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B. TECH.
(SEM-IV) THEORY EXAMINATION 2017-2018
MASS TRANSFER-I

Time: 3 Hours **Max. Marks: 70**

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

SECTION – A

1. Attempt all questions in brief. **2x7 = 14**

   a. Discuss Fick's law of diffusion.
   b. Differentiate between *Molecular diffusion* and *Knudsen diffusion*.
   c. Discuss Henry's law.
   d. Define HETP.
   e. Discuss the classification of cooling towers.
   f. Discuss about the Wet Bulb Temperature.
   g. Discuss the type of batch and continuous dryers.

SECTION - B

2. Attempt any **three** of the following. **7 x 3 = 21**

   a. Classify different mass transfer operations.
   b. Discuss Film theory of mass transfer.
   c. Discuss Non-adiabatic humidification.
   d. A wet solid is to be dried from 80 to 5% moisture, wet basis. Compute the moisture to be evaporated, per 1000 kg of dried product.
   e. Write short notes on Crystal growth rates.

SECTION – C

3. Attempt any ***one*** of the following: **7 x 1 = 7**

   a. In an oxygen- nitrogen gas mixture at 1 std atm, 25^{0}C, the concentration of oxygen at two planes 2mm apart are 10 and 20 vol%, respectively. Calculate the flux of diffusion of the oxygen for the case where
      (i) The nitrogen is non-diffusing
      (ii) There is equimolar counter diffusion of the two gases.
   b. Calculate the rate of diffusion of acetic acid (A) across a film of non-diffusing water (B) solution 1 mm thick at 17 ^{0}C when the concentration on opposite sides of the film are respectively, 9 and 3 wt % acid. The diffusivity of acetic acid in the solution is 0.95×10^{-9} m^2/s. The density of the 9% and 3% solution is 1012 kg/m^3 and 1003.2 kg/m^3.

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

   a. 5000 kg/hr of SO_2-Air mixture containing 5% by volume of SO_2 is to be scrubbed with 200000 Kg/hr of water in a packed tower. The exit

concentration of SO_2 is reduced to 0.15%. The tower operates at 1 atm. The equilibrium relation is given by: Y = 30X, where Y= mole SO_2/mole Air, X = mole SO_2/ mole water; If the packed height of tower is 0.42 m, calculate the height of transfer unit.

b. A Benzene air mixture is to be scrubbed in a counter countercurrent absorption column, using nonvolatile oil as a solvent. The inlet gas contains 5% benzene and the column operates at 27 0C and 1 atm. Find the number of trays needed to recover 90% of the benzene, using an air-oil ratio of 7.30. The column is 30% efficient. The equilibrium relationship for benzene is y*=0.136x.

5. Attempt any ***one*** of the following: **7 x 1 = 7**

a. Discuss the following terms (i) Dry-bulb temperature (ii) Relative saturation (iii) percentage saturation (iv) Humid volume and (v) Humid Heat.

b. The Differentiate among absolute humidity, relative humidity and percentage humidity. A gas (B)-benzene (A) mixture is saturated at 1 std. atm, 50oC. Calculate the absolute humidity if B is (a) nitrogen and (b) carbon dioxide. (Given: equilibrium vapor pressure of benzene at 50^0C is 275 mmHg)

6. Attempt any ***one*** of the following: **7 x 1 = 7**

a. Discuss Rotary driers and Spray driers.

b. Drying of a food product is carried out in an insulated tray. The drying air has a partial pressure of water vapor equal to 2360 Pa and a wet bulb temperature of 30 ^{0}C. The product has a drying surface of 0.05m^2/kg. The material has a critical moisture content of 0.12 (dry basis) and negligible equilibrium moisture content. The drying rate in the falling rate period is proportional to the moisture content and the mass transfer coefficient is $5.34x10^{-4}$ kg/m^3.h.Pa. Calculate the time required to dry the material from a moisture content of 0.22 to 0.06 (both on dry basis). Vapor pressure of water at 30^0C is 4232 Pa.

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

a. How does solution crystallization differ from melt crystallization? What are the two main methods used to cause crystallization from an aqueous solution? Which is more common and why?

b. Compute the heat evolved when 10 kg of benzene as a superheated vapor at 94 mmHg, 100^{o}C, is cooled and condensed to a liquid at 10^{o}C. the average heat capacity for the vapor may be taken as 1.256 and for the liquid 1.507 kJ/kg.K *(Given: At pressure 94 mmHg, saturation temperature of benzene is 25^{o}C and latent heat of vaporization at this temperature is 434 kJ/kg)*