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

PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Midterm Examination : Semester I — Academic year : 2007

Date : 2 August 2007 — Time : 9.00 – 12.00 am

Subject : 230-620 Advance Chemical Engineering Kinetics and Reactor Design — Room: R201

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	25	
2	20	
3	35	
4	20	
รวม	**100**	

Please note that the exam must consist of 10 pages (including this page)

Good luck and do your best on the exam

Assoc. Prof. Dr. Charun Bunyakan

July 27, 2007

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1. (25 points)

It is desired to carry out an elementary irreversible liquid phase reaction $A + B \longrightarrow C$ in an existing adiabatic CSTR. An equal molar feed in A and B enter at 27°C and the volumetric flow rate is 4 dm^3/s and C_{AO} is 0.5 mol/dm^3. Calculate the reactor volume and steady state reaction temperature necessary to achieve 90% conversion of A.

Additional information:

$H_A^o(273) = -20\,kcal/mol$, $H_B^o(273) = -15\,kcal/mol$, $H_C^o(273) = -41\,kcal/mol$

$C_{PA} = C_{PB} = 15\frac{cal}{mol\,K}$, $C_{PC} = 30\frac{cal}{mol\,K}$

$k = 0.05\frac{dm^3}{mol\ s}, at\ 300K$, $E = 12{,}000\frac{cal}{mol}$

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2. (20 points)

Repeat problem 1 when a heat exchanger is added. The overall heat transfer coefficient and the heat transfer area for such heat exchanger are 50 cal/m^2/s/K and 40 m^2, respectively, and the coolant temperature is constant at T_a = 350 K.

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3 (35 points)

The irreversible endothermic gas phase reaction, $A \longrightarrow B + C$, follows an elementary rate law and an is carried out adiabatically in a PFR. The feed stream is a mixture 40 mol% A and 60 mol% inert gas (I). This mixture is fed to the reactor at a rate of 100 mol/min and a pressure of 5 atm. The entrance temperature of both streams is 1100 K. Calculate the PFR volume and steady state reaction temperature necessary to necessary to achieve 80% conversion of A. Show your mass balance and energy equations and explain how to solve your equations to obtain the conversion and temperature profiles along the reactor volume.

Additional information:

$$k = \exp(34.34 - \frac{34{,}222}{T}), T \ in \ K, \quad \frac{dm^3}{mol \ \min}$$

$$C_{PA} = 120\frac{J}{mol\ K},\ C_{PB} = 90\frac{J}{mol\ K},\ C_{PC} = 80\frac{J}{mol\ K},\ C_{PI} = 200\frac{J}{mol\ K}$$

$$\Delta H^{o}_{Rx}(273) = 800\frac{J}{mol}$$

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4. (20 points)

From problem 3, if the heat exchanger is added with the Ua and the coolant temperature of 100 cal/m^3/s/K and 450 K, respectively. Detail your mass balance and energy equations. Evaluate the values of all parameters you can and explain how to solve your equations to obtain the conversion and temperature profiles along the reactor volume. (Do not attempt to solve the equations by hand).