U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2024 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 23CH4PCMT1 **Max Marks: 100**
Course: Mass Transfer-I

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Use of Steam table and humidity chart is permitted.
3. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT - I	CO	PO	Marks
1	a)		Derive the equation for diffusion of component A through non-diffusing component B for gases.	CO2	PO1	12
	b)		Calculate rate of diffusion (kmol/m^2 s) of acetic acid across a film of non-diffusing water of 1 mm thickness at 17°C. When the concentrations on opposite sides of 9 and 3 weight %, respectively. Data: • The diffusivity of acetic acid is 0.95×10^{-9} m^2/s. • Density at 17°C of 9% solution is 1012 kg/m^3. • Density at 17°C of 3% solution is 1003 kg/m^3. • Molecular weight of acetic acid =60.03 • Molecular weight of Water = 18.02	CO3	PO2	08
			OR			
2	a)		Derive an equation to relate individual and overall mass transfer coefficient in terms of gas and liquid phase concentration.	CO2	PO2	12
	b)		Hydrogen gas at 17 °C and 0.01 atm partial pressure is diffusing through a membrane of neoprene rubber 0.5 mm thick. Pressure of hydrogen on the other side of the membrane is zero. Calculate the steady state flux assuming the solubility of hydrogen gas in neoprene rubber membrane at 17 °C is 0.051 m^3 (at STP of 0° C and 1 atm) /m^3 of solid. atm and diffusivity $\mathbf{D}_{AB} = 1.03 \times 10^{-10} m^2/s$.	CO2	PO2	08
			UNIT - II			
3	a)		An air-water vapor sample at 101.3 kPa has a dry-bulb temperature of 333 K and an absolute humidity of 0.01 kg water/kg dry air. Using the Psychrometric chart, determine the following: i. The % humidity and % relative humidity ii. The dew point of the system and the wet bulb temperatures	CO4	PO2	08
	b)		Explain the different types of cooling towers used in industries. What are the advantages and disadvantages of a cooling tower?	CO5	PO5	12

			OR			
	4	a)	Show that the overall mass transfer coefficient K_y for a component transferring from gaseous phase to liquid phase, can be expressed as below. k_x and k_y individual phase mass transfer coefficient and slope of the equilibrium curve m´. $$\frac{1}{K_y} = \frac{1}{k_y} + \frac{m'}{k_x}$$	***CO2***	***PO2***	**10**
		b)	Discuss the working of a spray chamber with the help of a sketch.	***CO5***	***PO5***	**10**
			UNIT – III			
	5	a)	Derive the equation for drying time in the constant rate period and the falling rate period.	***CO2***	***PO2***	**12**
		b)	It takes 5 h to dry a wet solid, from 35% to 8% moisture content, using air at constant conditions. The critical and equilibrium moisture contents are 15% and 5%, respectively. Assume that the length of the preheat period is negligible and the falling-rate period is linear in free moisture. For the same drying conditions, determine the drying time, if the initial moisture content is 40% and the final moisture content is 7%. All moisture contents are on the dry basis.	***CO3***	***PO2***	**08**
			UNIT – IV			
	6	a)	Explain single stage and multistage cross current adsorption. Indicate the application of the Freundlich equation for adsorption.	***CO2***	***PO2***	**10**
		b)	A liquid solution is to be decolorized by adsorption. The adsorption equilibrium is represented by $x = 0.65y^{0.25}$ where x is parts of color removed per part of adsorbent and y is the part of color present in 1000 parts of carrier. Calculate the percent removal of color from a solution containing 100 kg color carrying materials with an initial concentration of 1 part color per 3 parts of carrier and is treated with 15 kg adsorbent using a single stage crosscurrent adsorber.	***CO3***	***PO2***	**10**
			UNIT - V			
	7	a)	A continuous evaporative crystallizer operating at 1 kPa and 290 K is fed with 4000 kg/h of a 50% (weight) aqueous solution of sodium acetate at 350 K. At 290 K, the solubility of sodium acetate in water is 54 kg/100 kg water. Determine the yield of $CH_3COONa.3H_2O$ crystals. Assume no water loss due to evaporation.	***CO3***	***PO2***	**10**
		b)	With a neat figure explain the working and construction of continuous vacuum crystallizer.	***CO5***	***PO5***	**10**

****