

(Following Roll No. to be filled by candidate)

Roll No.

1207351902

**B. TECH.
FIFTH SEMSTER EXAMINATION 2013 -14
ECH 501
MASS TRANSFER OPERATIONS-I**

Time: 3 Hours

Max. Marks: 100

Note:

- Attempt all questions.
- Marks and number of questions to be attempted from the section is mentioned before each section.
- Assume missing data suitably. Illustrate the answers with suitable sketches.

1. Attempt any *four* parts of the following:

[4 x 5]

- State and explain Fick's first law of diffusion with its limitations. Also, explain equimolecular counter diffusion with suitable example.
- 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 diffusivity of the liquid vapour in the gas.
- Describe two film theory of inter-phase transport. What is the importance of the line having slope $-k_g/k_l$?
- Obtain an expression for diffusion coefficient in multicomponent diffusion.
- How does the mass transfer coefficient vary with superficial velocity in case of a liquid fluidized bed?
- Small spheres of solid benzoic acid are dissolved in water in an agitated tank. If the Sherwood number is nearly constant at a value of 4.0, show how the time for complete dissolution varies with the initial size of the particle. How much time would be required for 100- μm particles to dissolve completely in pure water at 25°C? Solubility of benzoic acid in water at 25°C is 0.43 g/100g H_2O . Density of solid benzoic acid = 1.265 g/cm³. Diffusivity 'D' = 1.21×10^{-5} cm²/s.

2. Attempt any *four* parts of the following:

[4 x 5]

- Explain weeping and flooding phenomena in a sieve column.
- What are the different criteria of selection between tray tower and packed tower? Also, compare the different types of trays, based on their cost, capacity, operating range, efficiency and pressure drop.
- A gas is to be washed by a solvent. How will you determine the minimum solvent required?
- Obtain an expression for height of packed column based on the individual mass transfer coefficient in gas film.
- An acetone-air mixture containing 0.015 mole fraction of acetone has the mole fraction reduced to 1 per cent of this value by counter current absorption with water in a packed tower. The gas flow rate G' is 1 kg/m²s and the water enters at 1.6 kg/m²s. For this system, Henry's law holds and $y_e = 1.75 x$, where y_e is the mole fraction of acetone in the vapour in equilibrium with a mole fraction x in the liquid. How many overall transfer units are required?
- Explain the gas absorption with chemical reaction with suitable example and compare it with gas absorption without chemical reaction.

3. Attempt any *two* parts of the following:

[2 x 10]

- Explain the several graphical forms of representing the VLE data and method of calculating bubble point and dew point involved in VLE calculations.
- Define absolute humidity, relative humidity and wet bulb temperature. How to make use of psychrometric chart to determine these terms?
- Give the classification of cooling tower and explain natural draft & induced draft cooling towers. Also, give design procedure of cooling tower.

4. Attempt any *two* parts of the following:

[2 x 10]

- Explain the drying rate curve and obtain an expression for total time required for drying of material.
- A continuous counter-current dryer is used to dry 425.6 kg dry solid/h containing 0.035 kg total moisture/kg dry solid to a value of 0.0017 kg total moisture/kg dry solid. The granular solid enters at 25°C and leaves at 60°C. The heating medium is air which enters at 84.2°C, has a humidity of 0.0175 kg H_2O /kg

outlet humidity, assuming the heat losses from the dryer to be 9300 kJ/h. The constant heat capacity of the dry solid is 1.465 kJ/kg K.

- c. Give the classification of drying equipments. Explain rotary dryer with neat sketch and give its basic design procedure.

5. Attempt any *two* parts of the following:

[2 x 10]

- a. Describe various stages of crystal growth.
- b. With the help of neat sketch describe the construction and operation of forced circulation evaporative crystallizer.
- c. A dissolved solute in an aqueous solution is proposed to be separated by using forced circulation evaporative crystallizer; the concentration of solute in the solution is 220 kg/m^3 . Suggest the suitable diameter of crystallization vessel, if the rate of evaporation of the solvent is 12,500 kg/h at the operating pressure of 120 mm of Hg, boiling point of solution considering the boiling point elevation is 70°C , and the average density of solution is 1150 kg/m^3 .