大同大學 104 學年度研究所碩士班入學考試試題

考試科目：熱力與動力　　所別：化學工程研究所(甲組)　　

註：本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

1. [15%] Translate each of the following terms into Chinese and explain it briefly:

   1.1 Equation of State.
   1.2 Isenthalpic Process.
   1.3 Isolated System

2. [20%] The following equation is reasonably good for estimating the heat of vaporization, $\Delta \underline{H}^{vap}$ (J/mol), and vapor pressure, P^{vap} (bar), over small temperature ranges:

$$\ln (P^{vap}/C) = -\Delta \underline{H}^{vap}/RT$$

where T is the temperature in Kelvin and C is a constant in bar. Given that the vapor pressure of water at 120℃ is 1.985 bar, estimate the average heat of vaporization (in J/mol) between 100℃ and 120℃, and the vapor pressure (in bar) of water at 110℃. Note that the vapor pressure of water at its boiling point is 1 atm.

3. [15%] An expression for $d\underline{S}$ is given below:

$$d\underline{S} = \frac{C_v}{T}dT + \left(\frac{\partial P}{\partial T}\right)_{\underline{V}} d\underline{V} = \frac{C_p}{T}dT - \left(\frac{\partial \underline{V}}{\partial T}\right)_P dP$$

where $\underline{S}$ is molar entropy. Derive an expression of $\Delta \underline{S}$ $[\underline{S}_2(T_2,\underline{V}_2) - \underline{S}_1(T_1,\underline{V}_1)]$ in terms of T_1, $\underline{V}_1$, T_2 and $\underline{V}_2$ for an ideal gas, and then calculate the entropy change (in J/K) for 5 moles of ideal gas subject to a state change from (300℃, 0.0500 m^3/mol) to (600℃, 0.0300 m^3/mol)? Note that R = 8.314 J/mol/K, C_v = 2.5R.

4. [20%] Derive the governing equation for the PFR on a reactor system shown in Figure (1) based on (a) the general mole balance equation and (b) the shell balance equation.

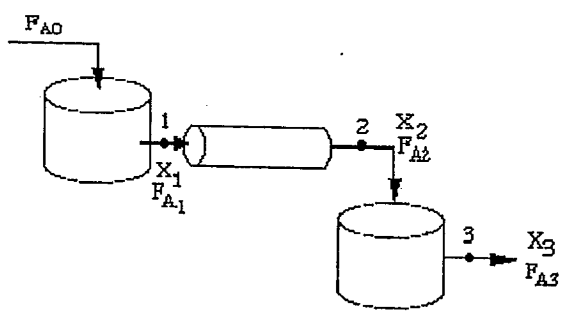

Figure (1)

5. [20%] The adiabatic exothermic irreversible gas-phase reaction $2A + B \rightarrow 2C$ is to be carried out in a flow reactor for an equimolar feed of A and B.

$$\frac{F_{A0}}{-r_A}(m^3) = 5\times10^5 - 8\times10^5 \cdot X \text{ for } 0 \le X \le 0.5;$$

$$\frac{F_{A0}}{-r_A}(m^3) = 1\times10^5 + 1\times10^6 \cdot (X - 0.5) \text{ for } 0.5 \le X \le 0.9.$$

What PFR volume is necessary to achieve 70% conversion?
If there is a CSTR ($9\times10^4 m^3$) +PFR ($6.5\times10^4 m^3$) reactor system, what conversion can be achieved at the exit of the CSTR and the PFR respectively? (20%)

6. [10%] The 2nd order reaction A+B→C ($-r_A = kC_A^2$) is carried out in a continuous stirred reactor in which the volumetric flow rate, v, is constant. Determine the reactor volume necessary to reduce the exiting concentration to 20% of the entering concentration given that the volumetric flow rate is 10 dm^3/min; the concentration is 1 mol/dm^3 and the specific reaction rate, k, is 0.23 dm^3/(min・mol).