PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination : Semester II	Academic Year	:	2002
Date : 20 February 2003	Time	:	9.00-12.00
Subject : 230-630 Advanced Transport Phenomena I	Room	:	R300

- ข้อสอบมี 5 ข้อ ต้องทำทุกข้อ คะแนนเต็ม 80 คะแนน
- ควรใช้เวลาทำข้อสอบโดยเฉลี่ย 2 นาที/คะแนน
- อนุญาตให้นำหนังสือ เอกสาร เครื่องคำนวณ และอุปกรณ์อื่น ๆ เข้าห้องสอบได้

สุธรรม สุขมณี
ผู้ออกข้อสอบ
9 กุมภาพันธ์ 2546

1) Predict the mass diffusivity of the gas mixture with 70 mole percent of Ethylene (C_2H_4) and 30 mole percent of Ethane (C_2H_6) at 347.4 K and 29.7 atm. (15 points)

2) Consider a ternary system consists of species *A* (Molecular weight of 28, Concentration of 0.04 mole/cm^3), *B* (Molecular weight of 2, Concentration of 0.06 mole/cm^3) and *AB* (Molecular weight of 30, Concentration of 0.05 mole/cm^3) at given time and position. If the absolute velocities of *A* and *B* relative to stationary coordinates (v_A and v_B) are +6 and +8 cm/s respectively and the local molar average velocity of the gas mixture is +2.8 cm/s. Determine the following quantities :
   2.1 Local absolute velocities of the species *AB*.
   2.2 Local mass average velocity of the gas mixture.
   2.3 Molar flux of *B* relatives to stationay coordinates.
   2.4 Mass flux of *A* relatives to mass average velocity.
   2.5 Molar flux of *AB* relatives to molar average velocity.

   (10 points)

3) Derive an expression for the steady concentration distribution (C_A) and mass transfer rate (W_A) of gas *A* in the hollow porous sphere with a constant effective mass diffusivity of D_A, an inside radius of λR and an outside radius of *R*. The concentration of *A* inside and outside the sphere are $C_{A\lambda}$ and C_{AR} respectively. For the diffusion of gas *A* in porous medium at constant temperature and pressure, one may assume that the molar flux of *A* relative to stationary plane as: $N_A = -D_A (dC_A/dr)$ (20 points)

4) Dry air with an uniform temperature of 30 ^{o}C and a pressure of 1.46 atm. (ρ = 1.7 kg/m^3, μ = 0.01822 mPa.s) is flowing in a smooth circular pipe of diameter 54.1 mm with a mass flow rate of 69.7 kg/h (Reynolds number of about 25000 and the wall shear stress (τ_o) for the flowing air stream may be taken as 0.13 N/m^2). Beginning at z = 0 to z = 2000 mm, there is a diffusing device that transfer water vapor from the tube wall to an air stream with a constant molar flux (N_{A0}) of –0.018 mole/m^2–s. At the distance of 2000 mm from the start of this constant wall molar flux, the time-smoothed concentration of water vapor ($\overline{C}_A$) at the pipe center-line is 0.8 mole/m^3 and the concentration of water vapor at the pipe wall (C_{A0}) is 2 mole/m^3. The diffusivity of water vapor in air (D_{AB}) at 30 ^{o}C is 1.78×10^{-5} m^2/s. Find the time-smoothed concentration of water vapor ($\overline{C}_A$) and the turbulent diffusivity ($\overline{D}_{AB}^{(t)}$) at the distance of 13.525 mm from the pipe wall. (20 points)

   Assumption In turbulent core and low molar flux : $\overline{J}_A^{(t)} \cong N_{A0} \cong -\overline{D}_{AB}^{(t)} \dfrac{d\overline{C}_A}{dr}$

5) Consider a cylindrical rod 2 inches in diameter of Naphthalene (Molecular weight of 128.2) placed in dry air at 115 ^{o}F (Density of 0.0692 lb/ft^3 and Viscosity of 0.0469 lb/ft-h) flowing perpendicular to the axis with a velocity of 15 ft/s. The vapor pressure of solid Naphthalene is 0.565 mmHg and the diffusivity of Naphthalene in air at 115 ^{o}F is 7.5×10^{-5} ft^2/s. Determine the mass transfer coefficient and the sublimation rate of Naphthalene to air per unit length of the rod at 115 ^{o}F and 760 mmHg. (15 points)