DEPARTMENT OF CHEMICAL ENGINEERING

MAJOR EXAMINATION. CLL 252. MASS TRANSFER I

Max. Time: 2 hrs Max. Marks: 40

Q.1. Explain the complete design for gas absorption, in a packed tower, from a concentrated vapor. (20 marks)

Q.2. Explain the surface renewal theory of mass transfer stating all the assumptions and deriving all the equations involved. (10 marks)

Q.3. Water flows through a thin tube, the walls of which are lightly coated with benzoic acid. Benzoic acid is dissolved very rapidly, and so is saturated at the pipe's wall. Water flows slowly, at room temperature and with an average velocity of 0.1 cm/sec. The pipe is 1 cm in diameter. Under these conditions, the mass transfer coefficient varies along the pipe according to the following correlation:

$$\frac{kx}{D} = 0.3 \left(\frac{xv\rho}{\mu}\right)^{\frac{1}{2}} \left(\frac{\mu}{\rho D}\right)^{1/3}$$

, where x = distance along the pipe, cm, v = average velocity in the pipe, cm/sec, D = diffusivity in water, 10^{-5} cm^2/sec, and k = mass transfer coefficient, cm/sec. (10 marks)

Department of Chemical Engineering

Minor II Examination: CLL 252. Mass Transfer I

Max. Time: 1 Hr | Max. Marks: 20

Q.1. Chlorine is being absorbed from a gas in a small experimental vertical wetted wall tower, of inside radius of 1.4 cm and height of 13 cm. The absorbing fluid is water flowing down, which is moving with an average velocity of 17.7 m/s. Gas containing chlorine moves upwards through the core. What is the absorption rate in g mol/hr if $DCl_2\text{-}H_2O = 1.26 \times 10^{-5}$ cm^2/s in the liquid phase and if the saturation concentration of chlorine in water is 0.823 g Cl_2 per 100 g of water at 16°C. Ignore the chemical reaction between chlorine and water. (10 marks)

Q.2. In an experimental wetted-wall column, pure carbon dioxide is absorbed in water. The mass transfer rate is calculated using the penetration theory, application of which is limited by the fact that the concentration should not reach more than 1 per cent of the saturation value at a depth below the surface at which the velocity is 95% of the surface velocity. What is the maximum length of column to which the theory can be applied if the flow rate of water is 3 cc/s.cm of perimeter? Viscosity of water = 0.001 Ns/m^2; Diffusivity of CO_2 in water $= 1.5 \times 10^{-9}$ m^2/s. (10 marks)