

Time - 135 minutes

Maximum Marks 60

(to be scaled down to 30)

Note: 1. Draw neat sketch(es), wherever necessary, and label the same.

2. Make suitable assumptions, if required, and state the same clearly.

1. Water is evaporating from one side of the wet surface of a porous board (0.25 m² cross-section and 0.02 m thick). The other surface and edges are sealed. The temperature of the wet surface is 40 °C and temperature of the ambient air is 80 °C. The thickness of the stagnant air film is 1mm. Diffusion coefficient of water vapor in the air is $3.00 \times 10^{-5} \text{ m}^2/\text{s}$.

(a). Determine the concentration of water vapor in the ambient air, mol/m³

(b). Determine the mass transfer coefficient, m/s

(c) Determine the rate of drying, kg/s.

(6+6+6)

2. A porous sphere (5 cm diameter) is soaked in a solution of copper sulfate. The concentration is 50 kg copper sulfate/m³ solution. The volume of pores in the sphere is 10 cm³. The sphere is brought in contact with 100 cm³ of pure water and the two are well agitated. After a sufficiently long time, concentration of copper sulfate is same every where, in the pores as well as in the bulk solution.

(a). Determine concentration of copper sulfate finally.

(b). Write unsteady state differential equation for mass balance, along with appropriate initial condition and boundary conditions. (Note: Solution of differential equation not required).

(c). Draw concentration profile in the particle and in the bulk solution at

(i) $t = 0$, (ii) $t = \text{a finite value}$, (iii) after a very long time. (6+6+6)

3. Explain briefly the following

- (a) In gas absorption, you have less soluble and more soluble gases. Will the slope of equilibrium curve be more for a less soluble gas or less than that for a more soluble gas. Explain qualitatively.
- (b) What is the significance of relative volatility in distillation? Should it approach or move away from unity?
- (c) 'For a mass transfer operation to be practicable, equilibrium should be avoided.' How do you justify this statement?
- (d) There are two operating lines in a distillation column- one each for enriching section and stripping section. Why there is one operating line under total reflux?
- (e) For packed towers, experimental data are commonly given in terms of HTU. Why? What is the physical meaning of a transfer unit?
- (f) An increase in system pressure increases the number of stages in a distillation column. It decreases the height in an absorption column. Explain.

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