國立中正大學九十學年度碩士班招生考試試題

系所別：化學工程學系　　科　目：化工熱力學與化工動力學

1. Calculate the equilibrium conversion and concentrations for each of the following reactions.
   (a) The liquid-phase reaction

   $$A+B \rightleftharpoons C$$

   with $C_{A0} = C_{B0} = 2\text{mol/dm}^3$ and $K_C = 10\text{dm}^3/\text{mol}$. (5%)
   (b) The gas-phase reaction

   $$A \rightleftharpoons 3C$$

   carried out in a flow reactor with no pressure drop. Pure A enters at a temperature of 400°K and 10 atm. At this temperature, $K_C = 0.25\ \text{dm}^3/\text{mol}^2$. (5%)
   (c) The gas-phase reaction in part (b) carried out in a constant-volume batch reaction. (5%)
   (d) The gas-phase reaction in part (b) carried out in a constant-pressure batch reaction. (5%)

2. Under appropriate conditions A decomposes as follows:

   $$A \xrightarrow{k_1=0.1/\text{min}} R \xrightarrow{k_2=0.1/\text{min}} S$$

   R is produced from 1000 liter/hr of feed in which $C_{A0} = 1$ mol/liter, $C_{R0} = C_{S0} = 0$.
   (a) What size of plug flow reactor will maximize the concentration of R, and what is that concentration in the effluent stream from this reactor? (10%)
   (b) What size of mixed flow reactor will maximize the concentration of R, and what is $C_{R,max}$ in the effluent stream from this reactor? (10%)

3. Consider the following power-law rate for the reaction

   $$A \rightarrow B \quad , \quad -r_A = kC_A^n$$

   The reaction is carried out isothermally. For what values of n will a CSTR give a greater conversion than a PFR of equal volume? (10%)

4. A stream of ethane gas at 220°C and 30 bar expands isentropically in a turbine to 2.6 bar. Assuming the ethane gas is an ideal gas and the heat capacity is 3.5R (where R is the gas constant), determine the temperature of the expanded gas and the work produced. (25%)

5. A 30 m^3 tank contains 14 m^3 of liquid *n*-butane in equilibrium with its vapor at 25°C. The vapor pressure of *n*-butane at the given temperature is 2.43 bar. The critical temperature of n-butane is 152°C and the critical pressure is 37.96 bar. Estimate the mass of *n*-butane vapor in the tank using the following compressibility factor: (25%)

   $$Z = 1 - 0.7861\frac{P_r}{T_r}$$

   where P_r and T_r are reduced P and T.