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 °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 °C. The ambient temperature is 0 °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 $\frac{G^E}{RT} = 0.5 x_A x_B$, 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 $P_A^{sat} = 0.12MPa$, $P_A^{sat} = 0.08MPa$. 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

$-r_A = -dC_A/dt = k_1C_A/(1+ k_2C_A)$ to obtain k_1 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℃. The kinetics of this liquid first-order reaction system is as follows.

$$A \xrightarrow{1} P \xrightarrow{2} S, \quad \begin{cases} k_1 = 30\, e^{-20\,000/\mathbf{R}T} & k = [\text{min}^{-1}] \\ k_2 = 1.9\, e^{-15\,000/\mathbf{R}T} & \mathbf{R} = 8.314\ \text{J/mol}\cdot\text{K} \end{cases}$$

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