PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Midterm Exam	: Semester I	Academic year	: 2009
Date	: August 2nd, 2009	Time	: 9.00 – 12.00
Subject	: (230-321) Chemical Engineering Kinetic & Reactor Design I		
Pages	: 11 (inc. front page)	Room	: หัวหุ่นยนต์

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชานั้น

และพักการเรียน 1 ภาคการศึกษา

คำสั่ง

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

Question #	Total Score	Score
1	30	
2	20	
3	20	
4	30	
Total	100	

ดร.พรศิริ แก้วประดิษฐ์

ผู้สอน/ออกข้อสอบ

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

1. **(30 points)** Initial reaction rates in three experiments of the chemical reaction, $A + B \rightarrow C$, are shown in the table under different initial concentration of A and B. The temperature is constant at 100 °C

Experiment	C_{A0}, mole/liter	C_{B0}, mole/liter	Initial rate, (mole/liter.s)
1	0.01	0.01	5×10^{-6}
2	0.02	0.01	2×10^{-5}
3	0.01	0.02	5×10^{-6}

1.1. **(10 points)** Using the information, find rate constant and the nonelementary rate law of this reaction

1.2. **(2 points)** What is overall order of this reaction (n), reaction order with respect to reactant A (α) and reaction order with respect to reactant B (β)

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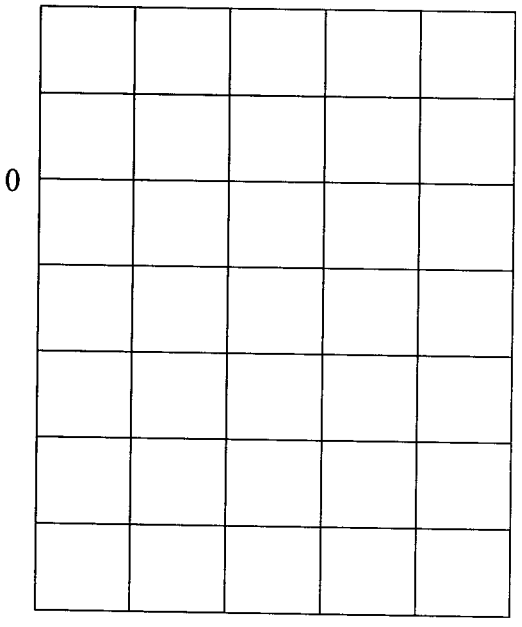
1.3. **(8 points)** Determine (by graphical) the activation energy and frequency factor for this reaction, if rate constant, k is 0.01 liter/mole.s at T = 0 °C and k is 0.05 liter/mole.s at T = 100 °C



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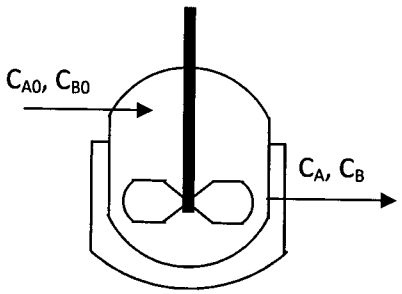
1.4. **(10 points)** Calculate CSTR reactor volume necessary to consume 98% of A when C_{A0} = 0.015 mole/liter, C_{B0} = 0.025 mole/liter and the entering constant volumetric flow rate $\upsilon = \upsilon_0$ = 2 liter/hr (Note: Answer in m^3)



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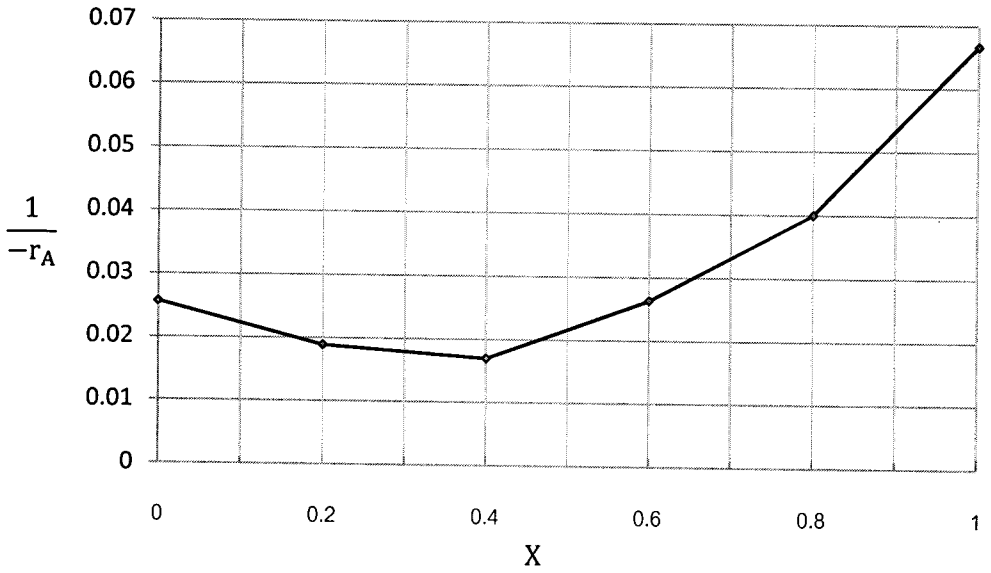
2. **(20 points)** The exothermic reaction A → B + C was carried out adiabatically in the liquid phase with the entering molar flow rate of A was 50 kmol/hr, and the following data recorded:

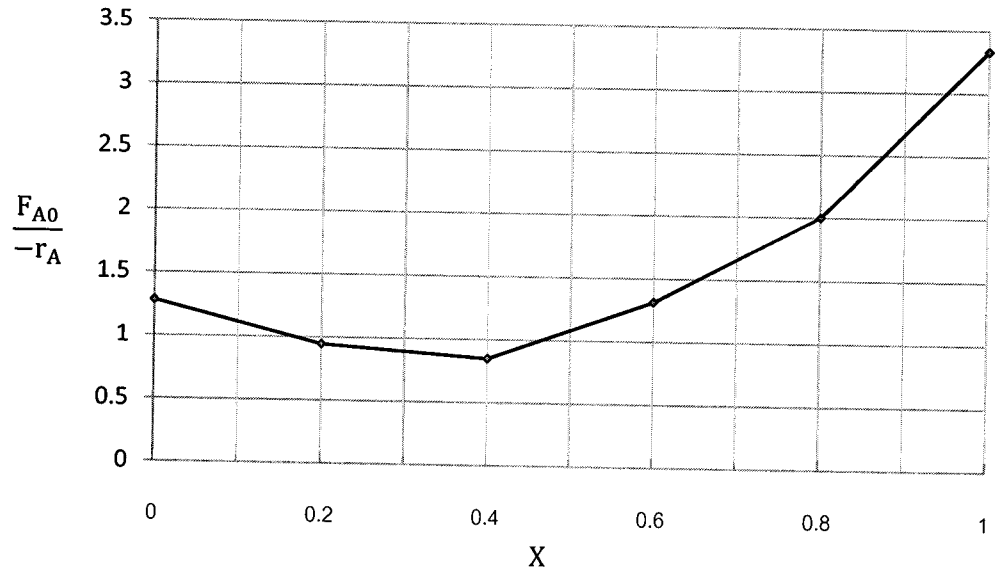


2.1. **(5 points)** Calculate CSTR volume necessary to achieve 40% conversion

2.2. **(8 points)** What is the maximum conversion that can be achieved in a 1.6 m^3 CSTR?

2.3. **(5 points)** If CSTR in 2.1 is followed by PFR in series, calculate PFR volume necessary to achieve 80% conversion

2.4. **(2 points)** From 2.3, shade the area in Levenspiel plot



3. **(20 points)** The liquid phase reaction,

$$A + B \leftrightarrow C$$

3.1. **(5 points)** Derive rate law of the elementary reversible reaction, $-r_A$ in term of concentration equilibrium constant, K_C

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3.2. **(5 points)** At equilibrium, find K_C in term of concentration C_{Ae}, C_{Be}, C_{Ce}

3.3. **(10 points)** Calculate equilibrium conversion X_e if $C_{A0} = C_{B0} = 2$ mol/dm^3 and $K_C = 10$ dm^3/mol

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4. (**30 points**) The gas phase reaction,

$$\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow NH_3$$

is to be carried out isothermally. The molar feed is 40% H_2 and 60% N_2 at a pressure of 16.4 atm and 227 °C

4.1. (**2 points**) Which reactant should be chosen as a basis of calculation?

4.2. (**3 points**) Set up a stoichiometric table

4.3. (**3 points**) What are C_{A0}, δ and ε when A is a limiting reactant?

4.4. **(2 points)** Write relative rate of reaction

4.5. **(10 points)** Find elementary rate law of N_2 as a function of conversion for a flow system, when $k_{N_2} = 40$ $dm^3/mol.s$

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4.6. **(10 points)** Find elementary rate law of N_2 as a function of conversion for a constant volume batch system, when $k_{N_2} = 40$ $dm^3/mol.s$