國立臺北科技大學

九十二學年度化學工程系碩士班入學考試

化工熱力學與反應工程試題

填准考證號碼

注意事項：

1. 本試題共 6 題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. Two perfectly insulated (thermally and mechanically insulated) tanks each having a volume of 1 m^3 are connected by means of a small pipeline containing a valve. Initially, one tank contains an ideal gas at 2 bar and 290K, and the other is completely evacuated. The valve is opened, and pressures and the temperatures are allowed to equalize.
   (a) What is the final temperature and pressure in the tanks?
   (b) What is the entropy change of the gas? (16%)
2. If the partial molar volume of species 1 in a binary solution at constant T and P is given $\overline{V_1} = V_1 + \alpha x_2$, ($\alpha$ is only a function of T and P), (V_1 = molar volume of pure 1) find the corresponding equation for $\overline{V_2}$. What equation for V (total molar volume) is consistent with these equations for the partial molar volumes? (16%)

3. A liquid mixture of cyclohexanone (1) /phenol (2) for which x_1 =0.6 is in equilibrium with it's vapor at 144℃. Determine the equilibrium pressure P and vapor composition y_1 from the following information:

(a)The activity coefficient γ_1 and γ_2 can be expressed as: $\ln\gamma_1 = Bx_2^2$,

$\ln\gamma_2 = Bx_1^2$; where B is a function of temperature only.

(b)At 144℃, P_1^{sat} =75.20 kP_a and P_2^{sat} =31.66kP_a

(c)The system forms an azeotrope at 144℃ for which $x_1^{az} = y_1^{az} = 0.294$

(d)The vapor phase can be assumed to follow ideal gas behavior. (18%)

4. A gas-phase reaction A→B+C is to be conducted in a 10-L (initially) isothermal batch reactor at 25℃ at constant P. The reaction is second-order with respect to A, with rate constant k_A=0.023$Lmol^{-1}s^{-1}$, Determine the time required for 75% conversion of 5 mol A.

(Hint : $t = n_{A0}\int_0^{f_A}\frac{df_A}{(-r_A)V}$, f_A = fractional conversion of A) (18%)

5. For a CSTR of volume 6 m^3 operating with a steady-state (liquid) feed rate of 0.4m^3min^{-1}, what fraction of the exit stream

(a) is of age less than 10 min?

(b) has been in the tank longer than 30 min?

(Hint:F(θ)=F(t)= $\int_0^t E(t)dt$, F(θ)=1-$e^{-\theta}$, t=time , $\bar{t}$=mean residence time=V/q ,

q=volumetric flow rate , $\theta = t/\bar{t}$, E(t)=exit-age distribution function) (14%)

6. A liquid-phase first order reaction A→B is to be conducted in a CSTR at steady-state at 163℃. The temperature of the feed is 20℃, and 90% conversion of A is required. Determine the volume of a CSTR to produce 130kg B h^{-1}, and calcute the heat load($\dot{Q}$) for the process. Does this represent addition or removal of heat from the system?

Data:

C_p = 2.0J $g^{-1}K^{-1}$ M_A=M_B=200g mol^{-1}

ρ=0.95g cm^{-3} ΔH_{RA}=−87kJmol^{-1}

k_A=0.80h^{-1} at 163℃

(Hint: mole balance: $V = F_{A0}f_A/(-r_A)$,

energy balance: $\dot{m}C_p(T_0 - T) + \dot{Q} + (-\Delta H_{RA})(-r_A)V = 0$)(18%)