

Instructions to the candidates if any: -

1. Question No. 1 is compulsory
2. Attempt any three questions from the remaining five questions
3. Assume suitable data wherever necessary
4. The figures to the right indicate full marks

Q. No. 1

- a. For molecular diffusion of A and B in their binary mixture, prove that $D_{AB} = D_{BA}$ [05]
- b. Discuss any one theory for predicting mass transfer coefficients in turbulent flow. [05]
- c. Discuss the factors that are to be considered while selecting a solvent for gas absorption. [05]
- d. 1500 kmole/hr of a gas mixture containing 2.5 volume % of solute is contacted with 7000 kmole/hr of pure water in a co-current absorption operation. What is the slope of the operating line? [05]

Q. No. 2

- a. What do you mean by equimolar counter diffusion in a mixture of liquid A and liquid B? Derive an equation for the steady-state mass transfer flux in this case [08]
- b. The air pressure in a tyre reduces from 2 bar to 1.99 bar in five days. The volume of the air in the tube is 0.03 m^3 , the surface area is 0.45 m^2 and the wall thickness is 0.015 m . The solubility of air in the rubber is $0.07 \text{ m}^3/\text{m}^3$. Estimate the diffusivity of air in the rubber [12]

Q. No. 3

- a. For interphase mass transfer from a gas phase to a liquid phase, derive a relation between individual and overall mass transfer coefficients and discuss the following cases-
 1. Mass transfer is controlled by gas-phase resistance
 2. Mass transfer is controlled by the liquid-phase resistance [12]
- b. Compare tray columns with packed columns [08]

Q. No. 4

- a. Draw a neat sketch of the typical rate of drying curve and explain it in detail. [08]
- b. 8500 kg/hr of a SO_2 – Air mixture containing 6 % by volume SO_2 is to be scrubbed with 200000 kg/hr of water in a packed column. The exit concentration of SO_2 is reduced to 0.18 %. The tower operates at 1 atm. The equilibrium relationship is given as $Y = 30X$, where X and Y are the concentrations of SO_2 in water and air on a solute-free basis, respectively. If the height of the packed bed is 435 cm, estimate the height of the transfer unit [12]

Q. No. 5

- a. Define mass absolute and molal absolute humidities and derive the relation between them. [05]
- b. 210 kg of a wet solid is to be dried from an initial moisture content of 29 % to a final moisture content of 7 %. Drying tests show that the rate of drying is constant at $3.8 \times 10^{-4} \text{ kg/m}^2\text{s}$ in the region $0.2 - 0.4 \frac{\text{kg water}}{\text{kg solid}}$. The drying rate falls linearly in the range of $0.01 - 0.2 \frac{\text{kg water}}{\text{kg solid}}$. If the equilibrium moisture content is $0.01 \frac{\text{kg water}}{\text{kg solid}}$, calculate the time of drying. The drying surface is $\frac{1 \text{ m}^2}{28 \text{ kg dry solid}}$ [10]
- c. Discuss the mechanism of diffusion through crystalline solids [05]

Q. No. 6

Write short notes on the following (Any four)- [20]

- b. Venturi scrubber
- c. Various moisture contents in a wet solid
- d. Classification of gas-liquid contact equipment.
- e. Wet-bulb thermometer
- f. Cooling towers
