國立臺灣科技大學101學年度碩士班招生試題

系所組別： 化學工程系碩士班

科　　目： 化工熱力學與動力學

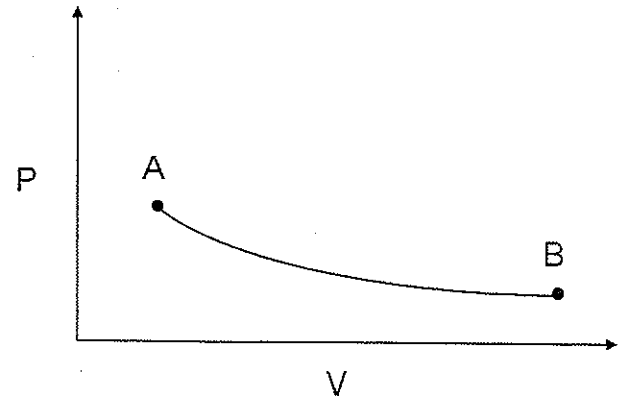
（總分為100分）

PART I 化工熱力學 (50 %)

1. Please describe the following thermodynamic behavior or noun.

   (1) Explain the relation between internal energy (U) and work (W)/heat (Q). (5%)
   (2) The first law and the second law of thermodynamics. (10%)
   (3) Please describe the detail whole operation processes of Carnot engine and prove that no engine can have a higher thermal efficiency than a Carnot engine. (10%)

2. Consider a fluid is changed following an ***irreversible adiabatic process*** from state A to state B. Please prove that the change of entropy is $\Delta S>0$. You can make any reasonable assumption to prove it. (10%)



3. Consider the liquid water changes from (1 bar, 25°C) to (1000 bar, 50°C). The following data is available for water. Please find the change of enthalpy and entropy in unit of $Jmol^{-1}$. (15%)

T/°C	P/bar	$C_P/Jmol^{-1}K^{-1}$	$V/cm^{-3}mol^{-1}$	β/K^{-1}
25	1	75.305	18.075	256×10^{-6}
25	1000	—	17.358	366×10^{-6}
50	1	75.314	18.240	458×10^{-6}
50	1000	—	17.535	568×10^{-6}

*β is volume expansivity= $\frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ and 1 J=10 cm^3bar.

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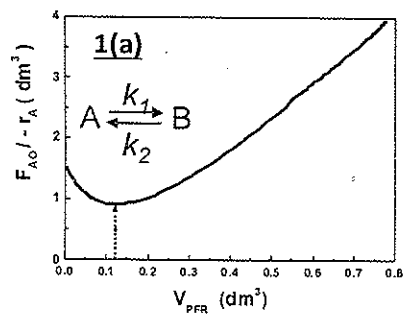
PART II. 化工動力學 (50 %)

1. (a)The relationship between $F_{A0}/-r_A$ and X in an adiabatic PFR for a 1st order reversible reactions is show in following figure. The feed is pure A. The maximum reaction rate is not at the entrance of PFR, why? Please explain the phenomenon in detail. (7 %)



(b) Why does the pressure drop decrease the gas-phase reaction rate in a PFR? (4 %)

(c) Make sketches to get maximum selectivity of D. Please describe the proper operation conditions, such as temperature, concentration, reactor type. (4 %)

A→D　　$-r_{1A}=k_1C_A$, $E_a=E_1$

D→U1　$-r_{2D}=k_2C_D$, $E_a=E_2$

A→U2　$-r_{2A}=k_3C_A$, $E_a=E_3$　　, where $E_1>E_3>E_2$

2. The gas-phase reaction, 3A + B → 6C, is carried out in a batch reactor. The feeds are $N_{A0}= N_{B0}$ and $N_{C0}=0$. The initial volume is 50 dm^3. What is the volume as X = 0.6? The reaction temperature increases from 27°C to 227°C as X=0.6.
Other information: $P_T = P_{T0} = 10$ bar (5 %)

3. 3A + B →5C+ D. The rate law is $-r_B=kC_AC_B$ and k at 300K is 0.2 dm^3/mol*h. The liquid-phase reaction is first carried out in a CSTR isothermally at 348.1K. The activation energy is 10000 cal/mol. C_{A0} = 12 mol/dm_3 and $F_{A0} = 3F_{B0}$. (a) The yield rate of C is 15000 mol/h. What is the conversion by using a CSTR of 125 dm^3? (b) We add another PFR with the 1st CSTR in series (CSTR→PFR) to increase 60% of yield rate. What is the volume of this isothermal PFR (348.1K)? R=2 cal/mol-K.
(20 %) (a.小題 12% ; b.小題 8%)

4. Derive the rate law for r_p the following reactions and estimate the value of r_p as X=0.5. All liquid reactions are elementary and proceed in an isothermal batch reactor. (• means the active intermediates, C_{A0}=2M, k_1= 0.1s^{-1}, k_2= 9 L/mol*s, k_3= 5s^{-1}, k_4= 20 L/mol*s) (10 %)

A→•A (k_1); A + •A → •B (k_2); •B → A + •A (k_3) ; •A + •B →P (k_4)

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