所　別：化學工程技術研究所　　組別：　　科目：化工熱力學與動力學
學程別：

1. $-R_A = 1/(10\ X)$ mol/(liter-s)

where $-R_A$ = rate of disappearance of A, mol/(liter-s)

X = conversion = 0.5

F_{A0} = molar flow rate of A fed to a system operated at steady state = 10 mol/s

V = reactor volume, liter

(A) calculate the value of V for a CSTR (10%)
(B) calculate the value of V for a PFR (10%)

2. Suppose that the stoichiometry of a reaction is:

$$A \longrightarrow B + C$$

The reaction occurs by the following mechanism:

(i) $A + A \underset{k_1'}{\overset{k_1}{\rightleftharpoons}} A^* + A$

(ii) $A^* \xrightarrow{k_2} B + C$

If the life-time of A* is extremely short and the concentration of A* at any time is negligible, please derive an expression for the net rate of disappearance of A (i.e., $-R_A = -dC_A/dt$ = ? where C_A is the concentration of A and t is the reaction time). (10%)

3. An ideal gas undergoes an isothermal, reversible compression in a frictionless piston-cylinder from 1 to 10 atm. Calculate the initial and final molar volumes of the gas and the work necessary to perform the compression if the gas is initially at 100 °F. ($R = 0.73$ atm-ft^3/(lb-mol °R) = 1.987 Btu/(lb-mol °R)) (20%)

4. a) Define the *general characteristics* of an *equilibrium state*. (5%)

   b) Define *excess mixing fugacity*. (5%)

   c) Define *van der Waals equation of state and the physical meaning of parameters a and b* in the equation. (5%)

5. The activity coefficient (γ_1) of component 1 in a binary mixture can be expressed in terms of the mole fraction (X_1):

$$\ln \gamma_1 = aX_2^2 + bX_2^3 + cX_2^4$$

a, b, and c are constants independent of concentration. Please express d, e, f, and g in terms of constants (a, b, c) if the activity coefficient of component 2 (γ_2) is:

$$\ln \gamma_2 = dX_1^2 + eX_1^3 + fX_1^4 + gX_1^5 \qquad (15\%)$$

6. For the irreversible aqueous-phase reaction

$$A \rightarrow 2B$$

The initial concentration of A is 0.2 M, and the volumetric flow rate is 50 $dm^3 s^{-1}$. The reaction rate follows:

For $X \leq 0.5$: $-\gamma_A^{-1} = 4.0\ sM^{-1}$

For $X > 0.5$: $-\gamma_A^{-1} = 4.0 + 10(X - 0.5)\ sM^{-1}$

   a) What conversion will be achieved in a CSTR that has a volume of 20 dm^3 ? (5%)

   b) What conversion will be achieved in a CSTR that has a volume of 32 dm^3 ? (5%)

   c) What plug-flow reactor volume is required to achieve 70% conversion ? (5%)

   d) What CSTR reactor volume is required if the effluent from the PFR in part (c) is fed to a CSTR to raise the conversion to 90% ? (5%)