(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, $k_1 = 1 \times 10^{-3}$ cm/s and $D_{AB} = 1 \times 10^{-5}$ cm²/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.

(Turn Over)

(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 hydro-carbon 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 useful-ness 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 dis-tilled 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.

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