

第一部份演算題(1-7)，題分註明於問題後方括弧內。

- (1) You are the engineer in charge of an adiabatic CSTR reactor of volume V for producing B from the irreversible elementary $A \rightarrow B$ in the liquid-phase. It is desired to feed pure $A(F_{A0})$ to this reactor at the inlet temperature $T_0(K)$. The data of k_0 (pre-exponential factor of rate constant), E (activation energy of reaction), H_i^o (heat of formation of A, B at the reference temperature 298K) and $C_{pi}(T)$ (heat capacity function of A, B) are given. You want to know the temperature at the outlet stream to prevent losing too much substance by vaporization through the vent system. Describe how to obtain the outlet conversion and temperature. (Note: You don't need to make any calculations, but you clearly list the relationships used.) (16%)
- (2) The following first-order reaction takes place in a CSTR with a volume of V
 $A \rightarrow B$
 The activation energy of the reaction, E_a , is 20 Kcal/mol. Pure A is fed to the reactor at $T=350$ K under the following conditions: F_{A0} (flow rate of A)=10 mol/min, C_{A0} (concentration of A)=1 mol/dm³ to have a conversion $X=0.8$. What is the conversion in a PFR at 315K with the same volume, F_{A0} and C_{A0} ? (12%)
- (3) A first order reaction $2A \rightarrow B$ is carried out in an isothermal plug flow reactor. The inlet gas contains 50% A , 5% B and 45% inert. The feed flow rate of A is 1 mole \cdot min⁻¹. The feed temperature is 100°C and the total pressure is 10 atm. At this temperature, the rate constant is 0.1 min⁻¹. What is the reactor volume to give the outlet gas containing 10% A ? (12%)
- (4) To remove NO from automobile exhaust, it has been proposed to use unburned CO in the exhaust to reduce NO over a solid catalyst according to the reaction:
 $CO + NO \rightarrow 0.5 N_2 + CO_2$
 Experimental data indicate that the reaction can be represented over a large temperature range by
 $-r_{NO} = k P_{NO} P_{CO} (1 + K_1 P_{NO} + K_2 P_{CO})^{-2}$
 where P_{NO} is the gas-phase partial pressure of NO , and P_{CO} is the gas-phase partial pressure of CO . Please propose an adsorption-surface reaction-desorption mechanism that will explain the experimentally derived reaction kinetics. (10%)

Answer the problems (5)~(7) based on the following information.

Consider a binary $A+B$ mixture at vapor-liquid equilibrium at 300 K and 15.0 bar. The mole fraction of component A in the liquid phase is 0.06. The mole fraction of component B in the vapor phase is negligible. A series of experimental data on the compressibility factor of pure component A gas at 300 K are curve fitted to give:

$$z = 1 - aP + bP^2, P = [\text{bar}], \text{ where } a = 2.00 \times 10^{-3} \text{ and } b = 3.50 \times 10^{-6}$$

- (5) Calculate the fugacity of component A in the liquid phase. (6%)
- (6) Calculate the Henry's constant of component A dissolved by component B liquid. That is, fugacity of pure liquid component A with the properties equal to those in an infinitely dilute solution of component B . (6%)
- (7) The vapor phase is mixed with a dissimilar gas which is insoluble in the liquid component B . The mole fraction of component A in the vapor phase is now 0.5 and the temperature and pressure are unchanged (300 K and 15.0 bar). The activity coefficient of component A in the vapor phase (relative to pure component A gas at 300 K and 15.0 bar) was calculated as 1.12. What is the equilibrium solubility of component A in the component B liquid in contact with this mixed vapor? (6%)

見背面

第二部份是非題(8-15)，每題 4 分，答對得 4 分，答錯倒扣 1 分。是非題答案如為”非”，請提出解釋。

True or false? If it is false, give your explanation.

- (8) For an ideal gas, constant pressure heat capacity C_p is independent of temperature.
- (9) The internal energy U remains constant in every isothermal process in a closed system.
- (10) A gas flows through a well-insulated pipe, the pressure is decreased and the temperature is decreased as well.
- (11) The actual work is always smaller than the reversible work.
- (12) The entropy of a spontaneous isothermal process occurring at constant volume always increases.
- (13) For an ideal gas reaction mixture, addition of a reactant gas always shifts the equilibrium to use up some of the added reactant gas.
- (14) For any closed system at constant temperature and volume, equilibrium corresponds to the position of minimum Gibbs free energy of the system.
- (15) Consider a pure component system at vapor-liquid equilibrium. The molar entropy of liquid phase is equal to the molar entropy of vapor phase.

試題隨卷繳回