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

III B.Tech I Semester Examinations,November 2010
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 with neat sketch
   (a) Venturi scrubbers
   (b) Agitated tanks. [8+8]
2. 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]
3. (a) Explain briefly the procedure for estimation of packed tower height for absorption.
   (b) What is HETP and in what way this helps in design of a packed column. [8+8]
4. (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]
5. (a) Why the interfacial concentrations are not used to calculate mass transfer rate?
   (b) Prove $I/K_x = 1/K_x$ with the assumptions involved
   (c) Define Henry's law. [6+6+4]
6. Derive the relation between wet bulb and dry bulb temperature. [16]
7. (a) Explain surface streched theory in detail
   (b) A mixture of 50% CO_2 and 50% N_2 is bubbling through water in a laboratory column at 30^0C and 1 atm. The depth of water in the column is 30cm. A single nozzle gas distributor is used. The gas flow rate is 15cc/min and the bubbles are of 1cm dia on the average. The bubble rise velocity is 20cm/sec. calculate the rate of absorption CO_2 in water is 2.19×10^{-5} m^2/sec. Henrys law can be used to calculate the solubility of CO_2 in water at the given temperature, p = 1860 x* (p:Partial pressure of CO_2) [8+8]

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 1 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**

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MASS TRANSFER OPERATIONS-I
Chemical Engineering

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

Answer any FIVE Questions
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1. (a) Write about stage wise operation
   (b) Write about continuous operation
   (c) Advantages and disadvantage of direct operations with examples. [4+6+6]
2. Explain different types of trays used with their advantages and drawbacks [16]
3. (a) Write short note on "Two-resistance theory".
   (b) Write the basic concept of equilibrium between two phases. [10+6]
4. (a) Explain Boundary layer theory in detail.
   (b) Write the assumptions involved for obtaining expression for mass transfer coefficient for gas transfer through falling liquid film. [10+6]
5. (a) A wet cake with a weight of 5 kg originally contains 50% moisture content on wet basis. The slab is 0.6m×1m×7.5cm thick. The equilibrium moisture content is 5%. When in contact with air of 400^0C and 20% humidity, the drying rate is given in the table below. For contact with air of the above quality and same velocity, how long will it take to dry the slab to 15% moisture content on wet basis? Drying is from one face.

Wet slab weight, kg:	5	4	3.6	3.5	3.4	3.06	2.85
Drying rate, kg/m^2hr:	5	5	4.5	4.0	3.5	2.0	1.04

   (b) Write short note on applications drying operation. [10+6]
6. (a) Explain diffusion through polymers
   (b) Calculate the rate of difusion of CO_2 through a membrane of vulcanized rubber 2mm thick at 25^0C if the partial pressure of CO_2 is 3 cm 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 0.9cc gas(STP)/cc atm. The diffusivity is 1.1×10^{-10} m^2/sec. [8+8]
7. (a) A coal gas is freed of its light oil content (benzene) by absorption into an absorbent oil. The inlet gas contains 2% benzene by volume and 95% removal is required. Inlet gas flow rate=0.25cu.m/s; Pressure =1.07×10^5N/sq.m; Temperature = 26^0C; Oil inlet flow rate (Ls) =1.787×10^{-3} k mol/s; Solute content of inlet oil=0.005 mole fraction benzene; Average molecular weight of oil = 260. Equilibrium data y = 0.125× (mole fraction units). Determine the N to G.

(b) What is absorption factor? How is this related to stripping factor? [12+4]

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, t_1 in ^{0}C 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,November 2010
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) Describe the humidity chart and write its uses
   (b) Importance of relative and percentage saturations. [8+8]
2. (a) Explain diffusion through Crystalline solids
   (b) Explain diffusion through polymers [8+8]
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) Discuss the parameters which characterize turbulent flow in detail.
   (b) obtain relation between F & K_G, F & K_y, F & K_g [10+6]
5. (a) A batch of solids is dried from 28% to 6% moisture, wet basis. The initial weight of the solid is 380 kg and drying surface is 0.15 m^2/40 kg dry weight. The critical moisture content is 28% dry basis and the constant drying rate is 0.32 kg/hr m^2. For the falling rate period, the following data are available:

Moisture content(% dry basis):	25	21.9	19	16	13.6	11	8.2	7.5	6.4
Rate of drying: (kg/hr m^2)	0.3	0.27	0.24	0.21	0.18	0.15	0.07	0.044	0.02

   (b) Define moisture content on wet and dry basis [12+4]
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) In a countercurrent column the concentrations of the solute at a section are x = 0.05 (liquid) and y = 0.17(gas). The individual coefficients are $k_y = 2.9 \times 10^{-4}$ and $k_x = 2.9 \times 10^{-4}$ and the equilibrium relation can be approximated by the function: $y* = 2.5x + 8x^2$, $0 \leq x \leq 0.2$. What is the direction of mass transfer (G to L or reverse)? Calculate the overall coefficients K_x and K_y. What fraction of mass transfer resistance occurs in the liquid phase.
   (b) Explain steady state cocurrent process. [8+8]

8. (a) Explain the procedure to calculate the diffusivity for mixtures of non polar gases or of a polar with a non polar gas.

   (b) Estimate the diffusivity of ethanol vapor, C_2H_5OH (A) through air (B) at 1 std atm pressure, 0^0C. Data: $\frac{E_B}{K}$= 78.6 Kelvin, r_B = 0.3711nm, $T_{b,A}$ = 351.4K and molar values of C, H&O are 0.0148, 0.0037 and 0.0074 m^3/katoms respectively.
   The functional data is given by

$kT/\in_{AB}$	$f(kT/\in_{AB})$
1	0.72
1.5	0. 6
1.8	0.56
2.0	0.54

[6+10]

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

III B.Tech I Semester Examinations,November 2010
MASS TRANSFER OPERATIONS-I
Chemical Engineering

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

Answer any FIVE Questions
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1. (a) What is "Interfacial turbulence"?
   (b) Explain the steady-state counter current process with help of material balance equations. [6+10]
2. Explain
   (a) Dumping
   (b) weeping
   (c) Flooding
   (d) coning [4+4+4+4]
3. (a) Explain the procedure for calculating the minimum liquid ratio. What will happen if the tower is operated at this flow rate
   (b) Define absorption. Give its industrial applications. [8+8]
4. (a) Explain Momentum, mass and thermal eddy diffusivities in detail.
   (b) Explain film theory in detail
   (c) Differentiate between F & K. [6+6+4]
5. (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]
6. (a) Explain any four mass transfer operations with their definitions and examples.
   (b) Explain different membrane techniques with examples. [8+8]
7. (a) A porous carbon diaphragam 1 inch (25.4mm) thick of average pore diameter 0.01cm permitted the flow of nitrogen at the rate of $0.0457 m^3$(measured at 1 std atm, 26.7^0C)/m^2.sec with a pressure difference across the diaphragm of 50.8mm H_2O. The down stream pressure is 0.1 std atm. Calculate the flow to be expected at 121^0C with the same pressure difference.
   (b) Draw the concentration profiles for diffusion from a slab with sealed edges and also Explain it. [10+6]

8. A plant requires 2000kg/min of cooling water to flow through its distillation equipment condensers, thereby removing the heat from the condensers, the water will leave the condensers at 50^0C. It is planned to design a counter current cooling tower in order to cool this water to 30^0C from 50^0 C for re use, by contact with air. Air is available at 30^0C dry bulb temperature and 24^0C wet bulb temperature. 30% excess air will be used and the make up water will enter at 15^0C. For the packing to be used the value of the mass transfer coefficient is expected to be 2500kg/hr m^3 molefraction, provided the minimum liquid rate and gas rates are 12000 and10000kg/hr m^2 respectively. Determine the height and the diameter of the cooling tower. [16]

DATA:

$t^0{}_1$C	25	30	35	40	45	50	55
H [kcal/ kg dry air]	19.1	23.9	31.8	40.4	51.3	53.1	82.3

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