M.E/M.TECH. Degree Examination, December 2020

Eighth Semester

CL18202 – ADVANCED CHEMICAL REACTION ENGINEERING

(Regulation 2018)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. Semi-batch reactor is a ---------- of reactor
   a)Steady b) Unsteady c)Adiabatic d)Homogenous
2. We can suggest more than one mechanism for a same reaction. Justify.
   a)True b) False
3. Catalyst ---------- the equilibrium constant of a chemical reaction.
   a)Increases b) decreases c)does not affect d) doubles
4. ---------- reactor is used for uniform temperature distribution.
   a) Fixed b) Fluidised c) Batch d) Semi--batch
5. Compare batch and semi-batch reactor with respect to its application.
6. Contrast PFR and packed bed reactor with respect to its design equation.
7. What is Eley-Rideal mechanism?
8. State the various non idealities in packed bed.

PART B - (4 X16 = 64 marks)

09. (a) Come up with (guess and verify) a mechanism that is consistent with the experimentally found rate equation for the following reaction **(16)**

$2A + B \longrightarrow A_2B$ with $r_{A2B} = k [A] [B]$

(OR)

(b) Compare the effect of flow on conversion in steady and unsteady state reactors. **(16)**

10. (a) Explain in detail about the optimal design of exothermic reversible reactions in any two reactors of your choice. **(16)**

(OR)

(b) The following reaction is to be carried out in the liquid phase

$NaOH + CH_3COOC_2H_5. \longrightarrow CH_3COO^-Na^+ + C_2H_5OH$

The initial concentrations are 0.2 M in NaOH and 0.25 M $CH_3COOC_2H_5$ with k= 5.2 x 10^{-5} m^3/mol. S at 20 °C with E= 42,810 J/mol. Design a set of operating conditions to produce 200 mol/day of ethanol in semi-batch reactor and not operate above 35°C and below a concentration of NaOH of 0.02 molar. The semibatch reactor you have available is 1.5 m in diameter and 2.5 m tall. **(16)**

11. (a) Spherical solid particles containing B are roasted at constant temperature in an oven by gas of constant composition. Solids are converted to give a firm non-flaking product according to the shrinking core model (SCM). From the following conversion data determine the rate controlling mechanism for the transformation of solid. **(16)**

Data

d_p (mm)	X_B	t, s
2.5	0.875	1
1.5	1	1

(OR)

(b) (i) Discuss about the various steps involved in the heterogeneous catalysis. **(12)**

(ii) List any four characteristics of catalysis. **(4)**

12. (a) The gas-phase cracking reaction'
Gas oil (g) $\longrightarrow$ Products (g) **(16)**

is carried out in fluidized CSTR reactor. The feed stream contains 80% crude (A) and 20% inert I. The crude oil contains sulfur compounds, which poison the catalyst. As a first approximation we will assume that the cracking reaction is first order in the crude oil concentration. The rate of catalyst decay is first order in the present activity, and first order in the reactant concentration. Assuming the bed can be modeled as a well-mixed CSTR, determine the reactant concentration. activity, and conversion as a function of time. The volumetric feed rate to the reactor is 5000 rn^3/ h. There are 50,000 kg of catalyst in the reactor and the bulk density is 500 kg/m^3.

Additional information:

$C_{A0} = 0.8$ mol/dm^3 $\quad\quad$ $k = \rho_B k^1 = 45\ h^{-1}$
$C_{Ţ0} = 1.0$ mol/dm^3 $\quad\quad$ $k_d = 9$ dm^3/mol h

(OR)

(b) Explain in detail about the various modeling aspects and factors involved in the design of fixed bed reactor. **(16)**