Name.....Student ID.....

PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Midterm Examination : Semester I — Academic year : 2009

Date : 30 July 2009 — Time : 9.00 – 12.00 am

Subject : 230-620 Advance Kinetics and Reactor Design — Room : R 201

ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น และพักการเรียน 1 ภาคการศึกษา โทษสูงสุด ให้ออก

1. The exam are not allow to leave an exam room
2. All books, notes, and all computing devices (i.e., calculator and computer) are allowed
3. Do not discuss or ask any person during taking an exam
4. Do all problems, the mark of each problem is listed below

Problem No.	Total Points	Point obtained
1	15	
2	15	
3	10	
4	20	
5	20	
6	20	
7	20	
รวม	**120**	

Please note that the exam must consist of 15 pages (included cover page)

Good luck and do your best on the exam

Assoc. Prof. Dr. Charun Bunyakan

July 27, 2007

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1. (15 points)

Determine the instantaneous selectivity, $S_{D/U}$, for the liquid phase reactions:

$$A + B \longrightarrow D \qquad r_D = k_1 C_A^2 C_B$$

$$A + B \longrightarrow U_1 \qquad r_{U_1} = k_2 C_A C_B$$

$$A + B \longrightarrow U_2 \qquad r_{U_2} = k_3 C_A^3 C_B$$

Sketch the selectivity as a function of the concentration of A. Is there an optimum and if so what is optimum condition. Suggest the type of reactor which suitable for this reaction system.

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2. (15 points)

For the elementary reactions:

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

with k_1=0.1 s^{-1} and k_2=0.2 s^{-1} with C_{AO}= 2 mol/dm^3. Determine the selectivity of B to C as a function of space time in a CSTR.

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3. (10 points)

The reactions:

$$(1) \qquad A + 2B \rightarrow 2C$$

$$(2) \qquad 2C + \tfrac{1}{2}B \rightarrow 3D$$

are elementary. Write the net rates of formation for A, B, C and D.

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4. (20 points)

Liquid Phase Reaction

$A + 2B \rightarrow C$ (1) $-r_{1A} = k_{1A} C_A C_B^2$

$3C + 2A \rightarrow D$ (2) $-r_{2C} = k_{2C} C_C^3 C_A^2$

a) Write the mole balances on a PFR in terms of concentration for each species and explain how to solve for concentration profiles in a PFR

b) Write the mole balances on a CSTR in terms of concentration for each species and explain how to solve for concentration profiles in a CSTR

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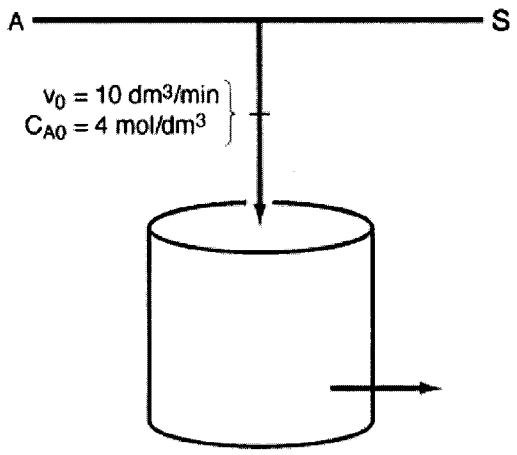
5. (20 points)

The acid-catalyzed irreversible liquid-phase reaction

$$A \longrightarrow B$$

is carried out adiabatically in a CSTR.



The reaction is second order in A. The feed, which is equimolar in a solvent (S) (which contains the catalyst) and A, enters the reactor at a total volumetric flow rate of 10 dm^3/min with the concentration of A being 4 mol/dm^3. The entering temperature is 300 K.

(a) What CSTR reactor volume is necessary to achieve 80% conversion?

(b) What conversion can be achieved in a 1000 dm^3 CSTR? What is the new exit temperature?

Additional Information:

$$\Delta H_{Rx}(300\ K) = -3300\ cal/mol \cdot °C$$
$$C_{P_A} = 15\ cal/mol \cdot °C$$
$$C_{P_B} = 15\ cal/mol \cdot °C$$
$$C_{P_S} = 18\ cal/mol \cdot °C$$
$$k(300\ K) = 0.0005\ dm^3/mol \cdot min$$
$$E = 15{,}000\ cal/mol$$

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6. (20 points)

The elementary adiabatic reaction $A + B \Leftrightarrow 2C$ is carried out adiabatically in a PFR. Show how to determine X and T vs. V. (Write the polymath program and detail all parameters you can)

Additional information:

$F_{Ao} = 5\,mol/s \quad C_{Ao} = 0.1 mol/dm^3 \quad F_{Bo} = 2F_{A0} \quad F_I = F_{Ao}, I = inert \quad T_o = 325K$

$E = 25 kcal/mol \quad \Delta H_{Rx} = -20 kcal/mol$

$C_{P_A} = C_{P_B} = C_{P_C} = 20\frac{cal}{mol\,K}, \; C_{P_I} = 40\frac{cal}{mol\,K}$

$k = 0.002\frac{dm^6}{mol\ s}, at\, 310K, \; K_C = 1000\ at\, 303K$

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7. (20 points)

For the elementary liquid phase reversible Reaction in problem 6

a) Make a plot of equilibrium conversion as a function of temperature and determine the adiabatic equilibrium temperature and conversion (The feed temperature is 325 K whereas the other additional information are same as given in problem 6)

b) Suggest how to increase the conversion and show in your plot