

# JK LAKSHMIPAT UNIVERSITY, JAIPUR

## INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular/ Backlog), November 2017

B. Tech in Chemical Engineering, Semester V

Roll No.....

CHE501: Chemical Reaction Engineering II

Time: 3 hours

Max. Marks: 100

### Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective type multiple choice questions (10 questions @ 1 mark) 10

- i. Which of the following is most suitable for high pressure gas phase reaction:  
a) Tubular flow reactor                      b) Batch reactor  
c) Fluidized bed reactor                      d) Stirred tank reactor
- ii. The rate constant of chemical reaction decreases by decreasing :  
a) Pressure                                      b) Concentration of reactant  
c) Temperature                                      d) Duration of reaction
- iii. For every 10°C rise in temperature, the rate of chemical reaction doubles. When the temperature increased from 30 to 70°C the rate of reaction increases .....times.  
a) 8                                                      b) 12  
c) 16                                                      d) 32
- iv. If a solid-gas non catalytic reaction occurs at a very high temperature, the rate controlling step is the ----- diffusion  
a) Internal                                              b) External  
c) Pore                                                      d) net
- v. For an ideal mixed flow reactor (CSTR), the exit age distribution  $E(t)$  is given by:  
a) a ramp function                                      b) a step function  
c) delta dirac function                                      d) none of the above
- vi. The reaction rates are considered to be constant at all the points in :  
a) Differential reactor                                      b) Integral reactor  
c) Mixed flow reactor                                      d) None of the above
- vii. Oxidation of sulfide ores is a type of :  
a) Catalytic reaction                                      b) Non-catalytic reaction  
c) Photo-catalytic reaction                                      d) None of the above
- viii. Which statement is correct for progressive core model:  
a) Solid reactant continuously converted throughout the particle  
b) Different rate of reactions occurred at different points  
c) both a) and b)  
d) none of the above
- ix. Concentration varies with time and distance in:  
a) Batch reactor                                      b) Continuous reactor

- c) Plug flow reactor d) All of above
- x. The time required for complete conversion in shrinking core model is:
- a)  $t_{total} = t_{ash} + t_{reaction}$  b)  $t_{total} = t_{film} + t_{ash} + t_{reaction}$
- c)  $t_{total} = t_{ash} + t_{film}$  d)  $t_{total} = t_{film} + t_{reaction}$

|     |                                                                      |    |
|-----|----------------------------------------------------------------------|----|
| Q.2 | Short answer type questions (4 questions @ 2.5 marks)                | 10 |
| 1.  | Define catalyst and classify them on the basis of chemical reaction? |    |
| 2.  | Write down the difference between physisorption and chemisorption?   |    |
| 3.  | Differentiate between progressive model and shrinking core model?    |    |
| 4.  | Write down the basic mechanism of catalytic reaction.                |    |

|      |                                                                              |    |
|------|------------------------------------------------------------------------------|----|
| Q.3A | Explain the concept of effectiveness factor.                                 | 05 |
| Q.3B | Explain, How the diffusion affects rate of reaction in a catalytic reaction. | 05 |

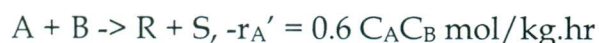
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|------|--------------------------------------------------------------------------------------------|----|
| Q.4A | Discuss various characterization techniques used for surface characterization of catalyst. | 05 |
| Q.4B | What are the methods used for catalyst deactivation?                                       | 05 |

|      |                                                                            |    |
|------|----------------------------------------------------------------------------|----|
| Q.5A | Discuss the Chemical Vapor Deposition (CVD) reactors.                      | 05 |
| Q.5B | Differentiate the mechanism of fluidized bed reactors and slurry reactors. | 05 |

|      |                                                                                                                                                |    |
|------|------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Q.6A | Explain the effect of particle size on reaction rate in a packed bed reactor.                                                                  | 05 |
| Q.6B | Determine the amount of catalyst required in a packed bed reactor for 75% conversion of 1000 mol A/min of a $C_{A0} = 8 \text{ mol/m}^3$ feed. | 05 |

OR

|      |                                                                                                                                                                            |    |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Q.6B | Gaseous feed with A and B ( $u = 10 \text{ m}^3/\text{hr}$ ) pass through an experimental reactor packed with catalyst ( $W = 4 \text{ kg}$ ). Reaction occurs as follows: | 05 |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|



Find the conversion of reactants if the feed contains  $C_{A0} = 0.1 \text{ mol/m}^3$  and  $C_{B0} = 10 \text{ mol/m}^3$ .

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |    |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Q.7A | Discuss thermal characterization techniques for catalyst.                                                                                                                                                                                                                                                                                                                                                                                                       | 05 |
| Q.7B | Nitrogen was employed to determine the surface area of 1.0 g sample of silica gel and results obtained shown in table below. The sample of silica gel was maintained at the normal boiling point of liquid nitrogen (77K). One molecule of nitrogen occupies $16.2 \times 10^{-20} \text{ m}^2$ area of plane surface. Calculate the specific surface area of silica gel by the BET method. The saturated vapor pressure $P_0$ of nitrogen at 77K is 101.3 kPa. | 05 |

|                                                    |     |     |     |     |      |
|----------------------------------------------------|-----|-----|-----|-----|------|
| Equilibrium Pressure [P]                           | 5.0 | 6.3 | 7.5 | 9.0 | 11.2 |
| Volume adsorbed (STP) $\times 10^{-6} \text{ m}^3$ | 7.3 | 7.5 | 7.8 | 8.1 | 8.2  |

OR

|      |                                                                                  |    |
|------|----------------------------------------------------------------------------------|----|
| Q.7B | Explain the factors affecting precursor distribution? Discuss different types of | 05 |
|------|----------------------------------------------------------------------------------|----|

precursor distribution and conditions required for the same.

|      |                                                                                                                                                                                                                                                                                                                                            |    |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Q.8A | Outline various methods of catalyst preparation with supporting examples.                                                                                                                                                                                                                                                                  | 10 |
| Q.9A | Explain shrinking core model along with various reaction rate controlling steps?                                                                                                                                                                                                                                                           | 12 |
| Q.9B | If a batch of solids of uniform size treated by a gas in uniform environment. Solid is converted to give a non-flaking product according to the shrinking core model. Conversion is about 7/8 for the reaction time of 1 hour, conversion is completed in two hours. What mechanism is rate controlling and how?<br>OR                     | 8  |
| Q.9B | Calculate the time needed to burn to completion particals of graphite ( $R_o = 5\text{mm}$ , $\rho = 2.2 \text{ gm/cm}^3$ , $k'' = 20 \text{ cm/sec}$ ) in an 8% oxygen stream. For the high velocity used assume that film diffusion does not offer any resistance to transfer and reaction. Reaction temperature = $900^\circ\text{C}$ . | 8  |

\*\*\*\*\* Best of Luck \*\*\*\*\*