9 June

T2525 / T0525 MASS TRANSFER OPERATIONS I

(01)

TE/Sem V/CHEM/CBSGS MAY-2017 MTO-I

Q.P. Code : 574000

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

(26)

N.B. 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.

1. a) Explain Fick's first law of diffusion. **04**
b) Explain penetration theory for mass transfer. **04**
c) What you mean by equilibrium, ideal or theoretical stage? **04**
d) Explain the concept of adiabatic saturation. **04**
e) With one example each, explain what you mean by batch and continuous drying. **04**

2. a) Derive the equation for N_A in steady state molecular diffusion of A through non-diffusing B for gases and liquids. **10**
b) A tube of small diameter was filled with acetone having density 790 kg /m^3 up to 1.1 x 10^{-2} m from top and maintained at temperature of 20 °C in gentle current of air. After 5 hours, the level of liquid falls to 2.05 x 10^{-2} m from top. Calculate diffusivity of acetone in air if barometric pressure was750 mm of Hg. Vapor pressure of acetone at 20 °C is 180 mm of Hg. **10**

3. a) Explain surface renewal theory for mass transfer. **05**
b) For mass transfer to a confined fluid, explain the concept of local mass transfer coefficient. **05**
c) A large volume of pure gas B at 2 atm. is flowing over a surface from which pure A is vaporizing. The liquid A completely wets the surface, which is a blotting paper. Hence partial pressure of A at the surface is vapor pressure of A at 298 K, which is 0.2 atm. The K_y'' has been estimated to be 6.75 x 10^{-5} Kmole/m^2s(mole fraction). Calculate: N_A, K_y and K_G.
[K_y'' is mass transfer coefficient for equimolar counter diffusion, K_y and K_G are mass transfer coefficients for diffusion through stagnant non diffusing B] **10**

(TURN OVER)

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4. a) Explain steady state countercurrent process with suitable diagrams with respect to material balance and operative curve. **05**

b) Explain the concept of Eddy diffusion. **05**

c) 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^{2}h and $K_y = 8$ kmole/m^2 h. Find: **10**

i. Overall mass transfer coefficient K_x''

ii. Determine interfacial compositions x_{Ai} and y_{Ai}

iii. Calculate molar flux N_A.

5. a) Draw a curve showing solid moisture content exposed to a gas of relative humidity A. Also show bound, equilibrium, free and unbound moisture. Define these terms. **10**

b) It is desired to dry a certain material of fiber board in sheets of 0.131 m x 0.162 m x 0.071 m from 58% to 5% moisture content (wet basis). Initial rate of drying at constant rate period was 8.9 kg/m^{2}h. 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**

6. a) Explain through circulation dryers. **05**

b) Differentiate for diffusion through porous solid, Fickian, Knudsen and Transient diffusion. **05**

c) Draw and explain typical equilibrium distribution curve of a solute between gas and liquid phase at constant temperature. **05**

d) Write comparison between packed column and tray towers. **05**

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