Code No: OR310853 **OR**

III B.Tech I Semester Supplementary Examinations, May 2005
MASS TRANSFER OPERATIONS-I
(Chemical Engineering)

Time: 3 hours **Max Marks: 70**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) An O_2-N_2 mixture at 5 atm and 25^oC, the concentration of O_2 at two places 0.2 cm apart are 20 and 30 volume % respectively. Calculate the rate of diffusion of oxygen in gm/m^2.hr for the case of unicomponent diffusion. The diffusivity of O_2 in N_2 is 1.81×10^{-5} m^2/s.
   (b) Derive the expression for steady state diffusion of gas A through non-diffusing gas B.

2. Prove or show the following relationships starting with the flux equations.
   (a) Convert k_c' to $k_y$and $k_{G.}$
   (b) Convert k_L to $k_x$and k_x'
   (c) Convert k_G to $k_y$and $k_{c.}$

3. Sulfur dioxide is to be removed from a gas with the characteristics of air by scrubbing with an aqueous ammonium salt solution in a tower packed with 25-mm ceramic Intalox saddles. The gas, entering at the rate 0.80 m^3/s at 30^oC, 1 bar, contains 7.0% SO_2, which is to be nearly completely removed. The washing solution will enter at the rate 3.8 kg/s and has a density 1235 kg/m^3, viscosity 2.5 x 10^{-3} kg/m.s.
   (a) Choose a suitable tower diameter.
   (b) If the irrigated packed height is 8.0 cm, and if 1 m of 25-mm ceramic Intalox saddles is used above the liquid inlet as an entertainment separator, estimate the power requirement to overcome the gas-pressure drop. The overall efficiency of fan and motor is 60%.

4. (a) Write about the desirable properties of a solvent to be selected for absorption.
   (b) Write about Murphree efficiency and overall tray efficiency with respect to an absorber design.

5. Explain the usefulness of humidity charts. Give the expressions for various lines.

6. Air containing 0.005Kg water vapor per Kg of dry air is heated to 325K in a dryer and passed to the lower shelves. It leaves these shelves at 60 percent humidity and is reheated to 325K and passed over another set of shelves, again leaving at 60 percent humidity. This is again repeated for the third and fourth sets of shelves, after which the air leaves the dryer. In the assumption that the material on each shelf has reached the wet-bulb temperature and that heat losses from the dryer may be neglected, determine:

(a) The temperature of the material on each tray.

(b) The amount of water removed in Kg1Sec, it $5m^3$/sec moist air leaves the dryer.

(c) The temperature to which the inlet air would have to be raised to carryout the drying in a single stage.

7. It is desired to dry sheet material from 55% to 4% moisture content. The sheets are 125 × 140 × 5 cm. The drying rate period during the constant rate period is 1.5 gm/hr.cm^2. The critical moisture content is 26% and the equilibrium moisture content is negligible. If the material is dried from both sides and has a bone dry density of 4000 kg/m^3, calculate the time required for drying assuming the falling rate period to be linear.

8. A counter current hot air rotary dryer is to be employed to dry ammonium nitrate from 5% to 0.2% moisture on wet basis. Air enters the dryer at 132 $^\circ$C with a humidity of 0.007 kg water per kg of dry air and is expected to be discharged at 82 $^\circ$C. The nitrate enters at 21 $^\circ$C and is expected to be discharged at 66 $^\circ$C. Product will be delivered at a rate of 6000 kg/hr. Calculate the mass of dry air passing through the dryer and humidity of air leaving the dryer. The heat capacity of $(NH_4)NO_3$ is 1.8828 kJ/kg.K. The heat capacity of water is 4187 J/kg.K. C_p of water vapor is 2.009 kJ/kg.K. C_p of dry air is 1.004 kJ/kg.K. Latent heat of vaporization of water at 0 $^\circ$C may be taken as 2512 kJ/kg. Neglect radiation loss.

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