DEPARTMENT OF CHEMICAL ENGINEERING

FACULTY OF ENGINEERING

PRINCE OF SONGKLA UNIVERSITY

Midterm Examination : 1st Semester Academic year : 2012

Date : Auguest 5th, 2012 9:00 – 12:00 Room : S817

Subject : 230-321 Chemical Engineering Kinetics and Reactor Design

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ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น หรือ พักการเรียน 1 ภาคการศึกษา และ โทษสูงสุดคือ ให้ออก

1. อนุญาตให้นำหนังสือ Elements of Chemical Reaction Engineering by Fogler 1 เล่ม และ Dictionary หรือ Talking Dictionary เข้าห้องสอบ
2. อนุญาตให้ใช้เครื่องคำนวณทุกชนิด และใช้ดินสอในการทำข้อสอบ
3. ห้ามพูดคุยหรือหยิบยืมหนังสือ เครื่องคำนวณ หรือเครื่องเขียน
4. หากท่านทำข้อสอบเสร็จก่อนหมดเวลา ให้นั่งอยู่กับที่แล้วยกมือแจ้งกรรมการคุมสอบ

ข้อสอบมี 4 ข้อ 8 หน้า (รวมปก)

Name.....ID.....

Problem	1.1	1.2	1.3	1.4	2	3	4	Total
Score	10	10	10	10	30	30	25	125
You got								

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July 2012

1. (40 points)

1.1 (10 points) The gas phase elementary reaction is to be carried out isothermally. The molar feed is 50% H_2 and 50% N_2 at a pressure of 16.4 atm and 227°C

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

1. What is limiting reactant? (4 points)
2. What is entering concentration of N_2? (4 points)
3. Write down the rate law base on the limiting reactant. (2 points)

1.2 (10 points) The rate law for the reaction $2A + B \longrightarrow 3C$ is $-r_A = kC_A^2C_B$ with $k_A = 25$ $(dm^3/mol)^2/s$. What are k_B and k_C?

1.3 (10 points) At equilibrium condition, calculate the concentration of each species and net rate of formation of A in term of K_C for the liquid phase reaction A $\leftrightarrow$ 3C in flow reactor with no pressure drop. At temperature 400K, $K_C = 0.25\ (mol/dm^3)^2$.

1.4 (10 points) The liquid phase elementary reaction of $2A \rightarrow B$ takes place in a PFR with a rate constant, $k = 0.02\ dm^3/(mol.sec)$ and initial concentration of A is $0.2\ mol/dm^3$. What is a space time required for 85% conversion?

2. (30 points, 10 points for each question) For the irreversible liquid-phase reaction: A⟶2B as carried out adiabatically and the following data recorded:

x	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
$-r_A$ ($mol/dm^3.min$)	1	1.5	2	3	4	5	5	4	3	2

The entering molar flow rate of A was 300 mol/min.

1. If the reaction is carried out in a batch reactor with constant volume at 50 dm^3 in which pure A is fed to the reactor for one minute, what length of time is necessary to achieve 60 % conversion?
2. Over what conversions would the CSTR and PFR reactor volumes be identical? (Assumption: Different in volume $\pm$ 20 dm^3 can accept as identical)
3. If effluent from CSTR in previous part (part 2) is desired to feed to one reactor in order to raise conversion to 90%. Which reactor you will choose, CSTR or PFR? And what is the volume of that reactor? (Assume: conversion from first CSTR in part 2 is 70%)

---------- THIS PAGE IS RESERVED FOR PROBLEM 2 ----------

3. (30 points) The gas-phase oxidation of ammonia. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

The feed consists of 25 mol% ammonia in air at 8.314 MPa and 227°C.

1. What is the total entering concentration? (5 points)
2. What is the entering concentration of ammonia and oxygen? (8 points)
3. Calculate volume of CSTR to obtain 70% conversion with initial volumetric flow rate 500 dm^3/min (17 points)

Assume: - the reaction is first order in both reactants
- rate constant 25 dm^3/ (mol.min)
- constant temperature and pressure

---------- THIS PAGE IS RESERVED FOR PROBLEM 3 ----------

4. (25 points) The gas phase elementary reaction A $\longrightarrow$ B takes place isothermally in a PBR with 1 kg. of catalyst. The feed consist of pure A, enters the PBR at a pressure 20 atm. The conversion exiting the PBR is 0.3 and the pressure at the exit of PBR is 5 atm. If the PBR were replaced by a "fluidized" CSTR with 1 kg. of catalyst, what will be the conversion at the exit of CSTR? Assume there is no pressure drop in CSTR