Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–II • EXAMINATION – SUMMER - 2017

Subject Code: 2721609 **Date: 26/05/2017**

Subject Name: Advanced Kinetics and Reaction Engineering

Time: 2:30 PM-5:00PM **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) Derive the equation for time required to completely react particle of size R_0,when the movement of the particle is in stokes Regime and Diffusion through Gas film controls the overall rate. **(07)**

(b) Solids of unchanging size R=0.3 mm, are reacted with gas in steady flow bench scale fluidized reactor with following result. **(07)**

F_0 =10gm/sec w = 1000 gm, $\bar{X}_B$ =0.75

Also, the conversion is strongly temperature-sensitive suggesting that the reaction step is rate-controlling. Design a commercial sized fluidized bed reactor to treat 4 metric tons/hr of solid feed of size R= 0.3 mm of 98 % conversion.

Q-2(a) A mixture of coal particles is burnt in air on amoving grate. The grate is moving with a velocity of 1 m/min.The composition and complete conversion for particle mixture is given in table.Calculate the minimum length of the grate to achieve average conversion of (a) 80% and (b) 95%. **(07)**

Mixture Composition (%)	Particle Size (µm)	Complete Conversion Time (min)
25	50	10
50	75	15
25	100	20

(b) Silicon particles of size 10 µm diameter are to be converted to Tetrachloro silane($Sicl_4$) by reacting them with Cl_2 gas at 300^0C in a fluidized bed reactor. Assuming that the process is mass transfer limited with S_{hd} =2.0, how long will it be required to react completely? Partial pressure of Cl_2 is 0.02 atm. The density of silicon is 2330 kg/m^3 and its atomic weight is 32.Assume diffusivity, D_{sicl4} = 0.1cm^2/sec. If a fluidized bed is to be designed to treat 1 Ton/hr of solid with stoichiometric feed rate of A, fed at C_{A0} , find the weight of solids in the reactor if gas is assumed to be in mixed flow. **(07)**

OR

(b) Write short note on : Monolithic Reactor **(07)**

Q-3 Fermentation for production of Alcohol from glucose in batch fermentor shows following results. **(14)**

C_s	68	54.6	33	20	12.2	7.4	4.5	2.7

Kmol/M^3								
$-r_s$	2.82	4.71	4.31	3.74	3.16	2.46	1.91	1.4

For flow rate of 5.5 × 10-3 m^3/hr, C_{S0} =70 kmol/m^3 and C_S =12 kmol/m^3, find volume of two equal size CSTRs operating in series.

OR

Q-3 The substrate concentration versus Specific growth rate data were collected for growth of S.Crevisiae on glucose in a fermenter and are given below **(14)**

S(g/l)	15	12	9	6	2.5	1.7
μ hr-1	0.34	0.33	0.32	0.3	0.22	0.18

Q-4 (a) Derive performance equation for fluidized bed reactor. **(07)**

(b) Explain with neat sketch about slurry reactor and derive its performance equation. **(07)**

OR

Q-4 (a) Derive the design equation for maximum rate of cell production for bioreactor. **(07)**

(b) Discuss: Bubble Column Reactor. **(07)**

Q-5 For given Bio-reaction following data were reported. **(14)**

C_c (g/L)	5.96	5.98	5.99	6.0	6.01
$1/C_s$ $(g/L)^{-1}$	1.75	3.0	4.3	7.0	9.0
T h	2.6	3.0	3.5	4.25	4.30

Using the above data , an existing 10,000 L tank is to be used for continuous service in which it must convert 80 % of sterile feed containing 120 g/L of substrate A. What feed rate is required ?

OR

Q-5 (a) Explain working of trickle bed reactor with neat sketch. **(07)**

(b) Derive the design equation for adiabatic Plug Flow Reactor. **(07)**

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