

國立中正大學八十五學年度碩士班考試試題

所 別：化學工程研究所

科 目：化工熱力學與化工動力學

(可攜帶電子計算器)

化工動力

1. Saponification is a reaction in which an ester is heated with aqueous alkali such as sodium hydroxide to form an alcohol. For saponification of ethyl acetate, $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{C}_2\text{H}_5\text{OH}$, at 298 °K in a well-stirred batch reactor, the following data were collected:

Time, min	5	9	13	20	25	33	37

Conc. of NaOH g.mol/L	0.00755	0.00633	0.00541	0.00434	0.00385	0.0032	0.00296

The run begins with equimolar (0.1 g.mol/L) amount of sodium hydroxide and ethyl acetate as the reactant. Show that the reaction can be considered to be irreversible and first-order in both reactants. Please also calculate the reaction rate constant at 298 °K. (15 分)

2. If an enzyme-catalyzed reaction proceeds by a sequence involving bonding of a reactant to the enzyme, that is, $\text{R} + \text{E} \rightleftharpoons \text{RE}$, then followed by the slow irreversible reaction of the resulting intermediate complex. Please derive a rate expression for the reaction. (15 分)
3. Show that the design equation for a continuous flow stirred tank reactor with isothermal operation is formulated as:
- $$X_A - X_{A0} = (V/F_{A0}) \times r_A$$
- where, X: fractional conversion, V: reactor volume, F: total molar flow rate, and r: reaction rate
- If the reaction is first-order and irreversible, what is the fractional conversion of A when n perfectly mixed reactors are connected in series?
- If you have available N such reactors, all of equal volume V. In order to process the maximum amount of feed F_A (kmol/s), determine the optimal arrangement of m-parallel processing lines, each with n reactors (i.e., $nm=N$). (20 分)

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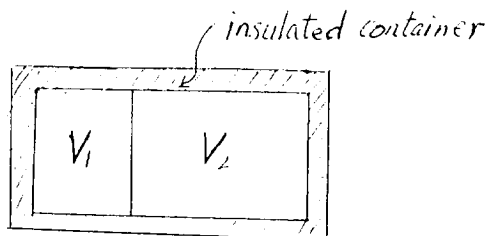
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Chemical Thermodynamics

1. What is a Carnot Cycle? Illustrate on a PV diagram and an ST diagram. Derive the efficiency of an engine using the Carnot cycle. (10分)
2. What is an ideal gas? An ideal gas is originally confined to a volume V_1 in an insulated container of volume $V_1 + V_2$. The remainder of the container is evacuated. The partition is then removed and the gas expands to fill the entire container. If the initial temperature of the gas was T , what is the final temperature? Justify your answer. (10分)



3. Starting from the first law of thermodynamics and the definitions of C_p and C_v , the specific heat capacities per mole at constant pressure and volume, respectively, show that

$$C_p - C_v = [P + (\frac{\partial U}{\partial V})_T] (\frac{\partial V}{\partial T})_P$$

where U and V are internal energy and volume of one mole. (10分)

4. One mole of a monoatomic ideal gas initially at temperature T_0 expands from volume V_0 to $2V_0$, (a) at constant temperature, (b) at constant pressure. Calculate the work of expansion and the heat absorbed by the gas in each case. (10分)
5. A certain system is found to have a Gibbs free energy given by

$$G(P, T) = RT \ln \left[\frac{aP}{(RT)^{5/2}} \right]$$

where a and R are constants. Find the specific heat at constant pressure, C_p . (10分)