Code No: 07A50805 **R07** **Set No. 2**

III B.Tech I Semester Examinations,May 2011
MASS TRANSFER OPERATIONS-I
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Explain the following terms in drying
   (a) Critical moisture content
   (b) Constant rate period
   (c) Falling rate period
   (d) Classification of driers. [4+4+4+4]
2. Explain the laws available to measure equilibrium data theoretically. [16]
3. Explain with neat sketch
   (a) Spray towers
   (b) Wetted wall towers in detail. [8+8]
4. Differentiate conventional mass transfer operations and membrane operations. [16]
5. Derive the relation between wet bulb and dry bulb temperature. [16]
6. Explain the procedure to calculate flux for mass transfer between a
   (a) phase boundary and a large quantity of unconfined fluid
   (b) phase boundary and quantity of confined fluid. [8+8]
7. A air NH_3mixture containing 8 mol % NH_3 is being scrubbed with water in a counter current packed tower to remove 90% NH_3. The tower is packed with 25mm Raschig rings and its temperature and pressure are 25^0c and 1 atm. The tower operates at 1.5 times the minimum liquid rate. Estimate the number of transfer units required and hence the packed height of the tower. Y_e=0.987X (Ye and X are expressed in mole ratios) K_Ga=65 kg-mole/hr m^3atm. [16]
8. (a) The effective diffusivities for passage of H_2 and N_2 at 20^0C through a 2mm thick piece of unglazed porcelain were measured by determining the counter current diffusion fluxes at 1 and 0.01 std atm pressure. The diffusivities are $D_{H2-N2,eff} = 5.3 \times 10^{-6}$ m^2/sec and $D_{K,H2,eff} = 1.17\times 10^{-5}$ m^2/sec at 1std atm. Estimate the equivalent pore diameter of the soild and the diffusion fluxes for O_2-N_2 mixtures at a total pressure of 0.1 std atm, 20^0C with mole fractions of O_2 is 0.8 and 0.2 on either side of the porcelain.
   (b) Explain the diffusion in crystalline solids [8 +8]

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Code No: 07A50805 **R07** **Set No. 4**

III B.Tech I Semester Examinations,May 2011
MASS TRANSFER OPERATIONS-I
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Explain the following
   (a) Shells and trays
   (b) Tray spacing
   (c) Tower diameter
   (d) weirs. [4+4+4+4]
2. Explain surface renewal theory and penetration theory in detail. [16]
3. Explain the mechanisms of batch drying.
   (a) Define drying and give some examples. Explain its equilibrium.
   (b) Explain cross circulation drying. [8+8]
4. An absorption column is to be designed for reducing the concentration of a toxic vapour in an air emission from 1% to 0.03 Kgmole%. The column will operate at 20^0C and 0.7×10^5 Pa gauge pressure. The scrubbing liquor flow rate is 1.3 times the minimum. The gas-liquid equilibrium relation (p=Hx) is linear and the Henrys law constant is 10^6 Pa . How many trays are required to achieve this separation if the overall tray efficiency is 50%. [16]
5. (a) Write the equation for Calculating diffusivity of gases and explain each term.
   (b) Calculate the diffusivity of H_2-CH_4 at
      i. 25^0C and 300KN/m^2
      ii. 30^0C and 200KN/m^2 if its diffusivity is 6.25×10^{-5} m^2/sec at 0^0C and 1atm
      iii. Define mean free path and rate of diffusion. [6+6+4]
6. (a) How can we generate equilibrium curve for a two phase system?
   (b) Explain the effect of surfactants, heat of solution on the concentrations at the interface. [8+8]
7. (a) Why the diffusion in the solids is unsteady state and explain the equations for various solids?
   (b) Compare diffusion in crystalline solids and polymers [8+8]

8. 6.5kg/s of water are to be cooled from 25^0C to 15^0C air with a wet bulb temperature of 100^0C is to be used at 50% more than the minimum rate. Calculate the height of tower required. The equilibrium data of water temperature, tl in 0c and enthalpy of air saturated at the temperature $t_1(^0C)$ h* kJ/kg are given as follows : [16]

t_1	10	15	17	19	21	23	25
h*	29	41.5	47.9	54.3	61	68	75.5

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Code No: 07A50805 **R07** **Set No. 1**

III B.Tech I Semester Examinations,May 2011
MASS TRANSFER OPERATIONS-I
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain
   i. Dew point
   ii. Humid heat
   iii. percentage saturation
   iv. Realtive saturation.
   (b) Explain the concept of adiabatic saturation curves and wet bulb temperature [8+8]

2. (a) The solubility of A in water is 0.5 kmol/m^3 at a partial pressure of 60 mm Hg. If the total pressure is 1.2 atm and the Henry's law is applicable, calculate the Henry's law constant.
   (b) What are parameters which will effect the equilibrium diagram?
   (c) What is Marangoni effect? [6+6+4]

3. (a) Explain the procedure for calculating no of plates by using Kremser equations.
   (b) Explain the desirable properties that a solvent should have for absorption. [10+6]

4. (a) Write short notes on necessity of drying operations in chemical process industry.
   (b) Explain the types of moisture with the help of graph, drawn between moisture content and relative humidity of gas. [8+8]

5. (a) Explain any four mass transfer operations with their definations and examples.
   (b) Explain different membrane techniques with examples. [8+8]

6. (a) What are the chief characteristics of the tower packings?
   (b) Write about liquid hold-up in packed bed.
   (c) Write about Flooding operation in packed town. [8+4+4]

7. (a) Write the equation for Flux for mass transfer from a gas into a falling liquid film with the assumptions involved
   (b) Estimate the rate of absorption of CO_2 into a water film flowing down a vertical wall 2m long at the rate of 0.05kg/sec per meter of width at 25^0C. The gas is pure CO_2 at 1std atm. The water is essentially CO_2 free initially. The solubility of CO_2 in water at 25^0C, 1 std atm is $C_{A,I}$ =0.0336kmol/m^3sol. $D_{AB} = 1.96 \times 10^{-9}$ m^2/sec. solution density is 998kg/m^3. $\mu = 8.94 \times 10^{-4}$ kg/msec. [8+8]

8. (a) Explain diffusion in porous solids in detail.

   (b) Calculate the rate of difusion of CO_2 through a membrane of vulcanized rubber 2mm thick at 25^0C if the p.p of CO_2 is 3cm Hg on one side and zero on the other. Calculate the permeability of the membrane for CO_2 . At 25^0C the solubility coefficient is 0.9ccgas(STP)/ccatm. The diffusivity is 1.1×10^{-10} m^2/sec. [8+8]

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Code No: 07A50805 **R07** **Set No. 3**

III B.Tech I Semester Examinations,May 2011
MASS TRANSFER OPERATIONS-I
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What do you mean by "Gas phase controlled" mass transfer
   (b) Discuss about equilibrium when a substance is distributed between two insol uble phases. [8+8]
2. (a) Explain the phenomenon of molecular diffusion
   (b) Explain absorption and adsorption with examples in detail. [8+8]
3. (a) Explain hydrodynamic flow of gases
   (b) Write the governing equations for momentum, heat and mass transfer
   (c) Explain the significance of N_{Sc} and N_{Pr} [6+6+4]
4. A packed tower is to be designed for the absorption of 98% of the ammonia (A) from an air- ammonia mixture containing 4% ammonia at a rate of 4000Nm^3 (normal cubic meter) per hour using water as the solvent. The tower operates at 105.1Kpa and 303K. The equilibrium data is

P.P of NH_3 (KPa)	2.573	3.968	5.3453	6.8	10.6	14.66
Kg NH_3 per 100kg water	2	3	4	5	7.5	10

   (a) Calculate and plot the equilibrium data as x_A vs p_A , x_A vs y_A and X_A vs Y_A .
   (b) Calculate the minimum liquid rate for the absorption(the inlet water is NH_3 free) of benzene at 25^0C, 12,500Pa. Assume Raoult's law is valid. [8+8]
5. (a) How will we calculate the enthalpy of humid air
   (b) Explain the Importance of wet bulb and dry bulb temperature. [8+8]
6. Explain
   (a) Flooding and loading
   (b) Liquid distributors.
   (c) Write short notes on volumetric mass transfer coefficients with their relative merits and dimerits. [6+4+6]
7. (a) Expain penetration theory in detail

(b) In an experimental agitated contactor pure CO_2 is being absorbed in water at 25^0C and 2 atm pressure. Water is pumped into the contactor at a rate of 1 lit/min and the carbonated water leaves the vessel continuously so that a constant volume is maintained in the contactor. The outlet water contains 2.3g CO_2 /lit. the specific interfacial area of G-L contact is 80 m^2/m^3 of the G-L dispersion. The volume of the G-L dispersion is 8 litre. The liquid phase can be assumed to be well mixed. The solubility of CO_2 in water is 1640atm/mol fraction and its diffusivity in water is 1.92×10^{-9} m^2/sec. calculate the contact time if penetration theory is applicable.

[8+8]

8. A porous solid is dried in a batch dryer under constant drying conditions. Six hours are required to reduce the moisture content from 3% to 10%. The critical moisture content was found to be 16% and equilibrium moisture 2%. All moisture contents are on the dry basis. Assuming that the rate of drying during the falling rate period is proportional to the free moisture content, how long will it take to dry a sample of the same solid from 35% to 6% under the same drying conditions? [16]

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