

甲. 化工熱力學部份 (50%)

(14%) 1. If the molar density of a binary mixture at different mole fractions is given by the empirical expression

$$\rho = a_0 + a_1x_1 + a_2x_1^2 \quad \text{where } a_0, a_1 \text{ and } a_2 \text{ are constants.}$$

Find the corresponding partial molar volumes, \bar{V}_1 and \bar{V}_2 , in terms of a_0, a_1, a_2 and x_1 .

(14%) 2. Estimate the value of ff^{sat} for liquid water at 150 °C and 15,000 kPa, where f^{sat} is the fugacity of saturated liquid at 150 °C and 476 kPa. The volume of saturated liquid water at 150 °C is 1.019 cm³/g.

[Hint: $G = VdP - SdT$, $G = \Gamma(T) + RT \ln f$, and the volume of liquid water is fairly constant.] $R = 8.314 \text{ (Pa m}^3\text{)/(mol K)}$.

(14%) 3. A 50-kg block of iron casting at 500 K is thrown into a large lake that is at a temperature of 285 K. The iron block eventually reaches thermal equilibrium with the lake water. Assuming an average specific heat of 0.45 kJ/(kg K) for the iron, determine

- the entropy change of the iron block,
- the entropy change of the lake water, and
- the entropy generated during the process.

(8%) 4. Derive the Clapeyron and the Clausius/Clapeyron equations for two-phase systems.

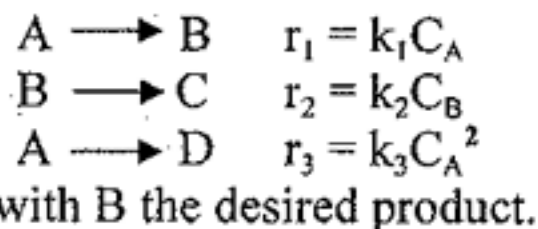
乙、反應工程 (50%)

1. How many steady states are possible for $A \rightarrow B$, $r = k$ in an adiabatic CSTR if the reaction is exothermic? endothermic? Please explain your answer in detail. (14%)

A general energy balance for a CSTR is
 $F_{A0}X\Delta H_R = F_{A0}C_{P0}(T-T_0) + UA(T-T_a)$

ΔH_R : heat of reaction
 T_0 : feed temperature
 T_a : ambient temperature
 U : heat transfer coefficient from the reactor to the ambient
 A : heat transfer area

2. Consider the reactions



Should one use a PFR or CSTR and is there an optimum residence time to obtain (a) maximum C_B or

(b) maximum selectivity, S , where $S = \frac{C_B}{C_{A0} - C_A}$?

Please explain your answer in detail. (18%)

3. The reaction $H_2 + 1/2 O_2 \rightarrow H_2O$ has a rate-limiting step $H_{(ads)} + O_{(ads)} \rightarrow OH_{(ads)}$ and the rate of the reaction is $r = K_R \theta_H \theta_O$

Derive a reaction rate expression $r(P_{H_2}, P_{O_2})$ for this reaction assuming Langmuir-Hinshelwood kinetics with competitive adsorption. (18%)