大同大學 100 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　　

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； 不可以使用計算器。

Thermodynamics

1. For a vapor-liquid equilibrium system of three components (A, B and C) without chemical reaction:

1.1 What is the degree of freedom for this system? [5%]

1.2 What are the equilibrium criterions for this system? [10%]

2. Two moles of an ideal gas undergo a state change from state 1 ($P_1 = 5$ bar, $\underline{V}_1 = 0.020$ m^3/mol) to state 2 ($P_2 = 2$ bar, $\underline{V}_2 =$ 0.050 m^3/mol) ***along a straight line on P-$\underline{V}$ plane***.

2.1 Is this an isothermal process? Why? [10%]

2.2 Calculate the total work done on the system by the surroundings. [10%]

3. An expression for ***d$\underline{S}$*** is given below:

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

3.1 Derive from this equation an expression for $\triangle\underline{S} = \underline{S}_2 - \underline{S}_1$ in terms of T_1, P_1, T_2 and P_2 for an ideal gas. [10%]

3.2 Calculate the entropy change $\triangle$S (in J/K) for 5 moles of ideal gas subject to a state change from (200℃, 5 bar) to (600℃, 15 bar)? Note that R = 8.314 J/mol-K, $C_p = 2.5$ R , $\underline{S}$ is molar entropy and S is entropy. [5%]

Chemical Reaction Engineering

4. Derive the working equation for a packed bed reactor by (1) the macroscopic volume (the general molar balance equation) (2) the differential volume approach. (10%)

5. The gas phase elementary reaction $2A \rightarrow B$ is to be carried out in a reactor. The additional information of the reaction are (a) only A fed (b) T_0=500K (c) $P_0 = 8.2$ atm (d) C_{A0}=0.2 mol/dm^3 (e) k=0.5dm^3/mol/s (f) v_0=2.5 dm^3/s.

(i) Find the time required for achieving 70% conversion in a constant volume steel container (gas: V=V_0)

(ii) For achieving 85% conversion, estimate the volume of the reacting mixture required in a continuous stirred tank reactor with T=T_0 and P=P_0. The subscript 0 denotes the initial or entering condition. (20%)

6. Please set up the mole balances for the multiple liquid phase reaction carried out in a plug flow reactor (the entering volumetric flow rate is v_0) (20%)

$A + 2B \rightarrow C$ (1) $\quad -r_{1A} = k_{1A}C_A C_B^2$

$3C + 2A \rightarrow D$ (2) $\quad -r_{2C} = k_{2C}C_C^3 C_A^2$