Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) - EXAMINATION – SUMMER 2016

Subject Code: 2163609 **Date:06/05/2016**

Subject Name: Basics of mass transfer

Time: 10:30 AM to 01:00 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)** Oxygen (A) is diffusing through carbon monoxide (B) under steady state conditions, with the carbon monoxide non-diffusing. The total pressure is $1.0 * 10^5$ N/m^2, and the temperature 0^0C. The partial pressure of oxygen at two planes 2 mm apart is, respectively, 13000 and 6500 N/m^2. The diffusivity for the mixture is $1.87 * 10^{-5}$ m^2/s. Calculate the rate of diffusion of oxygen in kmol/s through each square meter of the two planes. **07**

(b) Derive the steady state molecular diffusion equation for gas for both the cases. **07**

Q.2 **(a)** Calculate the rate of diffusion of acetic acid (A) across a film of non-diffusing water (B) solution 1 mm thick at 17^0C 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. **07**
The density of 9 % solution is 1012 kg/m^3,
The density of 3 % solution is 1003.2 kg/m^3

(b) Explain methods of conducting the mass transfer operations. **07**

OR

(b) Explain Direct contact of two Immiscible phases. **07**

Q.3 **(a)** Explain Film theory in detail with all assumptions and derivation. **07**

(b) The gas-phase mass transfer coefficient for the evaporation of a drop of ethyl alcohol in a stream of air at 300 K and 1.2 bar pressure is $k_G = 2.4 * 10^{-6}$ kmol/(s)(m^2)(mm Hg). **07**

(1) If the diffusivity of alcohol in air is 0.102 cm^2/s at 0^0C, estimate the thickness (in mm) of the stagnant gas-film. Vapor pressure of alcohol = 0.0877 bar at 300 K. (P_{A2}=0). R=0.08317 (m^3)(bar)/(kmol)(K)

(2) Express k_G in lbmol/(ft^2)(min)(psi) (Take 1 kmol= 2.2046 lbmol)

OR

Q.3 **(a)** Explain Penetration theory with all the detail. **07**

(b) The equilibrium distribution of a solute A between air and water is given by **07**

$$y=1.2x$$

At a certain point the concentration of solute A in the bulk air is 0.04 mole fraction and that in the bulk aqueous phase is 0.025 mole fraction.

1) Calculate the overall gas-phase and the overall liquid-phase driving forces for mass transfer?
2) At the same point, the local individual mass transfer coefficients for the transport of A are, k_y= 7.2 kmol/(h)(m^2)(Δy) and k_x= 4.6 kmol/(h)(m^2)(Δx). Calculate (a) the interfacial concentrations in both the gas-phase and liquid phase (b) The overall mass transfer coefficients, Kx and Ky (c) The local mass flux, N_A.

Q.4 **(a)** Derive Mass transfer coefficients of liquid for two different cases. **07**

(b) 200 moles of benzene & toluene containing 55 mole% benzene is subjected to a differential distillation at atmospheric pressure. The composition of the benzene in the residue is 30 mole%. Calculate the total moles of the mixture distilled. (Graphical method). **07**

Relative volatility is 1.8.

X	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6

OR

Q.4 **(a)** Explain differential distillation in detail and derive Rayleigh equation. **07**

(b) Explain drying rate curve with all graphs and rate equation. **07**

Q.5 **(a)** Derive the overall mass transfer coefficient (Ky and Kx) with the help of two film theory. **07**

(b) (1) Explain equilibrium between phases with example and three cases. **04**

(2) Define the term: **03**

(i) Schmidt number
(ii) Atmolysis
(iii) Differential contact operation

OR

Q.5 **(a)** A continuous counter-current dryer is used to dry 500 kg dry solid/h containing 0.035 kg total moisture/ kg dry solid to a value of 0.0017 kg total moisture/ kg dry solid. The granular solid enters at 25°C & leaves at 60°C. The heating medium is air which enters at 84.2°C, has a humidity of 0.0175 kg H_2O/kg dry air & leaves at 32.8°C. Calculate the air flow rate & the outlet humidity, assuming the heat losses from the dryer to be 9500 kJ/hr. The constant heat capacity of the dry solid is 1.465 kJ/kg.K **07**

Take reference temp. 0^0C, λ = 2501 kJ/kg

(b) (1) Explain Constant pressure Tx-y diagram with neat sketch. **04**

(2) Define the terms: **03**

(i) Unbound moisture
(ii) Moisture content
(iii) In which case flux N_A will equal to flux J_A?

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