

7. (a) Explain wet bulb temperature. 6
(b) Discuss different types of commercially important adsorbents and their characteristics with applications. 10
8. Write notes on :
(i) Two film theory
(ii) Conical vacuum dryer. 16

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Faculty of Engineering & Technology
Fifth Semester B.Tech. (Chemical Engg.) (C.B.S.)
Examination
MASS TRANSFER
Paper—III

Time : Three Hours] [Maximum Marks : 80

INSTRUCTIONS TO CANDIDATES

- (1) All questions carry marks as indicated.
(2) Answer any **FIVE** questions.
(3) Assume suitable data wherever necessary.
1. (a) Calculate the rate of diffusion of acetic acid
(A) across a film of non-diffusing water
(B) solution 1 mm thick at 17°C when the concentrations on opposite sides of the film are, respectively, 9 and 3 wt % acid. The diffusivity of acetic acid in the solution is $0.95 \times 10^{-9} \text{ m}^2/\text{s}$. Data

$$\rho_{\text{at 3 wt\%}} = 1003.2 \text{ kg/m}^3$$

$$\rho_{\text{at 9 wt\%}} = 1012 \text{ kg/m}^3 \quad 8$$

- (c) What is gas phase controlled rate of mass transfer ? 4
3. (a) Air at a temp. of 20°C and a pressure of 750 mmHg has a relative humidity of 80 percent, calculate :
- The molal humidity of air.
 - The molal humidity of air if its temp is reduced to 10°C and its press increased to 3.4 atm, condensing out some of the water.
 - The weight of water condensed from 1000 ft³ (28.6 m³) of the original wet air in cooling and compressing to condition of part (ii).
 - The final volume of air in part (iii).
- Data : V.P. of water at 20°C and 10°C are 17.5 and 9.2 mmHg. 8
- (b) Write notes on :
- Forced draft towers
 - Induced draft towers. 8

4. (a) 1400 kg (bone dry) of granular solid is to be dried under constant drying conditions from a moisture content of 0.2 kg/kg dry solid to a final moisture content 0.02 kg/kg dry solid. The material has an effective area of 0.0615 m²/kg. Under the same conditions the following rates were previously known. Calculate the time required for drying.

Moisture content kg/kg dry solid	Rate (kg/hr.m ²)
0.3	1.71
0.2	1.71
0.14	1.71
0.096	1.46
0.056	1.29
0.042	0.88
0.026	0.54
0.016	0.376

8

- (b) Discuss different theories of movement of moisture within the solid. 8

(b) Ammonia from an air-ammonia stream containing 5% ammonia by volume is absorbed by sulfuric acid in a counter current wetted wall column 15 mm is 800 mm long. The inlet gas rate is 0.15 kg moles/hr and exit gas contains 0.5% NH_3 by volume. The average temp. is 20°C and the pressure is normal. The change in acid concentration may be neglected.

- (i) Calculate the value of absorption coefficient kg
- (ii) If the value of heat transfer coeff. is 50 kcal/(hr.m 2 °C)

Estimate K_G by equating J_D and J_H .

Data for air :

$$C_p \mu/k = 0.174$$

$$C_p = 0.24 \text{ for } \text{NH}_3\text{-air}$$

$$\text{SC} = 0.61$$

$$P_{\text{BM}} = 1. \quad 8$$

2. (a) Write note on surface-renewal theory. 6

(b) Estimate the diffusivity of mannitol, $\text{C}_6\text{H}_{14}\text{O}_6$ [$\text{CH}_2\text{OH}(\text{CHOH})_4\text{CH}_2\text{OH}$] in dilute solution in water at 20°C and 70°C .

For C, $v = 0.0148$

$$\text{H}, v = 0.0037$$

$$\text{O}, v = 0.0074$$

$$\psi = 2.26$$

$$\mu_{\text{at } 20^\circ\text{C}} = 0.001005 \text{ kg/m.s}$$

$$\mu_{\text{at } 70^\circ\text{C}} = 0.4061 \times 10^{-3} \text{ kg/m.s.} \quad 6$$

5. (a) Write note on polymeric ion-exchange resins. 8

(b) Discuss Langmuir and Freundlich adsorption isotherm. 8

6. (a) Discuss the important nucleation mechanisms. 8

(b) One litre suspension from an MSMPR crystallizer containing 161.07 g yielded the following results on sieve analysis. Determine the crystal size distribution function and the nucleation rate :

Tyler Mesh	Mass
12/14	4.44
14/16	8.41
16/20	16.65
20/24	16.28
24/28	24.32
28/32	27.24
32/35	22.5
35/48	23.13
48/65	11.9
65/100	5.15
<100	1.05

Given : Solid density, $\rho_c = 2163 \text{ kg/m}^3$

Shape factor $\phi_v = 2.0$

Residence time $\tau = 0.9 \text{ h.} \quad 8$