國立臺北科技大學 103 學年度碩士班招生考試

系所組別：3510 化學工程與生物科技系化學工程碩士班甲組

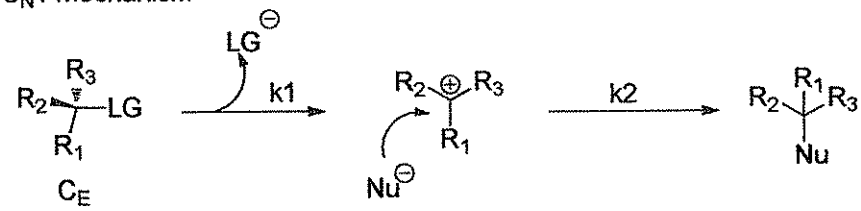
第二節　化工熱力學與反應工程　試題

注意事項：

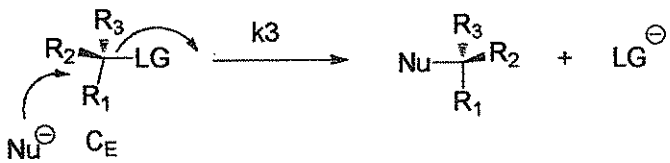
1. 本試題共七題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一. (20%) A nucleophile (Nu^- with concentration C_N) can react with an electrophile (with concentration C_E) via a S_N1 or S_N2 mechanism. The mechanisms of S_N1 (two steps) and S_N2 (one step) are shown as below. (a) Please derive the reaction rates for both reactions (S_N1 and S_N2) from the mechanisms. (15%) (b) From the kinetic experimental results, how to know the reaction carry out via S_N1 or S_N2 mechanism? (5%)

S_N1 mechanism



S_N2 mechanism



二. (10%) A stream aqueous monomer A (1 mol/liter, 4 liter/min) enters a 2-liter mixed flow reactor, is radiated therein, and polymerizes as follows:

$$A \xrightarrow{+A} A2 \xrightarrow{+A} A3 \xrightarrow{+A} A4 \xrightarrow{+A} A5 \ldots\ldots \xrightarrow{+A} An$$

In the exit stream C_A=0.01 mol/liter, and for a particular reaction product W, C_W=0.002 mol/liter. Find the rate of reaction of A and the rate of formation of W.

三. (20%) Originally we had planned to lower the activity of a gas stream containing radioactive Xe-138 (half-life = 14 min) by having it pass through two holdup tanks in series, both well mixed and such size that the mean residence time of gas is 2 weeks in each tank. It has been suggested that we replace the two tanks with a plug flow reactor (PFR). What must be the size of this PFR compared to the two original stirred tanks, and what should be the mean residence time of gas in this PFR for the same extent of radioactive decay?

四. (5%) Explain the third laws of thermodynamics as detail as you can.

五. (14%) (a) What is the phase rule? (5%)

How many degrees of freedom has each of the following systems?

(b) Liquid water in equilibrium with its vapor.(3%)

(c) Liquid water in equilibrium with a mixture of water vapor and nitrogen. (3%)

(d) A liquid solution of alcohol in water in equilibrium with its vapor. (3%)

六. (15%) A 40-kg steel casting (Cp = 0.5 $kJ.kg^{-1}K^{-1}$) at a temperature of 723.15 K (450 °C) is quenched in 150 kg of oil (Cp = 2.5 $kJ.kg^{-1}K^{-1}$) at 298.15 K (25 °C). If there are no heat losses, what is the change in entropy of (a) the casting, (5%) (b) the oil (5%), and (c) both considered together (5%)?

七. (16%) A house has a winter heating requirement of 30 kW and a summer cooling requirement of 60 kW. Consider a heat-pump installation to maintain the house temperature at 293.15 K (20 °C) in winter and 298.15 K (25 °C) in summer. This requires circulation of the refrigerant through interior exchanger coils at 303.15 K (30

注意：背面尚有試題

°C) in winter and 278.15 K (5 °C) in summer. Underground coils provide the heat source in winter and the heat sink in summer. For a year-round ground temperature of 288.15 K (15 °C), the heat-transfer characteristics of the coils necessitate refrigerate temperatures of 283.15 K (10 °C) in winter and 298.15 K (25 °C) in summer. What are the minimum power requirements for winter heating and summer cooling?