Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V(NEW) EXAMINATION – SUMMER 2022

Subject Code:3150501 Date:04/06/2022

Subject Name:Mass Transfer Operations I

Time:02:30 PM TO 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**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	(a)	State and discuss the Fick's law of Diffusion along with the significance of N & J flux.	03
	(b)	Prove that $D_{AB} = D_{BA}$.	04
	(c)	Discuss in brief about choice of separation methods.	07
Q.2	(a)	Derive the relation for steady state diffusion of A through non-diffusing B.	03
	(b)	Ammonia is diffusing through a stagnant gas mixture consisting of 1/3 N_2 and 2/3 H_2 by volume. The total pressure is 206.8 kN/m^2 and temperature 54^0C. Calculate the rate of diffusion of ammonia through a film of gas 0.5 mm thick, when concentration change across the film is 10 % to 5% by volume. The diffusivity of ammonia in gas mixture is 2.45×10^{-5} m^2/s.	04
	(c)	A volatile organic compound C_6H_6 costing Rs. 6/kg is stored in a tank of 10 m. dia. and open at top. A stagnant air film 10 mm thick is covering the surface of the compound beyond which the compound is deficient. If temp. is 25 ^OC and vapor pressure of the compound is 150 mm Hg and diffusivity is 0.02 m^2/hr. calculate the loss in Rs/day.	07
		OR	
	(c)	State the assumptions of film theory and derive the relation for mass transfer coefficient.	07
Q.3	(a)	Derive the relation for two film resistance theory in terms of overall mass transfer coefficient for gas and liquid.	03
	(b)	Write a short note on loading and flooding in packed tower.	04
	(c)	Expound briefly with neat sketch the working of tray tower and the problems associated with its working.	07
		OR	
Q.3	(a)	State the characteristics of ideal solution.	03
	(b)	Discuss the selection criteria for solvent in absorption.	04
	(c)	A coal gas is to be freed of its light oil by scrubbing with wash oil as an absorbent. The circumstances are as follows: Absorber: Gas in 0.250 m^3/s at	07

26°C, Pt = 1.07×10^5 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 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. Compute the oil circulation rate.(Solve analytically)

Q.4 **(a)** State the mixture rule **03**

(b) Write a short not on the system of three liquids-one pair partially soluble in extraction. **04**

(c) State the selection criteria for solvent in extraction. **07**

OR

Q.4 **(a)** Write a short note on heap leaching. **03**

(b) Expound briefly the Shanks system. **04**

(c) A solution of nicotine in water containing 1% nicotine is to be extracted with kerosene at 293 k. Water and kerosene are essentially insoluble. The equilibrium relation is **07**

$$y' = 0.9\,x'$$

Determine the % extraction of nicotine if 100 kg of feed solution is extracted with 150 kg solvent.
Repeat for three theoretical stages using 50 kg solvent each.

Q.5 **(a)** Explain equilibrium diagrams in leaching. **03**

(b) Write in short about preparation of solids in leaching. **04**

(c) State the various leaching equipments and explain the working of Bollman extractor. **07**

OR

Q.5 **(a)** Define super saturation and state the techniques to achieve it. **03**

(b) Explain with neat schematic diagram the working of Oslo Krystal evaporative crystallizer. **04**

(c) Calculate the yield of MgSO4.7H2O crystals when 1000 kg saturated solution of MgSO4 at 353 k is cooled to 303 k assuming 10% of the water is lost by evaporation during cooling. **07**

Data Given:
Solubility of MgSO4 at 353 K = 64.2 kg/100 kg of water.
Solubility of MgSO4 at 303 K = 40.8 kg/100 kg water.

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