BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP2023)

CLASS: B.TECH. **SEMESTER : IV**
BRANCH: CHEMICAL ENGINEERING **SESSION : SP2023**

SUBJECT: CL215 MASS TRANSFER OPERATION

TIME: 02 Hours **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

			CO	BL
Q.1(a)	Under what condition the approximation form of Fick's law is valid?	[1]	1	2
Q.1(b)	In sulphuric acid plant, the air used for burning Sulphur must be dry. Drying of air is done by countercurrent contact with concentrated sulphuric acid in a packed tower. At a particular section of the tower, the relative humidity of air is 30 % and the temperature is 35 ^oC. If moisture in the air diffuses to the surface of the acid through a stagnant film of thickness 1.2 mm, calculate the flux of moisture at the given section. The partial pressure of moisture at acid surface is zero because the concentrated acid has an extremely high affinity for moisture. The diffusivity value is 0.257 cm^2/s at 23 ^oC and the vapour pressure of water is 0.0552 bar at 35 ^oC.	[4]	2	3
Q.2(a)	What is the relation between the mass transfer coefficient and diffusivity for surface renewal theory?	[1]	2	2
Q.2(b)	Calculate the molar flux of butanol at 20°C under unidirectional steady state conditions through a 0.1 cm thick film of water when the concentrations of butanol at the opposite sides of the film are, respectively 10% and 4% butanol by weight. The diffusivity of butanol in water solution is 5.9×10^{-6} cm^2/sec. The densities of 10% and 4% butanol solutions at 20°C may be taken as 0.971 and 0.992 g/cc respectively. Molecular weight of Butanol is 74, and that of water 18.	[4]	2	3
Q.3(a)	Explain the significances of Sherwood number and Schmidt number.	[2]	2	2
Q.3(b)	The gas phase mass transfer coefficient for the evaporation of a drop of ethanol in a stream of air at 300K and 1.2 bar pressure is $k_G=2.6\times10^{-6}$ kmol/sm^2mmHg. Calculate the thickness of the stagnant gas film. Vaour pressure of alcohol at 300 K is 0.087 bar and diffusivity of alcohol in air is 0.102 cm^2/s.	[3]	2	3
Q.4(a)	What is the expression for the Colburn factor, j_D?	[1]	1	1
Q.4(b)	A plate, 0.5 m^2 coated with a layer of benzoic acid is placed in a stream of water flowing at a velocity of 0.25 m/s at a temperature of 25 ^oC. Calculate the average rate of dissolution of the acid per unit area of the plate and the equivalent thickness of a stagnant liquid film that would offer the same resistance to mass transfer. The following data are available: solubility of benzoic acid in water at 25 ^oC = 3.01 kg/m^3; diffusivity of benzoic acid in water = 10^{-9} m^2/s and the viscosity of water at 25 ^oC = 8.9 $x10^{-4}$ kg/m.s. [Given: $S_h = 0.664\ Re^{1/2}\ Sc^{1/3}$]	[4]	2	3
Q.5	A solute '*A*' is being absorbed from a gas mixture *A* and *B* in a gas-liquid contact vessel. At a certain point in the vessel the bulk concentration in gas is 0.38 mole fraction and that of in liquid is 0.1 mole fraction. The operating pressure and temperature are 1 atm. And 298 K, respectively. The solute diffuses through stagnant *B* and then through non-diffusing liquid. The gas phase film mass transfer coefficient, k_y is 1.465×10^{-3} kmol A/s.m^2.molfrac. and liquid phase film mass transfer coefficient, k_x is 1.967×10^{-3} kmol A/s.m^2.molfrac. Calculate the interfacial concentrations, overall mass transfer coefficient for gas phase, K_y and the mass flux. The equilibrium data is given as follows:	[5]	2	3

x_A	0	0.05	0.1	0.15	0.2	0.25	0.3	0.35
y_A	0	0.022	0.052	0.087	0.131	0.187	0.265	0.385

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