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

PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Final Examination : Semester I — Academic year : 2008

Date : July 31, 2008 — Time : 9.00 – 12.00 am

Subject : 230-620 Advance Chemical Engineering Kinetics And Reactor Design — Room: A 400

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	20	
2	20	
3	25	
4	20	
5	15	
รวม	**100**	

Please note that the exam must consist of 12 pages (including this page)

Good luck and do your best on the exam

Assoc. Prof. Dr. Charun Bunyakan

July, 2008

Student ID.....

1. (20 points)

a) The parallel reactions

$$A + C \longrightarrow D \quad r_D = 800\exp(\frac{-2000}{T})C_A^{0.5}C_C$$

$$A + C \longrightarrow U_1 \quad r_{U_1} = 10\exp(\frac{-300}{T})C_A C_C$$

where D is the desired product and U_1 is the undesired product.

a) What reaction schemes and conditions would you use to maximize the selectivity?

b) For a 2 dm^3 laboratory CSTR with $C_{C,o} = C_{A,o} = 1\,mol/dm^3$ and $v_o = 1\,dm^3/min$. Derive the equation of $\tilde{Y}_D$ and determine all related parameters as much as possible but no need to solve for $\tilde{Y}_D$ value.

Student ID.....

2 (20 points)

The following liquid-phase reactions were carried out in a CSTR at 325 K.

$$3A \longrightarrow B + C \qquad -r_{1A} = k_{1A}C_A \qquad k_{1A} = 0.7\ \text{min}^{-1}$$

$$2C + A \longrightarrow 3D \qquad r_{2D} = k_{2D}C_C^2 C_A \qquad k_{2D} = 0.3\ \frac{dm^6}{mol^2\ \text{min}}$$

$$4D + 3C \longrightarrow 3E \qquad r_{3E} = k_{3E}C_D C_C \qquad k_{3E} = 0.2\ \frac{dm^3}{mol\ \text{min}}$$

The concentrations measured inside the reactor were $C_A = 0.10, C_B = 0.93, C_C = 0.51$ and $C_D = 0.049$ all in mol/dm^3.

a). What are the net rates of A, B, C, D, and E?

b). The entering volumetric flow rate is 100 dm^3/min and the entering concentration of A is 3 mol/dm^3. What is the CSTR reactor volume?

c). What are $\tilde{S}_{D/E}$ and $\tilde{S}_{C/D}$?

d). Write a mole balance equation of each specie in terms of concentration, rate constant, and volume of reactor, and volumetric flow rate.

Student ID.....

3 (25 points)

The following gas-phase reactions take place simultaneously a PFR

$$3A \longrightarrow B + C \qquad -r_{1A} = k_{1A} C_A \qquad k_{1A} = 0.7 \text{ min}^{-1}$$

$$2C + A \longrightarrow 3D \qquad r_{2D} = k_{2D} C_C^2 C_A \qquad k_{2D} = 0.3 \frac{dm^6}{mol^2 \text{ min}}$$

$$4D + 3C \longrightarrow 3E \qquad r_{3E} = k_{3E} C_D C_C \qquad k_{3E} = 0.2 \frac{dm^3}{mol \text{ min}}$$

a) Write the mole balance equations in order to determine the molar flow rate of A, B, C, D, and E as a function of reactor volume? No needs to solve these equations but you are asked to explain how to solve them.

b) Explain, how to determine the $\tilde{S}_{D/E}$ as function of reactor volume?

c) Explain, how to determine the $\tilde{Y}_D$ as function of reactor volume?

Student ID.....

4 (20 points)

The pyrolysis of acetaldehyde is believed to take place according to the following sequence:

$$CH_3CHO \xrightarrow{k_1} CH_3^{\bullet} + CHO^{\bullet}$$

$$CH_3^{\bullet} + CH_3CHO \xrightarrow{k_2} CH_3^{\bullet} + CO + CH_4$$

$$CHO^{\bullet} + CH_3CHO \xrightarrow{k_3} CH_3^{\bullet} + 2CO + H_2$$

$$2CH_3^{\bullet} \xrightarrow{k_4} C_2H_6$$

a) Drive the rate expression for the rate of disappearance of acetaldehyde ($-r_{CH_3CHO}$).

b) Under what conditions does it reduce to the following equation?

$$-r_{CH_3CHO} = kC_{CH_3CHO}^{3/2}$$

Student ID.....

5 (15 points)

For the decomposition of ozone in an inert gas M, the rate expression is

$$-r_{O_3} = \frac{kC_{O_3}^2 C_M}{C_{O_2} C_M + k' C_{O_3}}$$

Suggest a mechanism of this reaction by applying the rules of thumb for development of a mechanism