Faculty of Engineering

Prince of Songkla University

Midterm Examination Paper: Semester I **Academic year:** 2014

Date: October 15, 2014 **Time:** 9.00-12.00

Subject: 230-620 Advanced Chemical Engineering Kinetics and Chemical Reactor Design **Room:** S817

คำสั่ง

- ❖ ให้ตอบคำถามลงในข้อสอบ
- ❖ ห้ามนำข้อสอบบางส่วนหรือทั้งหมดออกจากห้องสอบ
- ❖ ห้ามหยิบยืมเอกสารใดๆ และพูดคุยกับนักศึกษาอื่นขณะทำข้อสอบ

อนุญาต

- ❖ ให้นำเครื่องคิดเลข หนังสือ และเอกสารเข้าห้องสอบได้
- ❖ ให้นักศึกษาเขียนชื่อและรหัสลงในข้อสอบและกระดาษกราฟที่จัดให้ครบทุกแผ่น

สำหรับนักศึกษา

ชื่อ .....ตอน .....รหัสนักศึกษา .....

ข้อ	1	2	3	4	5	6	รวม
คะแนนเต็ม	15	15	20	15	25	10	100
ทำได้							

ทุจริตในการสอบ โทษขั้นต่ำคือปรับตกในวิชานั้น

และพักการเรียน 1 ภาคการศึกษา

ข้อสอบมีทั้งหมด 6 ข้อ 12 หน้า (รวมปก) โปรดดูความเรียบร้อยก่อนลงมือทำ

ดร. สุรัสวดี กังสนันท์

ผู้ออกข้อสอบ

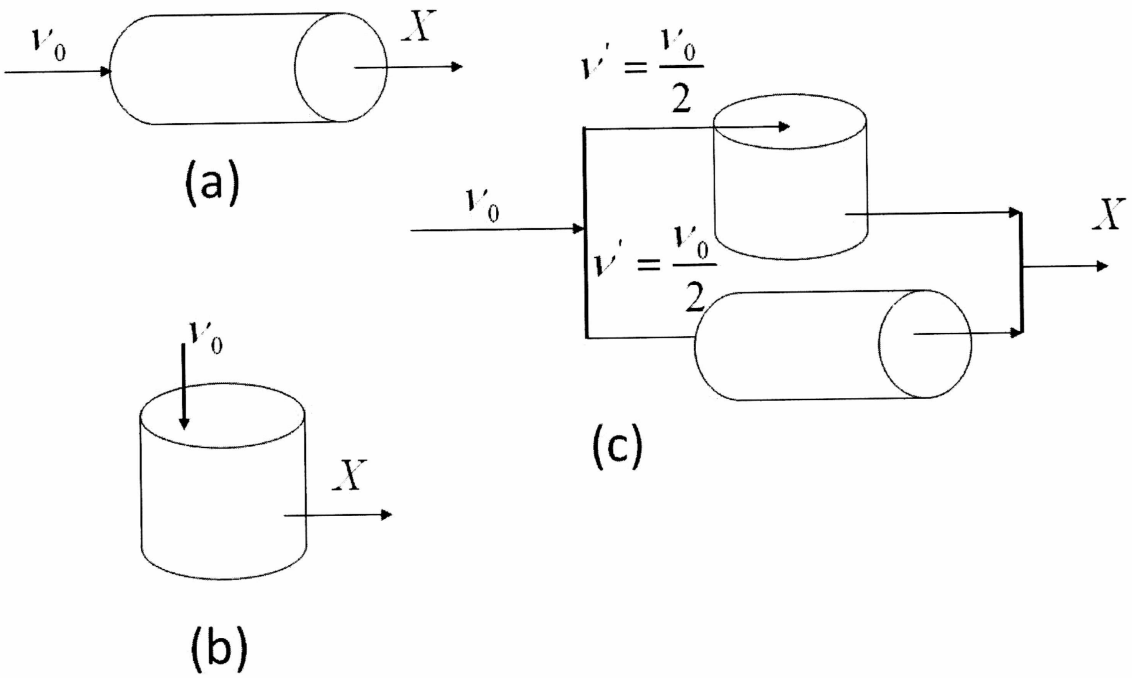
1. (15 points) There are two reactors, one a 200 dm^3 CSTR and a 100 dm^3 PFR available for your use the following elementary gas–phase irreversible reaction

$$A \rightarrow B$$

Pure A enters at flow rate of 20 mol/min. The entering concentration of A is 0.5 mol/dm^3. The reaction is carried out in isobaric and isothermal condition. The temperature of the reactor is maintained at 500K. Which of following scheme would give the highest conversion? Please show the calculation to support your answer.

Additional Information

$k = 2\ min^{-1}$ at 500 K

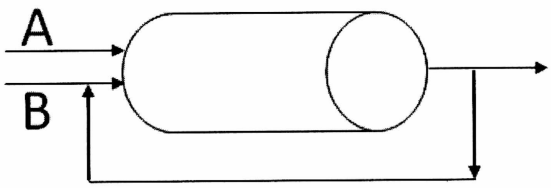


2. (15 points) In the reactor, the following elementary liquid phase reactions are to be carried out

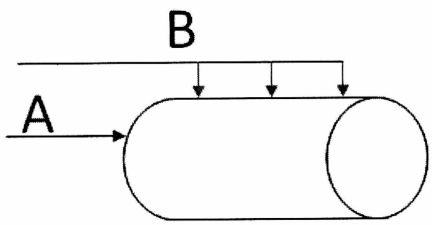
$$A + B \rightarrow D$$

$$D + B \rightarrow U$$

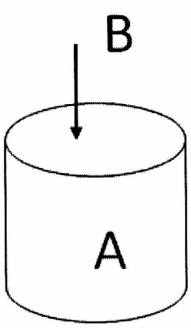
Species A is a basis reactant. Species D and U are the desired and undesired product, respectively. Which of the following schemes should be use? Please show the calculation to support your selection.



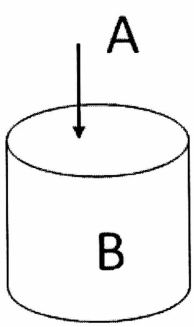
(a)



(b)



(c)



(d)

3. (20 points) In the reactor, the following liquid phase reactions are to be carried out

$A \rightarrow B$ $\qquad r_A = -k_A C_A^2$

$A + B \rightarrow 2C$ $\qquad r_C = k_C C_A C_B$

Species C is the desired product.

3.1 What is the selectivity of C to B?

3.2 Which reactors and condition would you use for maximizing C?

3.3 From 3.1, please sketch the selectivity as a function of C_B if the other parameters are constant.

Additional Information

C_{A0} = 5 mol/dm^3, k_A = 1 dm^3/mol.min at 300K with E=4,000 cal/mol,

k_C = 1 dm^3/mol.min at 300K with E=12,000 cal/mol

4. (15 points) The irreversible elementary endothermic gas-phase reaction

$$A \rightarrow C + D$$

is carried out adiabatically in a CSTR. Pure A enters at a rate of 10 mol/min, a concentration of 2 mol/dm^3, and a temperature of 80 °C. The activation energy is 20,000 cal/mol and the specific reaction rate is 500 min^{-1} at 100 °C. What reactor volume is necessary to achieve 80% conversion?

Additional Information

C_{pA} = 150 cal/mol °C, C_{pC} = 75 cal/mol °C, C_{pD} = 75 cal/mol °C

H_A^0 = 15000 cal/mol A, H_C^0 = 15000 cal/mol A, H_D^0 = 15000 cal/mol A

5. (25 points) The elementary liquid phase reaction

$$A + B \Leftrightarrow 2C$$

is carried out adiabatically in a series of staged packed-bed reactor with interstage cooling. The lowest temperature to which the reactant stream may be cooled is 300 K. The feed is equal molar in A and B and the catalyst weight in each reactor is sufficient to achieve 99.9% of the equilibrium conversion. The feed enter at 300 K. How many reactors and coolers necessary to be applied for this reaction? What is the maximum conversion can be achieved?

Additional Information at 300 K

C_{pA} = 50 cal/mol °C, C_{pB} = 50 cal/mol °C, C_{pC} = 50 cal/mol °C

H_A^0 = -10000 cal/mol A, H_B^0 = -10000 cal/mol A, H_C^0 = -20000 cal/mol A

K_c (315K) = 1500