U.S.N.										

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

Autonomous Institute Affiliated to VTU

October 2024 Supplementary 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 tables and humidity chart is permitted.
3. Missing data, if any, may be suitably assumed.

		UNIT - I	CO	PO	Marks
1	a)	Show that for a binary component mass transfer $D_{AB} = D_{BA}$	CO1	PO1	5
	b)	Derive the expression of gaseous state mass flux for diffusion of component A through stagnant B. Consider that the Gas A and Gas B behave as an ideal gas system.	CO2	PO2	5
	c)	A tube of 0.1 mm diameter is filled with acetone up to 2.3 cm and maintained at 1 atm pressure and 18°C in a gentle current of fresh air. The liquid surface after 80 minutes show that the liquid level has fallen by 0.148 cm. Calculate the diffusivity of acetone. Data: • Vapor pressure of acetone at 18°C = 170 mm Hg • Density of acetone= 790 kg/m^3 • Molecular weight of acetone=58.1	CO2	PO2	10
		OR			
2	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	06
	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 $\mathscr{D}_{AB} = 1.03 \times 10^{-10} m^2/s$.	CO2	PO2	07

	c)	Solute is absorbed from a gas mixture of A and B with liquid flowing as thin film along wall. At a certain point in 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. Use equilibrium data and find the interface composition in both the liquid and gas phases. Data: 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, 0.181, 0.265, 0.385 • $k_y=1.465\times10^{-3}$ kmol/m^2 s mole fraction • $k_x = 1.967\times10^{-3}$ kmol/m^2 s mole fraction	***CO5***	***PO5***	**7**
		UNIT – II			
3	a)	From the vapor pressure curve of pure liquid show that normal boiling point.	***CO4***	***PO2***	**5**
	b)	Define absolute humidity, relative humidity, relative saturation, humid volume, dew point.	***CO4***	***PO2***	**5**
	c)	Determine the percentage humidity, dew point, humid volume, humid heat, partial pressure and saturation humidity of air water vapor mixture at 55°C dry bulb temperature and absolute humidity of 0.035 kg water/kg dry air.	***CO4***	***PO2***	**10**
		OR			
4	a)	Derive the equation of adiabatic saturation temperature and show that adiabatic saturation temperature varies non-linearly with humidity.	***CO3***	***PO2***	**6**
	b)	What are water cooling towers? Enlist five functioning of natural draft, forced draft and countercurrent draft cooling water cooling tower with neat sketch and operational details.	***CO3***	***PO2***	**7**
	c)	Explain the functioning of spray chamber with neat diagram.	***CO3***	***PO2***	**7**
		Unit-III			
5	a)	Derive the expression for the time required for drying moisture from X_1 to X^*. Where, X_1 is more than critical mosture content X_C. Also, derive individually time required to dry moisture from X_1 to X_C and then from X_C to X*	***CO3***	***PO2***	**10**
	b)	Under constant drying condition a wet solid is dried from 30 % to 4 % moisture in dry basis. Time taken is 4 hours. Equilibrium moisture is 2% , critical moisture is 10 %. Determine time required to dry moisture to 7 % assuming falling rate period is linear.	***CO3***	***PO2***	**10**
		UNIT - IV			
6	a)	What are commonly used adsorbents? List the commonly used adsorbents with name and source.	***CO5***	***PO5***	**10**

	b)	It is to reduce the colour to 10 % of its original value of 9.6 by adsorption operation. Determine the quantity of fresh carbon required per 1000 kg of solution for a single stage operation. The adsorption equilibrium data is the following: kg carbon/kg solution: 0 | 0.001 | 0.004 | 0.008 | 0.02 | 0.04 Equilibrium Colour: 9.6 | 8.6 | 6.3 | 4.3 | 1.7 | 0.7	***CO5***	***PO5***	**10**
		UNIT - V			
7	a)	Explain functioning of Circulating magma crystallizer with diagram.	***CO***	***PO***	**10**
	b)	A feed solution of 2268 kg at 327 K contains 48 kg $MgSO_4$ /100 Kg water is cooled to 293 K where $MgSO_4$, 7 H_2O crystals are formed. Solubility of salt is 35.5 kg $MgSO_4$/100 kg water. Average heat capacity of feed is 2.93kJ/kg.K. The heat of solution is -13.31x 10^3 kJ/K mol $MgSO_4$.7 H_2O. Calculate the yield of crystals and make a heat balance to determine the total heat absorbed. Assume no water loss due to evaporation.	***CO***	***PO***	**10**

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