NATIONAL INSTITUTE OF TECHNOLOGY, CALICUT

Department of Chemical Engineering

CH 3002 – Mass Transfer I

Test II Examination (Monsoon Semester 2014)

Qn No | *Answer all questions* | *Max marks: 20*

1. Prove that $k_c = RTk_G$ for diffusion of A through non diffusing B. (2)

2. State and explain penetration theory and prove that $k_{L,av} = 2\sqrt{\frac{D_{AB}}{\pi t_c}}$. (3)

3. Air bubbles of 0.005 m diameter rise through a stagnant pool of 'oxygen-free' water at 30°C. The steady velocity of rise is 0.1 m/s. If the diffusivity of O_2 in water at 25°C is 2.1×10^{-9} m^2/s. Calculate the liquid side coefficient and the rate of mass transfer from a single gas bubble. The solubility of O_2 in water at 30°C can be calculated by using Henry's law coefficient as 4.75×10^4 atm/mol fraction (take partial pressure of O_2, p_{O2} approximately as 2 atm). The viscosities of water are 0.911cP and 0.817 cP at 25°C and 30°C respectively. (4)

4. The mass flux from a 5 cm diameter naphthalene ball placed in stagnant air at 40°C and atmospheric pressure, is 1.47×10^{-3}mol/m^2. sec. Assume the vapor pressure of naphthalene to be 0.15 atm at 40°C and negligible bulk concentration of naphthalene in air. If air starts blowing across the surface of naphthalene ball at 3 m/s by what factor will the mass transfer rate increase, all other conditions remaining the same? (4)

   For spheres :

   $Sh = 2.0 + 0.6\,(Re)^{0.5}\,(Sc)^{0.33}$

   Where Sh is the Sherwood number and Sc is the Schmids number. The viscosity and density of air are 1.8×10^{-5} kg/m.s and 1.123 kg/m^3, respectively and the gasconstant is 82.06 cm^3. atm/mol.K.

5. Explain and sketch the concentration profiles of the solute during mass transfer across an interface. (3)

6. In a certain equipment used for the absorption of SO_2 from air by water, at one section, the gas and liquid phase concentrations of the solute are 10 mole% and 4 mass % respectively. The solution density is 61.8 lb/ft^3. At the given temperature (40°C) and pressure (10 atm), the distribution of the SO_2 between air and water can be approximately described as $p_A = 25x_A$, where p_A is the partial pressure of SO_2 in the gas phase in atm. The individual mass transfer coefficients are $k_x = 10$ kmol/(h)(m^2)(Δx) and $k_y = 8$ kmol/(h)(m^2)(Δy). Calculate the overall coefficient, K_G and x_{Ai} and p_{Ai} at the gas-liquid interface. (4)