PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Midterm Examination : Semester I Academic year : 2008

Date : July 30th, 2008 Time : 9:00 – 12:00, Room : R200

Subject : 231-321 Chemical Engineering Kinetics & Reactor Design I

ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น หรือ พักการเรียน 1 ภาคการศึกษา และ โทษสูงสุดคือ ให้ออก

คำสั่ง

1. ห้ามนำข้อสอบบางส่วนหรือทั้งหมดออกจากห้องสอบ
2. อนุญาตให้นำเอกสาร หนังสือ เครื่องคำนวณ ทุกชนิด เข้าห้องสอบได้
3. ห้ามหยิบยืมเอกสารใดๆ และพูดคุยกับนักศึกษาอื่นขณะทำข้อสอบ
4. สามารถใช้ดินสอในการทำข้อสอบได้

Problem	Point	You earn
1	35	
2	35	
3	30	
4	20	
5	20	
Total	**140**	

ข้อสอบทั้งหมดมี 5 ข้อ 8 หน้า (รวมปก) กรุณาตรวจสอบความถูกต้องก่อนลงมือทำ

พิมพรรณ มายเออร์
ผู้สอน/ออกข้อสอบ
23 กรกฎาคม 2551

 Student ID.....

Problem 1 (35 points) From the following reversible reaction:

$$A + 2B \leftrightarrow C + 2D$$

It is a liquid phase reaction performed in a PFR. The reaction is isothermal and isobaric. The concentration equilibrium constant at the operating condition is 0.089. The concentration of A in feed stream is 0.2 mol/liter and $[C_{B0}/C_{A0}] = 5$. The forward and backward reactions follow elementary rate law.

a) (10 points) Write down $-r_A$ in the function of concentration **at the beginning of the reaction**.

b) (25 points) Find the concentration of substance B at equilibrium.

Student ID.....

Problem 2 (35 points) From the oxidation of ammonia in gas phase in a flow reactor:

$$4NH_3+5O_2 \rightarrow 4NO + 6H_2O$$

From the experiment, it found that

$$-r_{NH_3}\left(\text{mol/liter}\cdot\text{min}\right) = k\left(C_{NH_3}\right)^{0.36}\left(C_{O_2}\right)^{0.14}$$

When k (rate constant) = 20 ($mol^{0.5}$/liter·min)

C_{NH_3} = concentration of NH_3

C_{O_2} = concentration of O_2

Feed consists of 20% NH_3 and 80% air (containing 21% O_2 and 79% N_2). The reaction was carried out isothermally under 220 °C and 16.4 atm. It is assumed that there is no pressure drop.

(a) (15 points) Calculate C_{O_2} and C_{N_2} at 50% conversion

(b) (20 points) Calculate volume of a CSTR to obtain 65% conversion with the volumetric flowrate of 440 liter/min.

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Problem 3 (30 points) The reaction of $3A \rightarrow B$ is carried out as a liquid phase reaction in a 200 liter batch reactor. The reaction begins with 100 moles of reactant A. Given rate constant = 0.5 $(dm^3/mol)^2 \cdot min^{-1}$

a) (10 points) Write down $-r_A$ in term of conversion (X) only when the reaction rate follows elementary rate law.

b) (20 points) How much is conversion at 80 minutes of reaction time?

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Problem 4 (20 points) The homogeneous reaction of A → B with k = 0.01 liter·mol^{-1}sec^{-1} takes place in a PFR with cross section area of 4 cm^{3}. The concentration of A in feed is 4 mol/liter. The order or reaction is second order with respect to A.

a) (10 points) What is space time in the reaction required for 90% conversion?

b) (10 points) How long is the reactor required to achieve minimum 50% conversion? When volumetric flowrate is 4 liter/min.

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Problem 5 (20 points)

a) (15 points) Write down Arrehenius equation from the data of k (rate constant) and T (temperature) when Gas constant = 1.987 cal/mol·K. **There is no point given for any plot.**

b) (5 points) Estimate temperature at k = 4.0 (dm^3/mol•min)

T (^oC)	k (dm^3/mol•min)
30	0.29
50	0.44
80	0.75
100	0.95
150	1.67