

III B.Tech I Semester Supplementary Examinations, November 2006
MASS TRANSFER OPERATIONS-I
(Chemical Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. Larson using an Arnold cell measured the diffusivity of chloroform in air at 25 ° C and 760 mm Hg. The liquid density of chloroform at 25 ° C is 1485 kg/m³ and its vapor pressure at 25 ° C is 200 mm Hg. At time t=0, the liquid chloroform surface was 74 cm from top of the tube and after 10 hours the liquid surface had dropped by 0.44 cm. If the concentration of chloroform is zero at the top of the tube, what would be the gas diffusion coefficient of chloroform in air.

[16]
2. What are the theories available to explain the mass transfer in turbulent flow? Explain any two of them in detail.

[16]
3. (a) State the various characteristics of tower packings.

[10]

 (b) What are the two major types of packings? Explain each with neat diagram.

[6]
4. It is desired to absorb 95% of acetone in a 2 mole % mixture of acetone in air in a counter current bubble-cap tower using 20% more than the minimum water rate. Pure water is used in the top of the column. Find the number of equilibrium stages required for this separation, :

$$Y_A = 2.53X_A$$

Terminal compositions: Top	Bottom
$x_2 = 0$	$x_1 = 0.00658$
$y_2 = 0.00102$	$y_1 = 0.02$

[16]
5. Using the humidity chart find the following.

[4+8+4=16]

 - (a) Molal humidity of air whose dry bulb and wet bulb temperatures are 53°C and 30°C respectively.
 - (b) Air at 60% humidity and 40°C dry bulb is preheated to 60°C and adiabatically saturated. Find the saturation temperature and humidity.
 - (c) Find the humid volume and humid heat of air at 40°C dry bulb and 60% humidity.
6. It is required to maintain the Relative Humidity of the air in an auditorium at 75%. For this the fresh air at 40°C Dry Bulb and 24°C Wet Bulb is first saturated to 90% Relative Humidity and then heated indirectly (using steam at 2 bar absolute) to 75% Relative Humidity. Compute

- (a) The moisture added to the air during the above operation [8]
- (b) The dry bulb and wet bulb temperatures of the final air [8]
7. A wet material with initial moisture content of 30% is dried in a batch drier using hot air. It is found that 5 hr are required to bring down the moisture content to 10%. The critical moisture content and the equilibrium moisture content of the solid are 15% and 2% respectively. Estimate the time to dry the same material to final moisture content of 5%. State the assumptions made for the calculation of the time of drying during falling rate period. [16]
8. Air containing 0.005 kg of water vapor per kg of dry air is heated to 52°C in a dryer and passed to the lower shelves. It leaves the shelves at 60% RH and is reheated to 52°C and passed over another set of shelves, again leaving at 60% RH. This is again repeated for 3rd and 4th set of shelves after which the air leaves the dryer. On the assumption that the material on each shelf has reached the wet bulb temperature and the heat losses from the dryer can be neglected. Determine the temperature of the material on each tray, amount of water removed in kg/h if 10000 m³/min of moist air leaves the dryer. The temperature to which the inlet air has to be raised to carry out the drying in a single stage. [16]
