國立中正大學101學年度碩士班招生考試試題

系所別：化學工程學系　　科目：化工熱力學與化工動力學

第3節　　

一、化工動力學

1. Consider a simple reaction with one intermediate species, B:

$$A \xrightarrow{k1} B \xrightarrow{k2} C$$

If C_A^0 denote the concentration of A at t=0 and C_B^0, C_C^0 =0, the time (t) dependent concentration for species A and B is given as:

$C_A = C_A^0 \exp(-k1t)$

$C_B = C_A^0 (k1/(k2-k1)) (\exp(-k1t)-\exp(-k2t))$

a. Show that

$$dC_C/dt = (-dC_B/dt)\left(1 - \frac{\exp(-k1t)}{\left(\frac{k2\exp(-k2t)}{(k2-k1)} - \frac{k1\exp(-k1t)}{(k2-k1)}\right)}\right)$$ （10分）

b. When $k1 >> k2$, the overall rate of product is dominated by the slow reaction, $dC_C/dt = (-dC_B/dt)$. （5分）

c. For the opposite case of $k2 >> k1$, the overall rate of product is dominated by the conversion of A, $dC_C/dt = (-dC_A/dt)$. （5分）

2. The kinetics of the following reaction over a $CuO/Cr_2O_3/SiO_2$ catalyst at temperature of 225-285 °C:

$$CH_3CH_2OH\ (Et) = CH_3CHO\ (Ad) + H_2\ (DH)$$

can be formulated as:

$$\text{Rate} = \{k[P_{Et} - (P_{Ad}P_{DH})/Kc]\}/[1+K_{Et}P_{Et}+K_{Ad}P_{Ad}]^2$$

Write a reaction sequence that would give this rate expression. （15分）

3. 簡答題:

A. 對一化學平衡控制之反應如何在不改變溫度壓力之情況下增加單位時間產品量,請簡要說明其原理 （5分）

B. 說明不均相觸媒反應步驟，及其與均相觸媒之不同點。 （5分）

C. 簡要說明下列那一種反應器可能有較大的外在質傳阻力 (a) CSTR (b) Fixed Bed Reactor (c)Batch Reactor (d) Fluidized Bed Reactor . （5分）

二、化工熱力學

1. A particular power plant operates with a heat-source reservoir at 327℃ and a heat-sink reservoir at 27℃. It has a thermal efficiency equal to 60% of the Carnot-engine thermal efficiency for the same temperatures. Now, calculate
a. What is the thermal efficiency of the plant? (6 分)
b. To what temperature must the heat-sink reservoir be reset to increase the thermal efficiency of the plant to 40%? (Again η is 60% of the Carnot-engine) (6 分)

2. One mole of an ideal gas, initially at 30℃ and 1 bar, is changed to 130℃ and 10 bar by three different mechanically reversible processes:
a. The gas is heated at constant volume until its temperature is 130℃; then it is compressed isothermally until its pressure is 10 bar.
b. The gas is first heated at constant pressure until its temperature is 130℃; then it is compressed isothermally to 10 bar.
c. The gas is first compressed isothermally to 10 bar; then it is heated at constant pressure to 130℃.
Calculate Q, W, $\triangle U$ and $\triangle H$ in each case. Take $C_p = (7/2)R$ and $C_v = (5/2)R$. (24 分)

3. Thermodynamic data for n-pentane $_{(g)}$ and neopentane $_{(g)}$ at 25℃ and 1 atm are listed as the following:

	Enthalpy of formation ($\triangle H^\circ$)	Entropy ($\triangle S^\circ$)
n-pentane	-146.44 kJ/mol	349.0 J/mol.K
Neopentane	-165.98 kJ/mol	306.4 J/mol.K

a. Calculate the $\triangle G$ for the conversion of n-pentane to neopentane at 25℃ and 1 atm. (5 分)
b. 1 mole of pure n-pentane is added into a reactor, which is maintained at 25℃ and 1 atm, and then a catalyst is added to isomerize n-pentane into neopantane for reaching a thermodynamic equilibrium between n-pentane and neopantane. Calculate the equilibrium constant (4 分) and the final partial pressures of the two components (5 分).