

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular), November, 2016

B. Tech in Chemical Engineering, V Semester

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

i.	A catalyst (a) Decrease the activation energy (b) Alter the reaction mechanism (c) Increase the frequency of the collision (d) All of these answers	1
ii.	Chemical Reactions involves the participation of (a) Electron, (b) protons, (c) neutrons, (d) nuclei	1
iii.	If a solid gas non catalytic reaction occurs at very high temperature, the rate of controlling steps is (a) Film diffusion, (b) chemical reaction, (c) ash layer diffusion, (d) pore diffusion	1
iv.	For an ideal steady state mixed reactor the performance equation for constant density system is (a) $\tau = \frac{C_{AO} - C_A}{(-r_A)}$, (b) $\tau = \frac{C_{AO} - C_A}{(-r_A)V}$, (c) $\tau = \frac{C_{AO} - C_A}{(-r_A)C_{AO}}$, (d) $\tau = \frac{(-r_A)}{C_{AO} - C_A}$	1
v.	An irreversible first order reaction occurs in presence of a spherical porous catalyst particle. The expression for effectiveness factor(η) for a spherical catalyst particle is given by (a) $\eta = \frac{3}{\phi} \left(\frac{1}{\tanh \phi} - \frac{1}{\phi} \right)$; (b) $\eta = \frac{3}{\phi} \left(\frac{1}{\coth \phi} - \frac{1}{\phi} \right)$; (c) $\eta = \frac{1}{\phi} \left(\frac{1}{\coth \phi} - \frac{1}{\phi^2} \right)$; (d) $\eta = \frac{3\phi}{\tanh \phi}$	1
vi.	Consider an irreversible, solid catalysed, liquid phase first order reaction. The diffusion and the reaction resistances are comparable. The overall rate constant (k_o) is related to the overall mass transfer coefficient (k_m) and the reaction rate constant (k) as	1

	$(a)k_o = \frac{kk_m}{k+k_m};$ $(b)k_o = \frac{k+k_m}{kk_m};$ $(c)k_o = \frac{k+k_m}{2};$ $(d)k_o = k+k_m$	
vii.	For the reaction $2R \rightarrow T$, the rates of formation, r_R , r_S and r_T of the substances R, S and T respectively, are related by $(a) 2 r_R = r_T;$ $(b) 2 r_R = -r_T;$ $(c) r_R = -2r_T;$ $(d) r_R = -2r_T$	1
viii	The dimensions of rate constant for reactions $3A \rightarrow B$ are (1/g mole)/min. Therefore the reaction order is – $(a) 0;$ $(b) 1;$ $(c) 2;$ $(d) 3$	1
ix.	Match the following $(a) k = k_0 e^{-E/RT}$ (I) Effectiveness factor for 1 st order $(b) D/uL$ (II) Dispersion number $(c) \frac{\tanh(L/\sqrt{k/D})}{L\sqrt{k/D}}$ (III) Arrhenius law	2
Q.2	Short answer type questions (4 questions @ 5 marks)	10
i.	Define the Prandtl, Schmidt, Lewis numbers and effective diffusivity (D_e).	
ii.	Explain the rate controlling step with some examples.	
Q.3A	Define the Thiele modulus and Effectiveness factor for first order catalytic reaction.	10
Q.4A	The overall reaction $A \rightleftharpoons B$ (single site mechanism). How to derive the overall rate law if Adsorption is rate controlling step.	10
Q.5A	Why most of chemical process industry using heterogeneous catalytic as compare to the homogeneous catalytic. What are the different types of heterogeneous catalyst?	10
Q.6A	If in the reaction two molecule are participating than $A + B \rightleftharpoons C$. Write the Adsorption, chemical reaction and desorption steps for single site mechanism.	10
	OR	
Q.6A	The overall reaction $A \rightleftharpoons B$ (single site mechanism). How to derive the overall rate law if Adsorption is rate controlling step.	10
Q.7A	How is the binary diffusivity defined? How is self-diffusion defined? Give typical orders of magnitude of diffusivities for gases, liquids, and solids.	10
	OR	
Q.7A	Explain the Eley-Rideal mechanics with the help of Reaction.	10

Q.8A Derive the fundamental diffusion equation for rectangular coordinate system 10

$$-\frac{\partial W_{Ax}}{\partial x} - \frac{\partial W_{Ay}}{\partial y} - \frac{\partial W_{Az}}{\partial z} + r_A = \frac{\partial C_A}{\partial t}$$

Where W_{Ax} , W_{Ay} and W_{Az} are the molar flux in x , y and z respectively.

Q.9A Calculate the mass flux of reactant A to a single catalyst pellet 1 cm in diameter suspended in a large body of liquid. The reactant is present in dilute concentrations, and the reaction is considered to take place instantaneously at the external pellet surface (i.e., $C_A \approx 0$). The bulk concentration of the reactant is 1.0M, and the free-system liquid velocity is 0.1 m/s. The kinematic viscosity is 0.5 centistoke (cS; 1 centistoke = 10^{-6} m²/s) and liquid diffusivity of A is 10^{-10} m²/s. T = 300K. 20

OR

Q.9A Define the adsorption isotherm and derive the isotherm equation $C_{os} = \frac{(k_A P_{co})^{1/2} C_l}{1 + 2(k_A P_{co})^{1/2}}$ for 20
dual site Adsorption $CO + 2S \rightarrow C.S + O.S$.

