Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI(NEW) – EXAMINATION – SUMMER 2019

Subject Code:2163609 Date:10/05/2019

Subject Name: Basic 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.**

			MARKS
Q.1	**(a)**	Define following terms: (1) Diffusivity (2) Mass transfer coefficient (3) Absorption Factor	**03**
	(b)	Explain direct contact of two Immiscible Phases.	**04**
	(c)	A layer of benzene 3 mm deep lies at the bottom of an open tank 5 m in diameter. The tank temperature is 295 k and the diffusivity of benzene in air is 8 X 10^{-6} m^2/s at this temperature. If the vapor pressure of benzene in the tank is 13.3 KN/m^2 and diffusion may be assumed to take place through stagnant air film of 3 mm thick. How long (in sec) will it take for the benzene to evaporate? The density of the benzene is 880 Kg/m^3.Molecular weight of benzene is 78 kg/Kmol.	**07**
Q.2	**(a)**	Prove that $D_{AB} = D_{BA}$ with proper assumptions.	**03**
	(b)	Derive an equation of flux N_A For diffusion from a sphere in to the infinite air medium.	**04**
	(c)	An ethanol (A) Water (B) solution in the form of a stagnant film 2.0 mm thick at 293 K is in contact at one surface with an organic solvent in which ethanol is soluble and water is insoluble. Hence, $N_B = 0$. At point 1 the concentration of ethanol is 16.8 wt% and the solution density is $\rho_1 = 972.8$ Kg/m^3. At point 2 the concentration of ethanol is 6.8 wt% and $\rho_2 = 988.1$ Kg/m^3. The diffusivity of ethanol is 0.740 x 10^{-9} m^2/s. Calculate the Steady State flux N_A. Take the molecular weights of ethanol and water as 46.05 and 18.02 respectively.	**07**
		OR	
	(c)	Derive the equation of flux N_A for A diffusing through non diffusing B; assume the ideal gases.	**07**
Q.3	**(a)**	Differentiate J and N flux.	**03**
	(b)	Explain Film theory of Mass Transfer.	**04**
	(c)	In a laboratory experiment, the solute A is being absorbed from a mixture with an insoluble gas in a falling film of water at 30 ^{O}C and pressure of 1.45 bar. The gas phase mass transfer coefficient $k_c = 90.3$ Kmol/h(m^2) (Kmol/m^3). It is known that 13.6 % of the total mass transfer resistance lies in gas phase. At a particular section of the apparatus the mole fraction of the solute in the liquid is known to be $x_i = 0.00201$. The equilibrium solubility of the gas in water at the given temperature is $p = 3.318 X 10^4 x^*$, where p is partial pressure of gas in mm Hg and x^* is the solubility of A in water in mole fraction. **Calculate:** a) The overall liquid phase mass transfer coefficient b) The individual gas phase driving force Δp and Δy	**07**

OR

Q.3 **(a)** Discuss different types of Diffusivity. **03**

(b) Discuss application of the molecular diffusion. **04**

(c) Derive the equation of overall resistance using two phase mass transfer theory, from both the liquid and gas phase. **07**

Q.4 **(a)** Briefly explain the difference between Absorption, Adsorption and Extraction. **03**

(b) Write a short note on a choice of solvent for Absorption. **04**

(c) A coal gas is to be freed of its light oil by scrubbing with wash oil as an absorbent and the light oil recovered by stripping the resulting solution with steam. ***Absorber:*** Gas in 0.250 m^3/s at 26°c, P_t = 1.07 x 10^5 N/m^2 Containing 2.0% by volume of light oil vapors. The light oil will be assumed to be entirely benzene and a 95% removal is required. The wash oil is to enter at 26°C, containing 0.005 mole fraction benzene and has an average molecular weight is 260. An oil circulation rate of 1.5 times the minimum is to be used. Wash oil-benzene solutions are ideal. The temperature will be constant at 26°C. At 26°C, the vapor pressure of benzene is 13330 N/m^2. Assume the system as a counter current packed tower. Compute the oil circulation rate required. **07**

OR

Q.4 **(a)** Define different moistures, (a) unbound (b) bound (c) equilibrium **03**

(b) Discuss Minimum Liquid-Gas Ratio theory for absorbers. **04**

(c) A gas mixture containing 15 mole % 'A' and 85 mole % inerts is fed to an absorption tower where it is contacted with liquid solvent 'B' which absorbs 'A'. The mole ratio of solvent to gas entering the tower is 1.5:1. The gas leaving the absorber contains 2.5 % 'A', 1.5 % 'B' and rest is inert on mole basis. **07**

Calculate:

(i) the percentage of the original solute 'A' that remains un recovered.

(ii) the fraction of solvent 'B' fed to the tower lost in gas leaving the column.

Q.5 **(a)** Discuss minimum reflux ratio theory. **03**

(b) Explain role of Raoult's law in distillation and derive the following equation $y = \alpha x / 1 + (\alpha - 1)x$ **04**

(c) A binary feed has q = 0.25 is separated in a staged distillation column. The mole fraction of the more volatile component in the distillate product is 0.95. The molar flow rate of the distillate is 50% of the feed flow rate and the maccabe-Thile method can be used to analyze the column. The q-line intersects the operating line of the enriching section at (0.35, 0.5) on the x-y diagram. Calculate the slope of the Stripping section operating line. **07**

OR

Q.5 **(a)** Explain positive and negative deviation from ideality. **03**

(b) Explain Drying Rate Curve. **04**

(c) Calculate the time (in hours) required to reduce the moisture contents of a solid from 0.66 to 0.25 Kg moisture/Kg dry solid. The rate of drying N (Kg Water evaporated/m^2 s) is given as following, **07**

$$N = 0.0015\,X \text{ for } X \le 0.3$$
$$= 0.00045 \quad \text{for } X > 0.3$$

where X = Kg moisture/Kg dry solid. The drying surface is 0.025 m^2/Kg dry solid

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