編號： 79

國立成功大學 108 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：0223，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、The liquid-phase reaction, $A + B \rightarrow C$, follows an elementary rate law with $k = 0.05$ liter/mol/min at 300 K and $E = 10$ kcal/mol ($R = 1.987$ cal/mol/K). The concentrations of the A and B feed streams are 4 M with volumetric flow rate of 5 liter/min each. These two feed streams are mixed thoroughly before entering reactor. To achieve 90% of conversion, please estimate the volume of reactor for (20%)

(a) an ideal plug flow reactor operated isothermally at 300 K; (5%)

(b) an ideal continuous-stirred tank reactor operated isothermally at 300 K; (5%)

(c) an ideal continuous-stirred tank reactor operated isothermally at 350 K. (5%)

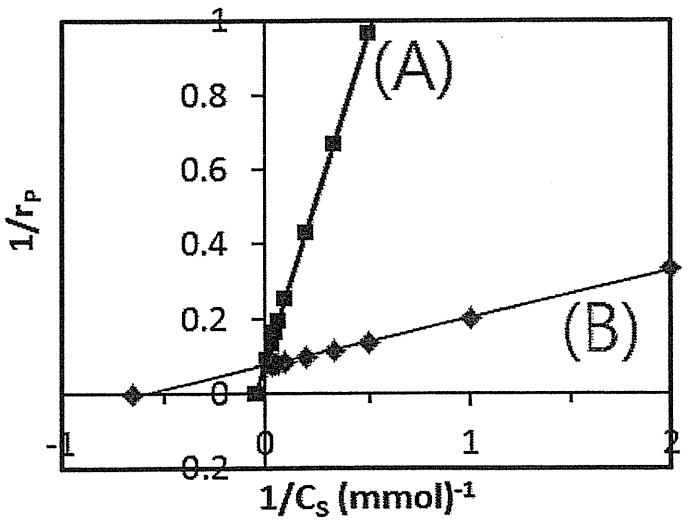
(d) Please compare answers in (a) ~ (c) and comment the effects of mixing condition in reactor and temperature on reaction rate. (5%)

2、The elementary and reversible reaction, $A+B \leftrightarrow C+D+E$, is carried out in a semibatch reactor in liquid phase isothermally at 300 K ($k = 5$ liter/mol/hr, $K_C = 3$ mol/liter). Pure A ($C_{A0} = 2$M; $v_0 = 0.5$ liter/min) enters the reactor containing of B ($V_0 = 2000$ liters; $C_{B0} = 1$ M). Assume constant density for the solution. (15%)

(a) List all the equations required for calculating the reaction rates, concentrations of all species, and conversion of A as a function of reaction time. (10%)

(b) Please qualitatively estimate the change of the concentrations of A, B and C with reaction time in this semibatch reactor. (5%)

3、Below shows the Lineweaver-Burk plot for competitive inhibition of an enzymatic reaction. r_P is the production rate of product and C_S is the concentration of substrate. (15%)



Please solve this problem by following the steps:

(a) Propose the mechanism of competitive inhibition between substrate (S) and inhibitor (I). (5%)

(b) Derive the production rate of product (P). (5%)

(c) Explain whether line (A) or (B) is more likely to be the trend of no inhibition. (5%)

4、The reaction A + B ⇔ C + D is performed adiabatically in a series of staged packed-bed reactors with inter-stage cooling. The lowest temperature to which the reactant stream may be cooled is 300 K. The feed is equimolar in A and B and the catalyst weight in each reactor is sufficient to achieve 99.9% equilibrium conversion. The feed enters at 300 K and the reaction is performed adiabatically. If three reactors and two coolers are used, what conversion may be achieved? Please explain your answer step-by-step. (20%)

Additional information:

ΔH^{o} = -30000 cal/mol A; $C_{PA} = C_{PB} = C_{PC} = C_{PD}$ = 25 cal/g/mol/K;

Ke(323 K) = 500000; F_{A0} = 10 mol A/min

5、The following data were obtained for the oxidation of CO ($2CO + O_2 \leftrightarrow 2CO_2$) over a catalyst. All rates are initial rates. The CO adsorbed as a molecular adsorption, while the O_2 is via dissociative adsorption. (24%)

Run	$-r'_{CO}$ [mol/dm^3·s]	C_{CO} [mol/dm^3]	C_{O2} [mol/dm^3]
1	0.020	0.01	1
2	0.035	0.01	3
3	0.049	0.01	6
4	0.060	0.01	9
5	0.196	0.1	1
6	0.384	0.2	1
7	0.902	0.5	1
8	1.653	1	1
9	4.44	5	1
10	5.00	10	1
11	4.44	20	1
12	2.77	50	1

(a) Suggest a rate law consistent with the data. (10%)

(b) Suggest reaction mechanisms consistent with the rate law and verify it. (14%)

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6、For a first-order reaction in spherical particles, if the reaction is limited by the internal mass transfer, please describe and explain how the reaction rate changes with particle diameter (d_p), velocity (U), and temperature (T). You should start from the definition of the internal effectiveness factor, η, to find out the relationship. (6%)