2005 JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

III B.TECH I SEMESTER SUPPLEMENTARY EXAMINATIONS
MASS TRANSFER OPERATIONS - I
(CHEMICAL ENGINEERING)

NOVEMBER 2005

TIME – 3 HOUR
MARK – 80

Answer any FIVE Questions
All Questions carry equal marks

1. A layer of water 2 mm thick is maintained at a constant temperature of 20oC in contact with dry air at 30oC and 1.01325×105 N/m2 pressure. Assuming evaporation to take place by molecular diffusion through a gas film 5 mm thick, calculate the time for water to evaporate completely. The diffusivity for water vapor in air at 30oC may be taken as $0.26 \times 10-4$ m2/s. The vapor pressure of water at 20oC is 2.33714×103 N/m2. [16]

2. Discuss about

(a) Diffusion through crystalline solids.

(b) Diffusion in porous solids . [8+8]

3. Discuss:

(a) Counter current flow of liquid and gas through packings.

(b) Pressure drop for single - phase and two phase flow.

(c) Flooding and Loading. [4+8+4]

4. An ammonia-air mixture containing 2% ammonia at 25oC and 1 atm is to be scrubbed with water in a tower packed with 2.54 cm stoneware Raschig rings. The water and gas rate will be 1200kg/hrm2 each. Water and gas are fed at the top and bottom respectively. Assume that the tower operates isothermally at 25oC. At this temperature, the partial pressure of ammonia (pg) over aqueous solution of ammonia are as follows: pg, mm of Hg Concn. C, 12.0 18.2 31.7 50.0 69.5 166.0 kg NH3/100kg water 2.0 3.0 5.0 7.5 10.0 20.0 For the above packing, kGa = 62.39 kg mol/ hr m3 atm. Using the logarithmic mean driving force, estimate the required height for the absorption of 98% of the ammonia in the entering gas. [16]

5. Write short notes on:

(a) Use of humidity chart [4]

(b) Determination of humidity [4]

(c) Factors influencing the wet bulb temperature [4]

(d) Humidification equipment. [4]

6. Water is to be cooled in a packed tower from 330 to 295K by means of air flowing counter currently. The liquid flows at a rate of 275cm3/m2 s and the air at 0.7m3/m2s. The entering air has a temperature of 295K and a humidity of 20%. Calculate the required height of tower and the condition of the air leaving at the top. The whole resistance to heat and mass transfer coefficient and the transfer surface area per unit volume of column (KGa) can be taken as 0.2s-1. [16]

7. (a) The following experimental data were obtained in the laboratory. Total drying time is 7 hours. Initial moisture content is 80% by weight (WB). Final moisture content is 10% by weight (WB). Calculate time required to dry to a moisture content of 5% (WB) when the equilibrium moisture is zero and the critical moisture is 15% of initial moisture content.

(b) Discuss the effect of the following on the rate of the drying velocity of air, Temperature of air, humidity of air.   [12+4]

8. Write short notes on concept of:

(a) HTU and NTU in rotary drier,

(b) fluidized bed drying,

(c) spray drying and its applications,

(d) freeze drying technique.   [4×4]