(Set-SP)

B. Tech-5 (Chem. Engg)

Mass Transfer-I

Full Marks : 70

Time : 3 hours

Answer **all** questions.

The figures in the right-hand margin indicate marks.

Symbols carry usual meaning.

1. Answer *all* questions :

   (*a*) How the eddy diffusion is differentiated from molecular diffusion ?

   (*b*) Give the relationship between mass transfer coefficient and diffusivity.

   (*c*) For a certain mass transfer process, $k_l = 1 \times 10^{-3}$ cm/s and $D_{AB} = 1 \times 10^{-5}$ cm^2/s. Then calculate the film thickness.

   (*d*) What is 'Relative volatility' ? Give expression for a binary mixture.

   (*e*) Write the limitations of McCabe Thiele method.

(*f*) What is the difference between absorption and desorption ?

(*g*) What do you mean by channeling ? How it can be avoided or minimized ?

(*h*) The partial pressure of acetone in air 28 °C and 100 kpa is 12 kpa. The vapor pressure of water is 28 kpa (at 32 °C). Then find the relative humidity.

(*i*) What is humid volume ?

(*j*) What is the use of psychometric charts ?

2. Define mass transfer coefficient. Discuss in detail about two film theory of mass transfer. 10

Or

Ammonia is diffusing through a stagnant mixture consisting of one-third Nitrogen and two thirds Hydrogen by volume. The total pressure is 1 atm and the temperature is 200 °C. Calculate the rate of diffusion of ammonia through a film of gas 0.5 mm thick, when ammonia concentration changes across the film is 12% and 7% by volume. The diffusivities at 200 °C and 1 atm pressure are $D_{AB} = 5.391 \times 10^{-5}$ m²/s and $D_{BC} = 1.737 \times 10^{-4}$ m²/s.

3. A feed mixture of *A* and *B* (45 mol% *A* and 55 mol% *B*) is to be separated into a top product containing 96 mol% *A* and bottom product having 95 mol% *B*. The feed is 50% vapor and reflux ratio is 1.5 times the minimum. Determine the number of ideal trays required and the location of feed tray. Given $\alpha_{AB} = 2.8$. 10

Or

Explain the following processes :

(*i*) Steam Distillation

(*ii*) Extractive distillation.

4. Distinguish Plate and Packed towers. Explain Flooding and loading in packed towers. 10

Or

A gas from a petroleum distillation column has its concentration of H_2S reduced from 0.03 kg mole H_2S/kgmoles inert gas to 1% of its value by scrubbing with a tri ethanol amine with water as a solvent in a counter current tower of height 7.79 meter operating at 300 °C and 1 atm. The equilibrium relation is $Y = 2X$. Pure solvent enters the

tower and leaves containing 0.013 kg mole H_2S/ kg mole of solvent. If the flow of inert hydrocarbon gas is 0.015 kg mole/m^2s and the gas phase controls the mass transfer. Calculate the overall coefficient for absorption.

5. Air at a temperature of 30 °C and a pressure of 100 KPa has a relative humidity of 80%.

   (*i*) Calculate the molar humidity of air.

   (*ii*) Calculate molar humidity of air if it is reduced to 15 °C and its pressure is increased to 200 KPa, condensing out some water.

   (*iii*) Calculate the weight of water condensed from 100 m^3 of original wet air in cooling to 15 °C and compressing to 200 KPa. 10

Or

Write a short note on spray tower and its applications.

6. Explain briefly the Analogies and their usefulness in mass transfer studies. 10

Or

The vapor-liquid equilibrium curve of a binary mixture *A-B*, may be approximated by a linear equation over a narrow range of liquid mole fractions ($0.2 < X_A < 0.3$) as follows

$$Y_A^* = 1.325\, X_A + 0.121$$

Here, Y_A^* is the mole of fraction of A in the vapor. 100 moles of a feed ($X_{A,F} = 0.28$) is batch distilled to a final residue ($X_{A,W} = 0.20$). Using the Rayleigh equation, find the number of moles of the residue left behind in the distillation unit.
