

淡江大學 100 學年度碩士班招生考試試題

57-1

系別：化學工程與材料工程學系

科目：化工熱力學及反應工程

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Problem 1 (25pt)

An ideal gas undergoes the following reversible processes in a cycle: (i) from an initial state of 80 °C and 1 bar, it is compressed adiabatically to 160 °C; (ii) the gas is cooled from 160 °C to 80 °C at constant pressure; (iii) the gas is expanded isothermally to its original state. Calculate the work (W), heat (Q), ΔU , and ΔH per g-mole of the gas for each of the three processes and for the entire cycle. The heat capacity of the gas at constant volume, C_v , is $3R/2$, and gas constant $R = 8.314 \text{ J/g-mole K}$.

Problem 2 (25pt)

A gas enters a reversible isothermal compressor at 520 °R and 10 atm and is continuously compressed to 150 atm. Calculate the work per lb-mole of the gas needed to run the compressor and the amount of the heat per lb-mole of the gas that must be removed from the compressor if the gas behaves according the equation of state

$$PV = RT + \left(b - \frac{a}{T}\right)P$$

where $a = 11.13 \text{ °R ft}^3/\text{lb-mole}$, $b = 0.2445 \text{ ft}^3/\text{lb-mole}$.

Hint: The gas constant $R = 1.987 \text{ Btu/lb-mole °R}$, and $1 \text{ Btu} = 0.367 \text{ atm ft}^3$.

$$dH = C_p dT + \left[V - T\left(\frac{\partial V}{\partial T}\right)_P\right]dP \quad \text{and} \quad dS = C_p \frac{dT}{T} - \left(\frac{\partial V}{\partial T}\right)_P dP$$

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Problem 3 (25pt)

The elementary liquid-phase reaction



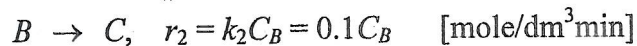
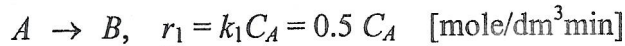
with rate equation

$$-r_A = -\frac{1}{2}r_B = 2.5C_A C_B^2 \left[\frac{\text{mol}}{\text{dm}^3 \text{ min}} \right], \text{ where } C_A \text{ and } C_B \text{ are in unit of } [\text{mol}/\text{dm}^3]$$

is carried out in a CSTR reactor. Two feed streams are introduced into the reactor. The inlet of reactant A is in one feed of $1.0 \text{ dm}^3/\text{min}$ flow rate containing $2.0 \text{ mol } A/\text{dm}^3$, and the inlet of reactant B is in the other feed of $2.0 \text{ dm}^3/\text{min}$ flow rate containing $1.5 \text{ mol } B/\text{dm}^3$. If 80% conversion of component B is desired, calculate the required volume of the CSTR? Assume a constant density system.

Problem 4 (25pt)

The series reaction $A \rightarrow B \rightarrow C$ with the reaction rates



is carried out in a plug-flow reactor (PFR). The volumetric flow rate of feed is $4 \text{ dm}^3/\text{min}$ having $C_{A0} = 2 \text{ mole}/\text{dm}^3$ and without component B or C . The volumetric flow rate in the reactor is assumed to be constant. If the conversion of A is 80%, calculate the space time, reactor volume, outlet concentrations of B and C , the overall selectivity of B/C , and the overall yield of B .