of reverse osmosis. Give its applications.

(b) Explain ultra filtration and micro filtration processes with the help of neat schematic diagrams.

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