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B. TECH.

(SEM IV) THEORY EXAMINATION 2018-19

MASS TRANSFER-I

Time: 3 Hours

Total Marks: 100

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

SECTION-A1. Attempt **all** parts of the following: [2x10=20]

- a. What is Fick's law of diffusion?
- b. Define absorption factor and its significance.
- c. Discuss the type of batch and continuous dryers.
- d. Define flooding, Loading in packed column.
- e. Discuss about WBT & DBT.
- f. What do you mean by super saturation?
- g. Differentiate b/w molecular diffusion and eddy diffusion
- h. Define HTU & NTU.
- i. Define humidity and saturation humidity.
- j. Define mass transfer coefficient.

SECTION-B2. Attempt any **three** parts of the following: [10x3=30]

- a. Derive an expression, based on the film theory, for the overall mass-transfer coefficient for the absorption of gas in liquid in terms of both liquid-side and gas-side mass-transfer coefficients and Henry's constant.
- b. Oxygen (A) is diffusing through carbon monoxide (B) under steady state condition with carbon monoxide non-diffusing. The total pressure is 1×10^5 N/m² and temperature is 0 °C. The partial pressure of oxygen at two planes 3.0 mm apart is respectively 12500 and 7000 N/m². The diffusivity for the mixture is 1.87×10^{-5} m²/s. Calculate the rate of diffusion of oxygen in kmol/s through each square meter of the two planes.
- c. Calculate the rate of diffusion of methanol at 20 °C under unidirectional steady state condition through a 20 mm thick film of water when the concentrations of methanol at the opposite sides of the film are respectively 10% to 4 % methanol by weight. The diffusivity of methanol in water solution is 5.9×10^{-6} cm²/s. The density of 10% & 4% methanol solution at 20 °C may be taken as 0.951 and 0.986 g/cc respectively.
- d. What is the Knudsen Diffusion Coefficient? How does it vary with Temperature & Pressure?
- e. With the help of neat diagram describe the construction and working of packed absorption column.

SECTION-C3. Attempt any **one** part of the following: [10x1=10]

- a. In an O₂-N₂ gas mixture at 1 std. atm 25°C, the concentration of O₂ at two planes 2mm apart are 10 and 20 vol% respectively. Calculate the flux of diffusion of the O₂ for the case where-(a) the N₂ is non-diffusing (b) there is equimolar counter diffusion of the two gases. Diffusivity of O₂ in N₂ is 1.81×10^{-5} m²/s. Draw and explain the different types of equilibrium curve which may be encountered in leaching operation.

- b. Write the short note of the following –
- (i) Penetration theory of mass transfer
 - (ii) Non-adiabatic humidification

4. Attempt any **one** part of the following: [10x1=10]

- a. A wet solid is dried from 35% to 10% moisture under constant drying conditions in 5 hours. If the equilibrium moisture content is 4% and the critical moisture content is 14%, how long will it take to dry from 30% to 6% moisture under the same conditions. All percentages are on wet basis. Assume linear relation between rate of drying and moisture content during falling rate period.
- b. Classify the various types of dryer and explain the construction and working of Rotary dryer?

5. Attempt any **one** part of the following: [10x1=10]

- a. Write the different types of crystallizer. Explain in details any one of them with neat sketch.
- b. A hot solution $\text{Ba}(\text{NO}_3)_2$ from an evaporator contains 30.6 kg $\text{Ba}(\text{NO}_3)_2/100$ kg H_2O and goes to a crystallizer, where the solution cooled and $\text{Ba}(\text{NO}_3)_2$ crystallizers. 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 290 K, where the solubility is 8.6 kg $\text{Ba}(\text{NO}_3)_2/100$ kg total water.

6. Attempt any **one** part of the following: [10x1=10]

- a. A mixture of nitrogen-acetone vapors at 800 mmHg and has percentage saturation of 80%. Calculate- i) absolute molal humidity, ii) absolute humidity (kg acetone/kg nitrogen), iii) partial pressure of acetone, iv) relative humidity, v) volume percentage of acetone. Assume vapor pressure of acetone at 25°C as 190 mmHg and the Mol. Wt of nitrogen is 28.02 & acetone is 58.06.
- b. Given design procedures for determining of cooling towers. How to make use of psychometric charts for the purpose.

7. Attempt any **one** part of the following: [10x1=10]

- a. A slab of paper pulp 100cm X 100cm X 1.5cm 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 weight of each slab is 2.5 kg. All the moisture content are on wet basis.
- b. Write the short note of the following-
 - (i) McCabe 'Δ Law
 - (ii) Factors governing nucleation
 - (iii) Diffusion reaction theory of crystal growth