Q. Code:746453

Reg. No. | | | | | | | | | | | | | |

B.E./ B. TECH.DEGREE EXAMINATIONS, MAY 2024

Fourth Semester

CH22402 – MASS TRANSFER I

(Chemical Engineering)

(Regulation 2022)

(Psychrometric chart shall be provided)

TIME: 3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Apply the principles of diffusion in measuring diffusivity.	**3**
CO 2	Calculate different types of Mass transfer co-efficient and identify the relation between them.	**3**
CO 3	Apply mass transfer concepts in designing humidification units.	**3**
CO 4	Calculate rate of drying using Mass transfer concepts.	**3**
CO 5	Apply mass transfer concepts in designing crystallization units.	**3**

PART- A (20x2=40Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Brief Knudson diffusion.	**1**	**2**
2.	State any two examples for Fick's first law of diffusion.	**1**	**2**
3.	Show the final expression of flux for diffusion of gases A and B plus convection.	**1**	**2**
4.	Differentiate molecular and total flux.	**1**	**2**
5.	Differentiate the significance of HETP and HTU.	**2**	**2**
6.	Brief surface renewal theory.	**2**	**2**
7.	Indicate the Colbourn analogy equation.	**2**	**2**
8.	List any four examples of stage-wise gas-liquid contactors.	**2**	**2**
9.	Differentiate sensible heat and latent heat.	**3**	**2**
10.	Outline the use of Psychrometric chart.	**3**	**2**
11.	Brief humid heat.	**3**	**2**
12.	Identify the significance of temperature approach in design of cooling towers.	**3**	**2**
13.	Sketch drying rate curve.	**4**	**2**
14.	Write the material and heat balance for the dryer.	**4**	**2**
15.	Mention any four applications of dryer.	**4**	**2**
16.	Differentiate bound and unbound moisture.	**4**	**2**
17.	Mention the material and energy balance equation of a Crystallizer.	**5**	**2**

18.	State Mier's explanation.	**5**		**2**
19.	Differentiate saturated and supersaturated solution.	**5**		**2**
20.	State ΔL law of crystal growth.	**5**		**2**

PART- B (5x 10=50Marks)

		Marks	CO	RBT LEVEL
21. (a)	Derive the flux equation for diffusion through a varying cross sectional area.	**(10)**	**1**	**3**
	(OR)			
(b)	Ammonia gas diffuses through a 2 mm thick stagnant air film to a sulphuric acid stream, where it disappears immediately in a chemical reaction. Calculate the rate of transfer into 1 m^2 of surface of this acid if the temperature is 20°C and the pressure is atmospheric. The concentration of ammonia is 2 mole% at the outer edge of the air layer. Data: Diffusivity of ammonia in air= 0.2 cm^2/s ; The volume of 1kgmol of ideal gas occupies 22.4 m^3 at STP.	**(10)**	**1**	**3**
22. (a)	Explain two film theory and penetration theory with a neat sketch and show their applications in Mass Transfer.	**(10)**	**2**	**3**
	(OR)			
(b)	In a wetted wall column carbon dioxide is being absorbed from air by water flowing at 2 atm pressure and 25°C. The mass transfer coefficient k'_y has been estimated to be 6.78 X 10^{-5} $kmol/m^2$ s (mole fraction). Calculate the rate of absorption if the partial pressure of carbon dioxide at the interface is 0.2 atm and the air is pure. Determine k_y and k_G.	**(10)**	**2**	**3**
23. (a)	Derive the design equation of Cooling tower using enthalpy concept.	**(10)**	**3**	**3**
	(OR)			
(b)	A stream of air at 37°C and 50% relative humidity flowing at a rate of 1250 kg/h is to be cooled to 15°C and dehumidified in a spray tower. The air is saturated as it emerges from the tower. Liquid water leaves the tower at 12°C. Calculate **(i).** The rate (kg/h) at which water must be removed and (5 Marks) **(ii).** The heat duty on the cooler (kW). (5 Marks)	**(10)**	**3**	**3**
24. (a)	Explain elaborately the working mechanism of vacuum dryer and list their	**(10)**	**4**	**3**

applications.

(OR)

(b)	A granular material containing 40% moisture by weight (wet basis) is fed to a counter-current rotary dryer at a temperature of 20°C and is withdrawn at 35°C, containing 5% moisture (wet basis). The air supplied which contains 0.006 kg water/kg dry air, enters at 110°C and leaves at 38°C. The dryer handles 500kg/h wet stock. Radiation losses amount to 20 kJ/kg dry air used, determine the mass flow rate of dry air supplied to the dryer and the humidity of the exit air. Specific heat capacity of water vapour = 2 kJ/kg.K Specific heat capacity of dried solid = 0.8 kJ/kg K specific heat capacity of dry air = 1.00 kJ/kg K, specific heat capacity of water = 4 kJ/kg K.	**(10)**	**4**	**3**

25. (a)	Discuss elaborately Circulating-liquid evaporator crystallizers and Circulating-magma vacuum crystallizer.	**(10)**	**5**	**3**

(OR)

(b)	Glauber's salt, $Na_2SO_4.10H_2O$, is to be produced in a Swenson-Walker Crystalliser by cooling to 290K a solution of anhydrous Na_2SO_4, which is saturated at 300K. If cooling water enters and leaves the unit at 275K and 290K, respectively, and evaporation is negligible, calculate the sections of crystalliser, each 3 m long, will be required to process 0.25 kg/s of the product. The solubilities of anhydrous Na_2SO_4 in water are 40 and 14 kg/100 kg water at 300K and 290K, respectively. The mean heat capacity of the liquor is 3.8 kJ/kg.K and the heat of crystallisation is 230 kJ/kg. For the crystallizer, the available heat transfer area is 3 m^2/m length, the overall heat transfer coefficient is 0.15 kW/m^2.K and the molecular weights of $Na_2SO_4.10H_2O$ and Na_2SO_4 are 322 and 142 kg/kgmol, respectively.	**(10)**	**5**	**3**

PART- C (1x 10=10Marks)

(Q.No.26 is compulsory)

		Marks	CO	RBT LEVEL
26.	Justify crystallization plays a very important role in sugar industry.	**(10)**	**5**	**5**

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