Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–I(New course)• EXAMINATION – WINTER- 2015

Subject Code: 2713008 **Date: 01/01/2016**

Subject Name: Advanced Reaction Engineering

Time:2:30 pm to 5:00 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 reactor pure reactant gas is bubbled through liquid containing suspended catalyst particles. As per the film theory to reach the surface of solid, the reactant 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 the particle reactant yields product according to first order kinetics. Derive an expression for the rate of reaction in terms of these resistances. Draw the detailed diagram of various film resistances. 07

b) Derive design equations for moving bed reactors with the help of neat diagram. Also discuss the heat effects in moving beds. 07

Q.2 a) Discuss the new development in Catalysis. Also discuss straight through transport reactor and also derive the performance equation for the same. 07

b) Discuss the characteristics and uses of trickle bed reactor. Also develop the equation for rate of transport of each step involved in trickle bed reactor. 07

OR

b) Describe stepwise: Design of combination of catalytic reactor and regenerator. 07

Q.3 a) The desired liquid phase reaction 07

$$A + B \rightarrow R + T \quad \frac{dC_R}{dt} = \frac{dC_T}{dt} = k_1 C_A^{1.5} C_B^{0.3}$$

is accompanied by the undesired side reaction

$$A + B \rightarrow S + U \quad \frac{dC_S}{dt} = \frac{dC_U}{dt} = k_2 C_A^{0.5} C_B^{1.8}$$

Based on the following contacting schemes discuss about the selectivity and concentration requirement from the stand point of favorable product distribution- from most favorable to the least favorable.

Contacting schemes:

i) A plug flow reactor ii) A plug flow reactor with side stream of B

iii) A plug flow reactor with side stream of A iv) A CSTR

b) Define and explain desired and undesired reactions, yield and selectivity with necessary equations. Compare the overall and instantaneous selectivities for a CSTR and reaction yield for batch system and flow system. 07

OR

Q.3 a) Explain briefly about the conditions to minimize unwanted products and the proper choice of reactors for the parallel reactions. 07

$$A + B \longrightarrow D$$
$$A + B \longrightarrow U$$

b) State and discuss the various types of reactions with suitable examples. 07

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

b) Derive the energy balance equation for a steady state tubular reactor with heat exchange. 07

OR

Q.4 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) Write a short note on reactor staging with interstage cooling or heating 05

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

OR

Q.5 a) Discuss different types of reactors for solid reaction. 07

b) What are slurry reactors? Derive performance equation for slurry reactor with the help of diagram. 07

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