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**B.TECH
(SEM-IV) THEORY EXAMINATION 2017-18
MASS TRANSFER -I**

Time: 3 Hours

Total Marks: 100

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt all questions in brief. 2 x 10 = 20

- a) Humidification & Dehumidification
- b) Knudsen & surface diffusion
- c) Convective mass transfer
- d) Bound and unbound moisture content.
- e) Relative volatility
- f) Vapour pressure
- g) Knudsen diffusion
- h) Freeze drying,
- i) Inter- phase mass transfer
- j) Mass transfer coefficients

SECTION B

2. Attempt any three of the following: 10 x 3 = 30

- a) A narrow tube is partially filled with a liquid and maintained at a constant temperature. A gentle stream of gas is passing across the open end of the tube .As the liquid evaporates, the level drops slowly. At a given time t, the level is Z from the top. Derive an equation to calculate the value of the diffusivity of the liquid vapour in the gas.
- b) Hydrochloric acid (A) diffuses through a thin film of water (B) 4.0mm thick at 283 k. The concentration of HCl at point 1 one boundary of the film is 12 wt%(density $\rho_1=1060.7\text{kg/m}^3$) and on the other boundary at point 2, is 4wt%(density $\rho_2 =1020.15\text{kg/m}^3$).The diffusivity of HCl in water is $2.5 \times 10^{-9} \text{ m}^2/\text{s}$. Calculate the flux of HCl considering water to be stagnant.
- c) Explain the construction and operation of a forced draft cooling tower with neat sketch.
- d) A mixture of Acetone vapour and nitrogen contains 14.8 % Acetone by volume. Calculate the following at 293K(20 C) and pressure of 99.33kpa.Vapour pressure of Acetone at 293K =24.638kpa.Calculate (a)partial pressure of Acetone (b)% relative saturation (c)% saturation
- e) Discuss the rate of drying curve of a wet solid, and explain critical moisture on the equilibrium curve.

SECTION C

3. Attempt any one part of the following: 10 x 1 = 10

- a) Explain the penetration and film theory of mass transfer?

- b) Discuss local and overall mass transfer coefficients. Write short note on the analogy between momentum, heat and mass transfer?

4. Attempt any one part of the following: 10 x 1 = 10

- a) Discuss the criteria for choosing the solvent for absorption. Discuss with diagram equipment for Gas liquid operations for a batch system.
- b) A packed tower is to be designed to absorb sulfur dioxide from air by scrubbing the gas with water. The entering gas is 18.6% SO₂ by volume. The water flow is to be 2.3 times the minimum. The air flow rate (SO₂ free basis) is 1100 m³/hr. The temperature is 30 °C and the total pressure is 2 atm. The equilibrium data is governed by $y=21.8x$ where y and x are in mole fractions units. 95% solute removal is necessary. Compute the number of overall gas phase transfer units.

5. Attempt any one part of the following: 10 x 1 = 10

- a) Air at 30⁰ C and 150 kPa in a closed container is compressed and cooled. It is found that the first droplet of water condenses at 200 kPa and 15⁰ C. calculate the percent relative humidity of the original air. The vapor pressures of water at 15⁰ C and 30⁰ C are 1.7051 kPa and 4.246 kPa respectively.
- b) Define the term with reference to air-water humidification operation :
- Dry-Bulb Temperature
 - Absolute Humidity
 - Relative Humidity
 - Saturation Humidity
 - Wet-Bulb Temperature

6. Attempt any one part of the following: 10 x 1 = 10

- a) A slab of paper pulp 100cmx100cmx1.5cm is to be dried under constant drying conditions from 66.7% to 30% moisture. The value of equilibrium moisture for material is 0.5%.If critical moisture content is 60% and the rate of drying at the critical point is 1.5 kg/hr m², calculate the drying time. The dry weight of each slab is 2.5 kg. All the moisture content are on wet basis.
- b) Classify the various types of dryer and explain the construction and working of a Rotary dryer.

7. Attempt any one part of the following: 10 x 1 = 10

- a) Write the any two name of the crystallizer. Explain in detail any one of them with neat sketch.
- b) A hot solution of Ba(NO₃)₂ from an evaporator contains 30.6 kg Ba(NO₃)₂/ 100 kg H₂O and goes to a crystallizer, where the solution is cooled and Ba(NO₃)₂ crystallizes. On cooling, 10% of the original water present evaporates. For a feed solution of 100 kg total, calculate the yield of crystals if the solution is cooled to 290 K, where the solubility is 8.6 kg Ba(NO₃)₂/ 100 kg total water.