Q.P.Code: 21969

[3 Hours] **[Total Marks: 80]**

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. Figures to the right indicates full marks

Q. No. 1

a. Explain Fick's first law of diffusion. (05)
b. Discuss different types of packings used in packed towers (05)
c. Write a short note on ideal solutions (05)
d. Explain the concept of adiabatic saturation. (05)

Q. No. 2

a. Derive the steady state flux equation for gas A diffusing in stagnant gas B. and hence write down the steady state flux equation for liquid A diffusing in stagnant B (08)
b. In a wetted wall column where ammonia was stripped from an ammonia-water solution into an air stream, the overall liquid mass transfer coefficient K_L was $0.0875 \frac{kmole}{hr\ m^2\left(\frac{kmole}{m^3}\right)}$. At a point in the column, the concentration of ammonia in water was $0.3\ kmole/m^3$ and partial pressure of ammonia in gas stream was $0.06\ atm$. For dilute solution of ammonia in water, the equilibrium relationship is $P_A = 0.25C_A$, where P_A is in atm and C_A is in $kmole/m^3$. If the gas phase resistance is $70\ \%$ of the total resistance, calculate
    a) Individual mass transfer coefficients
    b) Interfacial compositions of ammonia. (12)

Q. No. 3

a. For mass transfer to a confined fluid, explain the concept of local mass transfer coefficient (05)
b. Explain surface renewal theory for mass transfer.. (05)
c. It is desired to dry a certain material of fiber board in sheets of $0.131\ m \times 0.162\ m \times 0.071\ m$ from $58\ \%$ to $5\ \%$ moisture content (wet basis). Initial rate of drying at constant rate period was $8.9\ kg/m^2h$. The critical moisture content was $24.9\ \%$ and the equilibrium moisture content was $1\ \%$. The fiber board is to be dried from one side only and has bone dry density of $210\ kg/m^3$. Determine time required for drying. Falling rate may be assumed linear. (10)

Q. No. 4

a. In a dilute concentration region, equilibrium data for SO_2 distributed between air and water can be approximated by: $P_A = 25x_A$ (P_A is partial pressure of SO_2 in air in $atm.$ and x_A is the mole fraction of SO_2 in water). For absorption column operating at $10\ atm.$., the bulk vapour and liquid concentrations at one point in the column are $y_A = 0.01$ and $x_A = 0.05$. The individual mass transfer coefficients, $K_x = 10\ kmole/m^2h$ and $K_y = 8\ kmole/m^2h$. Find:

   i. Overall mass transfer coefficient K'_x
   ii. Determine interfacial compositions x_{Ai} and y_{Ai}
   iii. Calculate molar flux N_A. (10)

b. Discuss the typical rate of drying curve (05)

c. Derive equation for operating line for counter current absorption operation (05)

Q. No. 5

a. Discuss the theory of wet bulb temperature (04)

b. Write a short note on natural draft cooling towers (04)

c. An acetone-air mixture containing 0.015 mole fraction acetone has the mole fraction reduced to $1\ \%$ of this value by counter current absorption with pure water in a packed tower. The gas flow rate is $1\ kg/m^2s$ and the water entering is at a rate of $1.6\ kg/m^2s$. For this system Henry's law holds and the equilibrium relationship is given as $y = 1.75x$ where y is mole fraction of acetone in air in equilibrium with mole fraction x in the liquid. How many overall gas transfer units are required? (12)

Q. No. 6

Write Short Note on the following [Any four] [20]

a. Requirements of Solvent for absorption
b. Mass Transfer Coefficients
c. Cooling Towers
d. Tray Towers Vs Packed Towers
e. Diffusion through porous solids

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