編號： 78

國立成功大學 109 學年度碩士班招生考試試題

系　　所：化學工程學系

考試科目：化學反應工程

考試日期：0210，節次：3

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. An elementary and liquid-phase reaction, $2A \rightarrow B$, with rate constant of $k = 0.05$ liter/mol/min at 300 K is carried out isothermally in a reactor system consists of a 500-liter plug flow reactor (PFR) and a 500-liter continuous-stirred tank reactor (CSTR). The entrance stream is a solution of A with molar flow rate (F_{A0}) of 10 mol/min and concentration (C_{A0}) of 1 M.

(a) Please estimate exit conversion of A if the two reactors are connected in parallel and the entrance stream is distributed equally. (8%)

(b) Please estimate exit conversion of A if the two reactors are connected in series with PFR followed by CSTR. (8%)

(c) Please estimate exit conversion of A if the two reactors are connected in series with PFR preceded by CSTR. (8%)

(d) Please compare results in (b) and (c) and comment on the differences. (3%)

2. For a second-order reaction, please comment on the following facts based on the Levenspiel plot [($F_{A0}/-r_A$) vs. x_A]. (6%)

(a) The required reactor volume to achieve certain conversion for CSTR is larger than that for PFR. (3%)

(b) A PFR can be approximated by infinite CSTRs in series with the same total volume. (3%)

3. An enzyme (E) is known to promote hydrogen peroxide decomposition into water and oxygen. The concentration of hydrogen peroxide is given as a function of time for a reaction mixture with a pH value of 6.7 and at 30 °C as below. Please determine the Michaelis-Menten parameters V_{max} and K_M. (16%)

time (min)	0	10	20	50	100
Concentration of H_2O_2 (M)	0.02	0.01775	0.0158	0.0106	0.005

4. The first-order irreversible liquid phase reaction (A = > B) is performed in a jacketed CSTR. Pure A is fed to the reactor at a rate of 0.5 g mol/min. The heat-generation curve for this reaction and reactor system is shown in **Figure 1**:

$$G(T) = \frac{-\Delta H^{o}_{RX}}{1 + 1/(\tau k)}$$

(a) To what inlet temperature must the fluid be preheated for the reactor to operate at a conversion of 95%? (9%)

(b) What is the corresponding temperature of the fluid in the CSTR at this inlet temperature? (9%)

Additional information: heat of reaction (constant) = -100 cal/g mol A; heat capacities of A and B are both equal to 2 cal/g mol/°C; UA = 1 cal/min/°C, ambient temperature (T_a) = 100 °C.

國立成功大學 109 學年度碩士班招生考試試題

系　　所：化學工程學系

考試科目：化學反應工程

考試日期：0210，節次：3

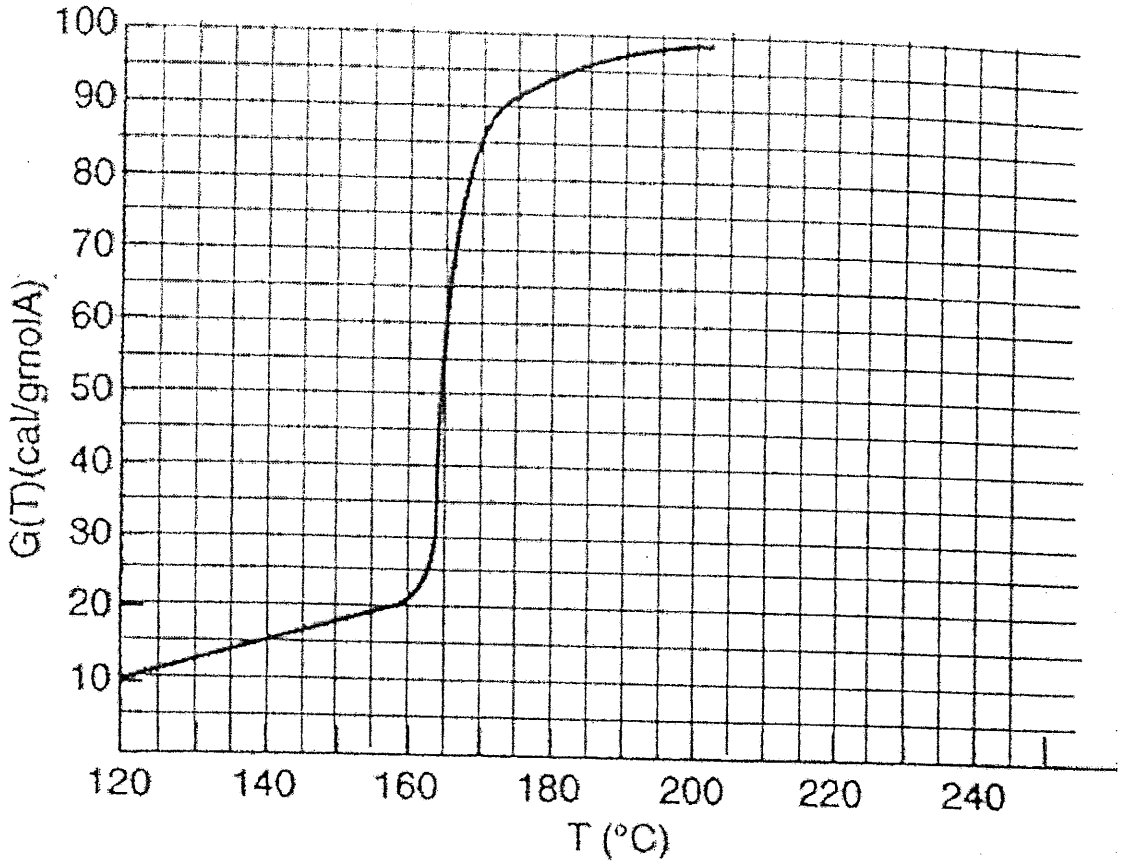

Figure 1. G(T) curve

5. Vanadium triisopropoxide (VTIPO) was used to grow vanadium oxide films by chemical vapor deposition. The deposition rate as a function of VTIPO pressure for two different temperatures follows:

at T = 120 °C

Growth Rate (μm/h)	0.004	0.015	0.025	0.04	0.068	0.08	0.095	0.1
VTIPO Pressure (torr)	0.1	0.2	0.3	0.5	0.8	1.0	1.5	2.0

at T = 200 °C

Growth Rate (μm/h)	0.028	0.45	1.8	2.8	7.2
VTIPO Pressure (torr)	0.05	0.2	0.4	0.5	0.8

a) Please analyze the data and suggest a rate law consistent with the data. (9%)

b) Please calculate the activation energy, E (cal/mol). (6%)

國立成功大學 109 學年度碩士班招生考試試題

系　　所：化學工程學系

考試科目：化學反應工程

考試日期：0210，節次：3

6. What are the definitions of internal effectiveness factor (η) and overall effectiveness factor (Ω)? (6%) Please derive the "Ω" for a first-order reaction in packed beds is: (12%)

$$\Omega = \frac{\eta}{1 + \eta k_1'' S_a \rho_b / k_c a_c}$$

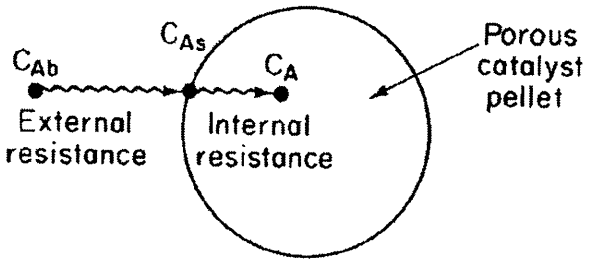

Figure 2. Mass transfer and reaction steps. Both internal and external diffusion are important.