國立雲林科技大學
101 學年度碩士班暨碩士在職專班招生考試試題
系所：化材系
科目：化工動力學

本科目總分為 100 分

1. (10 分)(a) It has been well known that equilibrium constants (K) will be decreased with an increase of temperature for an exothermic reaction. Please explain the above concept by *van't Hoff* equation:

$$\frac{d(\ell nK)}{dT}=\frac{\Delta H^{o}}{RT^{2}}$$

where ΔH^{o} is the standard state enthalpy change for the reaction.

(10 分)(b) For an elementary reversible reaction whose rates are rapid enough to achieve a dynamic equilibrium, please derive the Arrhenius equation form " $k = Ae^{-E/RT}$ " using the *van't Hoff* equation.

2. (10 分)(a) For a first-order irreversible elementary reaction, please derive the concentration of reactant $C_A(t)$ as a function of C_{Ao} (initial concentration), k (rate constant) and t.

(20 分)(b) For a first-order reversible elementary reaction, please derive the concentration of reactant $C_A(t)$ as a function of C_{Ao} (initial concentration), k_1 (forward rate constant), K (equilibrium constant), C_{Ae} (equilibrium concentration) and t.

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[ln (2) = 0.693, ln (3) = 1.099, and ln (5) = 1.609]

3. (20分) Consider a feed of gaseous pure A (100 mol/liter) to a steady-state 2 liters mixed flow reactor, and the isothermal reaction is

$$2A \longrightarrow R, \quad -r_A = 0.05\, C_A^2 \text{ mol/liter-min}$$

Find what feed rate (liter/h) will give an outlet concentration C_A = 50 mol/liter?

4. (15分) The rate for a gaseous reaction $A \longrightarrow B + C$ at any point in a cylindrical plug-flow reactor of constant diameter is $-r_A = k_A C_A$ (where $k_A = 0.254\ s^{-1}$ at 1000 K). The reactor operates isothermally and at constant pressure. Assume: (1) The feed is pure A at 1 kg/s, 1000 K and 2 bar. (2) The flowing system behaves as an ideal-gas mixture. (3) The fractional conversion of A (f_A) = 0.20 at the outlet. Calculate the residence time, t.

5. (15分) An aqueous reactant (A) is decomposed in the presence of a catalyst according to

$$-r_A = r_{max} C_A / (K_M + C_A) \quad \text{with} \quad K_M = 10 \text{ g/L} \quad \text{and} \quad r_{max} = 7 \text{ g/L-min}$$

If we operate two one-liter mixed flow reactors in series at steady state, what will be the concentration of the reactant leaving the second reactor? The flow rate is 0.5 L/min. The inlet reactant concentration is 50 g/L and the catalyst concentration in the two reactors is maintained at the same value all of the time.