

所別：化學工程與材料工程學系碩士班 一般生 科目：化工熱力學及化學反應工程  
學位在職生

- A1. For a steady state flow process using saturated steam at temperature  $100\text{ }^{\circ}\text{C}$  as the inlet stream, calculate the maximum amount of heat per unit mass of the steam that can be obtained at a downstream temperature  $200\text{ }^{\circ}\text{C}$ . The ambient temperature is  $0\text{ }^{\circ}\text{C}$ . (10%)
- A2. Show that the molecular diffusion process is irreversible. (10%)
- A3. Use the equation of state,  $Z = 1 + B(T)/V$ , to derive the expression for the molar residual Helmholtz energy,  $A^R = A - A^{ig}$ , of a pure substance. (10%)
- A4. The excess Gibbs free energy ( $G^E$ ) of the system A+B can be represented by  $\frac{G^E}{RT} = 0.5x_Ax_B$ , where  $x_A$  and  $x_B$  denote the mole fractions of compounds A and B. The vapor pressures of A and B at 353K are  $P_A^{sat} = 0.12\text{MPa}$ ,  $P_B^{sat} = 0.08\text{MPa}$ . Is there an azeotrope in the system at 353K? If so, what is the azeotrope pressure and composition? (20%)

注意：背面有試題

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(B1) 7%

An aqueous reactant stream (3 mol A/liter) passes through a mixed flow reactor followed by a plug flow reactor. Find the concentration at the exit of the plug flow reactor if in the mixed flow reactor  $C_A = 1$  mol/liter. The reaction is second-order with respect to A, and the volume of the plug flow unit is two times that of the mixed flow unit.

(B2) 8%

Enzyme E catalyzes the transformation of reactant A to product R as follows:  
 $A \rightarrow R$ ,  $-r_A = (160 C_A C_{E0}) / (4 + C_A)$  mol/ (liter·min). If we introduce enzyme ( $C_{E0} = 0.02$  mol/liter) and reactant ( $C_{A0} = 10$  mol/liter) into a batch reactor and let the reaction proceed, find the time needed for the concentration of reactant to drop to 0.025 mol/liter. Note that the concentration of enzyme remains unchanged during the reaction.

(B3) 10%

Find the first-order rate constant for the disappearance of A in the gas reaction  $A \rightarrow 1.7 R$  if the volume of the reaction mixture, starting with pure A increases by 30% in 4 min. The total pressure within the system stays constant at 1.2 atm, and the temperature is 25 °C.

(B4) 7%

Describe how to make a kinetics analysis for a single reaction with the rate form

$$-r_A = -dC_A/dt = k_1 C_A / (1 + k_2 C_A) \text{ to obtain } k_1 \text{ and } k_2 .$$

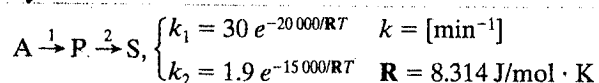
(B5) 8%

For multiple reactions (in parallel or in series) a change in the observed activation energy with temperature might indicate a shift in the controlling step of reaction. You are asked to describe the possible type of the reaction and explain the reasons for the following two cases.

- (a)  $E_{obs}$  rises for an increase in temperature.
- (b)  $E_{obs}$  falls for an increase in temperature.

(6B) 10%

We want to produce R from A in a batch reactor at a temperature somewhere between 5 and 90°C. The kinetics of this liquid first-order reaction system is as follows.



Determine the optimum temperature to give  $C_{Rmax}$  and run time to use, and the corresponding conversion of A to R.