

DEPARTMENT OF CHEMICAL ENGINEERING
FACULTY OF ENGINEERING
PRINCE OF SONGKLA UNIVERSITY

Midterm Examination : 1st Semester

Academic year : 2012

Date : August 5th, 2012 9:00 – 12:00

Room : S817

Subject : 230-321 Chemical Engineering Kinetics and Reactor Design

ทฤษฎีในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น หรือ พักรการเรียน
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.....

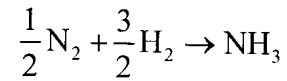
Problem	1.1	1.2	1.3	1.4	2	3	4	Total
Score	10	10	10	10	30	30	25	125
You got								

Sukritthira Ratanawilai

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% H₂ and 50% N₂ at a pressure of 16.4 atm and 227°C



1. What is limiting reactant? (4 points)
2. What is entering concentration of N₂? (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 $2\text{A} + \text{B} \rightarrow 3\text{C}$ is $-r_{\text{A}} = k_{\text{A}}^2 C_{\text{B}}$ with $k_{\text{A}} = 25$ (dm³/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, $K_C = 0.25 \text{ (mol/dm}^3\text{)}^2$.

1.4 (10 points) The liquid phase elementary reaction of $2A \rightarrow B$ takes place in a PFR with a rate constant, $k = 0.02 \text{ dm}^3/(\text{mol}\cdot\text{sec})$ 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: $A \rightarrow 2B$ 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 dm³ 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 ± 20 dm³ 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%)

Student ID.....

3. (30 points) The gas-phase oxidation of ammonia. $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$

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 $25 \text{ dm}^3 / (\text{mol}\cdot\text{min})$
- constant temperature and pressure

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

4. (25 points) The gas phase elementary reaction $A \rightarrow B$ 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