Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER I - EXAMINATION – SUMMER 2017

Subject Code: 2713008 **Date:09/05/2017**

Subject Name: Advanced Reaction Engineering

Time: 02:30 pm to 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 a) In slurry reactors pure reactant gas is bubbled through liquid containing suspended catalyst particles. Initially the reactant gas which enters the liquid must diffuse through the liquid film into the main body of liquid, and then through the film surrounding the catalyst particle. At the surface of particle reactant yields product according to first order kinetics. Draw the concentration profile of gaseous reactant in slurry reactor and derive an expression for the rate of reaction in terms of resistances encountered in the reactor. 07

b) Discuss fluidized bed reactor and also derive the performance equation for the same. 07

Q.2 a) What are moving bed reactors? Derive design equations for moving bed reactors with the help of neat diagram. Also discuss the heat effects in moving beds. 07

b) Discuss in detail: New Development in Catalysis. 07

OR

b) Derive the equation for effectiveness factor for a LPCVD reactor. 07

Q.3 a) Discuss in brief about the choice of reactors and various conditions to minimize unwanted products in case of parallel reactions with two reactants. 07

b) Oxidation of ethanol to form acetaldehyde is carried out on a catalyst of 4 wt % Cu – 2 wt % Cr on Al_2O_3. Unfortunately, acetaldehyde is also oxidized on this catalyst to form carbon dioxide. The reaction is carried out in a threefold excess of oxygen and in dilute concentration [0.1 % ethanol, 1 % O_2 and 98.9 % N_2]. The volume change with reaction can be neglected. Derive the expression in terms of concentration of acetaldehyde as a function of space time. The reactions are irreversible and of first order in ethanol and acetaldehyde. 07

OR

Q.3 a) In the cracking of vapor phase acetone to ketone and methane as shown. 09

$$CH_3COCH_3 \longrightarrow CH_2CO + CH_4$$

The reaction is said to be first order with respect to acetone and the specific reaction rate expressed as

$$\ln k = 34.34 - \frac{34222}{T}$$

Where k is sec^{-1} and T is in kelvin. 7850 kg of acetone per hr is expected to be fed to the tubular reactor. The reactor consists of 1000 tubes of 1-inch schedule 40. For adiabatically operated reactor determine the mole balance parameters such as F_{A0}, C_{A0}, V_o and energy balance parameters such as std. heat of formation, mean heat capacities. The inlet temperature of feed is 1035 K and 162 kPa. Pressure. The std. heat of formation for acetone, ketone and methane is -216.67 kJ/mol, -61.09 kJ/mol and -74.81 kJ/mol respectively and the heat capacity is 164 J/mol K, 83 J/mol. K and 71 J/mol. K respectively.

b) Define and explain desired and undesired reactions, yield and selectivity with necessary equations. 04

Q.4 a) Using first law of thermodynamics derive the energy balance equation along with the evaluation of the work term. 07

b) .Write in brief about reactor staging with inter stage cooling and heating with suitable example. 07

OR

Q.4 a) The kinetic data for three parallel reactions are given below: 14

$A \rightarrow R \quad r_R = 1$ gmol/lit.s

$A \rightarrow S \quad r_S = 2C_A$ gmol/lit.s

$A \rightarrow T \quad r_T = C_A^2$ gmol/lit.s

For $C_{A0} = 2$ gmol/lit, find the maximum expected C_S for the isothermal operation (S is the desired product) in a mixed flow reactor and in plug flow reactor.

Q.5 a) State and explain Monod equation of microbial growth. How do you determine the kinetic parameters of the above equation graphically? 07

b) Explain the construction and working of Monolithic reactors. 07

OR

Q.5 a) Discuss mass balance and design equation of bio-reaction 07

b) Derive differential form of design equation for gauze reactors. Also discuss the mass transfer correlation for the same. 07

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