

Total number of printed pages – 7 B. Tech  
CPCH 7306

## Sixth Semester Examination – 2008

### CHEMICAL REACTION ENGINEERING

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory  
and any **five** from the rest.

The figures in the right-hand margin  
indicate marks.



1. Answer the following questions : 2 × 10
- (a) Define order of reaction. What is the difference between molecularity and order of reaction ?
- (b) For the irreversible unimolecular type reaction  $A \rightarrow \text{Product}$  in a batch reactor,

80% reactant A ( $C_{A0} = 1$  mole/lit) is converted in 480 seconds run and conversion is 90% after 18 minute. The order of this reaction is \_\_\_\_\_ .

- (c) What are the draw backs of collision theory ?
- (d) For an ideal steady state mixed reactor the performance equation for constant density system is \_\_\_\_\_ .
- (e) For identical feed composition, flow rate, conversion and for zero order reaction, the ratio of volume of mixed reactor to the volume of plug flow reactor is \_\_\_\_\_ .
- (f) Define vessel dispersion number. For PFR it is \_\_\_\_\_ .
- (g) Differentiate between space time and space velocity. A space velocity of 4/h means that \_\_\_\_\_ reactor volume of feed at specified conditions are being fed in to the reactor per hour.

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- (h) What are the factor decided in the design of a reactor ?
- (i) The experimental technique used to study the non ideal flow reactor is called \_\_\_\_\_ and the response curve for a pulse input from a reactor is called \_\_\_\_\_ .
- (j) What is the best combination of reactor for an exothermic reaction ? The most suitable reactor for autocatalytic reaction is \_\_\_\_\_ .
2. (a) The pyrolysis of ethane proceeds with an activation energy about 75000 cal. How much faster is the decomposition at 650 °C than at 500 °C ? 5
- (b) Draw graph for zero order reaction. 2
- (c) Define  $\epsilon_A$ . Derive the equation for first order reversible reaction ? 3

3. (a) A zero order homogeneous gaseous reaction  $A \rightarrow rR$  takes place in a constant volume bomb.  $P = 1$  atm when  $t = 0$  and  $P = 1.5$  atm when  $t = 1$  min. If the same reaction, same feed composition, and initial pressure takes place in a constant pressure apparatus, find  $V$  at  $t = 1$  min if  $V = 1$  lit at  $t = 0$ . 5
- (b) What is the unit of rate constant ? 5
4. (a) What are the advantage and disadvantage of batch reactor ? What are the industrial application of batch reactor ? 5
- (b) Assuming a stoichiometry  $A \rightarrow R$  for first order gas phase reaction, the size (volume) of a plug flow reactor for 99% conversion of pure A is calculated to be 32 lit. In fact however, the stoichiometry of the reaction is  $A \rightarrow 3R$ . For the corrected stoichiometry, find the required volume of reactor. 5

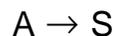
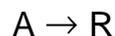
5. (a) Derive the performance equation for CSTR.

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- (b) The elementary liquid phase reaction  $A + B \rightarrow C + D$  is carried out in PFR. For equimolar amount of A and B ( $C_{A0} = C_{B0} = 0.9$  mole/lit) 94% conversion is achieved in it. If a CSTR is 10 times as large as PFR, were arranged in series with the existing unit, which unit needs to be arranged first (in series) to enhance the production rate.

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6. Liquid reactant A decomposes per the following reaction scheme



With rate  $r_R = K_1 C_A^2$   $K_1 = 0.4$  m<sup>3</sup>/mole/min

$r_S = K_2 C_A$   $K_2 = 2$  min<sup>-1</sup>

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An aqueous feed containing A with  $C = 40$  mole/m<sup>3</sup> enters a reactor, decomposes and a mixture of A, R, and S leaves the reactor. Find the operating condition ( $X_A$ ,  $\tau$ , &  $C_R$ ) which maximizes  $C_R$  in a mixed flow reactor. 10

7. (a) What are the characteristics of chemical equilibrium? 5

- (b) The standard heat of gas phase reaction at 250 °C (298K)



Indicating that the reaction is strongly exothermic, it is planned to run this reaction at 1000 °C. What is the value of heat of reaction at that temperature? Is the reaction still exothermic at 1000 °C? 5

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8. Write short notes of (any *two*) :  $5 \times 2$

- (a) Transition state theory
  - (b) Integral method of analysis of data
  - (c) Multiple reactor system
  - (d) Variable volume batch reactor.
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