U.S.N.										

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

Autonomous Institute Affiliated to VTU

December 2023 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH4PCMT1 **Max Marks: 100**
Course: Mass Transfer-I

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

		UNIT - I	CO	PO	Marks
1	a)	List the various types of diffusions, based on the phases involved, number of components diffusing, and method of operation.	CO1	PO1	**06**
	b)	Ammonia vapour is diffusing at a constant rate through a stagnant layer of air 1 mm thick. Conditions are fixed so that the gas contains 50% by volume of ammonia at one boundary of the stagnant layer. The ammonia diffusing to the other boundary is quikly absorbed and the concentration is negligible at that place. The temperature is 295 K and the pressure is atmospheric and under these conditions the diffusivity of ammonia in air is 0.18 cm^2/s. Calculate the rate of diffusion of ammonia through the layer. Data: partial pressure of ammonia is 0.5 atm.	CO3	PO2	**06**
	c)	With a neat diagram, explain how diffusivity of acetone vapor is measured with the help of Arnold's diffusivity cell.	CO2	PO2	**08**
		OR			
2	a)	Solute A is absorbed from a gas mixture of A and B with liquid flowing as a thin film downward along the wall of a tower. At a certain point in the tower, the bulk gas concentration is 0.38 mole fraction and the bulk liquid concentration is 0.1 mole fraction. Solute A is moving and B is stagnant in the gas phase and gets absorbed in a non-diffusing liquid. Use the equilibrium data and find the interface compositions in both the liquid and gas phases. Considering the solution to be dilute, estimate flux conditions. Data is given as follows.	CO3	PO2	**10**

x_A	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35
y_A	0	0.022	0.052	0.087	0.131	0.181	0.265	0.385

			k_y = 1.465 × 10^{-3} kmol/m^2 s mole fraction and k_x = 1.967 × 10^{-3} kmol/m^2 s mole fraction			
		b)	Name the theories that explain the mechanism of mass transfer in turbulent flow. Explain any two of them with relevant sketches	*CO2*	*PO2*	**10**
			UNIT - II			
	3	a)	Draw the humidity chart with at least four psychometric properties and explain them.	*CO1*	*PO1*	**10**
		b)	A sample of air is at 1.013 bar and 35°C with a % saturation of 60%. It is required to alter the condition to i) temperature 25°C and humidity of 70% ii) Temperature 50 º C and % humidity 30%. Recommend operations to achieve above stated conditions.	*CO4*	*PO2*	**10**
			OR			
	4	a)	Draw neat sketches of cooling tower arrangements and discuss	*CO1*	*PO1*	**08**
		b)	A forced draft cooling tower 5mx3m cross section is to cool 100 ton of water/h from 30°C to 13°C with air entering at 7.5°C and humidity of 0.004 kg water /kg dry air. Air leaves the tower at 19°C fully saturated. Estimate air velocity and makeup water required assuming a windage loss of 1% of water circulation rate. Saturation humidity of air at 19°C = 0.014 kg water / kg dry air. Latent heat of vaporization is 2460 kJ/ kg	*CO3*	*PO2*	**12**
			UNIT - III			
	5	a)	Draw the rate of drying curve showing the different zones of drying and explain the mechanism of drying in each zone.	*CO1*	*PO1*	**10**
		b)	1400 of bone dry granular solid is to be dried under constant drying conditions from moisture content of 0.2 kg/kg dry solid to a final moisture constant of 0.02 kg/kg dry solid. The material has an effective area of 0.0615 m^2/kg dry solid. Under the same conditions the following rate were previously known. Calculate the time required for drying.	*CO3*	*PO2*	**10**

X, kg moisture/kg dry solid	Rate of drying, N, kg/h/m^2
0.3	1.71
0.2	1.71
0.14	1.71
0.096	1.46
0.056	1.29
0.046	0.88
0.026	0.54
0.016	0.376

			UNIT - IV			
	6	a)	Compare physical adsorption with chemisorption	*CO1*	*PO1*	**04**

		b)	Give the list of any three adsorbents commonly used. Mention their applications.	*CO1*	*PO1*	**04**
		c)	Air is being dried by passing it over silica gel. In a particular operation, 600 cm^3 of moist air measured at 25ºC and 1 atm. pressure with an initial moisture content equivalent to 22 mm Hg pressure is passed over certain weight of silica gel (with an initial residual moisture content of 5 g. of moisture per 100 g of dry gel) until the gel has attained 15 g of moisture per 100 g of dry gel. The resulting air is passed over new silica gel of equal quantity as used in the first operation. Calculate i) the least moisture content of air that can be obtained ii) the final moisture content of silica gel Equilibrium data:	*CO3*	*PO2*	**12**
			UNIT - V			
	7	a)	Discuss the methods of saturation and super saturation of a solution before crystallization giving suitable examples.	*CO1*	*PO1*	**06**
		b)	What is caking in crystallization? How is it prevented?	*CO1*	*PO1*	**04**
		c)	A Swenson Walker crystallizer is used to crystallize $Na_2SO_4.10H_2O$ at the rate of 1000 kg/h. by cooling a saturated solution of Na_2SO_4 from 40°C to 17°C. Cooling water enters the unit at 12°C and leaving at 27°C. Evaporation is negligible. The solubility of anhydrous Na_2SO_4 in water are 49 and 15 kg/100 kg water at 40°C and 17°C, respectively. Calculate the feed and mother liquor flow rates.	*CO3*	*PO2*	**10**

g moisture/ 100 gm Gel	0	5	10	15	20	25	30	35	40
Partial pressure of water, mm Hg	0	2.1	4.7	7.1	9.1	10	13	14	16.7

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