AQ–2745

Faculty of Engineering & Technology

M.Tech. (Membrane & Separation Tech.) (F.T.) Second Semester Examination

ADVANCED REACTOR DESIGN

Paper—2 MST 4

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Answer any **SIX** questions.

(3) Due credit will be given to neatness and adequate dimensions.

(4) Assume suitable data wherever necessary.

(5) Diagrams and Chemical equations should be given wherever necessary.

(6) Illustrate your answers wherever necessary with the help of neat sketches.

(7) Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.

(8) Discuss the reaction, mechanism wherever necessary.

(9) Use pen of Blue/Black ink/refill only for writing the answer book.

1. Derive performance equation for MFR. From it derive design equations for :

(i) CVR — FO

(ii) CVR — SO

(iii) VVR — FO

(iv) VVR — SO. 14

2. On the assumption that the closed vessel is represented by dispersion model, calculate the D/uL :

t (min)	CE(g/L)
0	0
5	3
10	5
15	5
20	4
25	2
30	1
35	0

13

3. Derive kinetic expression for VVR for :

(i) Zero order

(ii) FO

(iii) SO. 13

4. Calculate the amount of catalyst required in a PBR to achieve 80 % conv of 1000 m^3/L of pure gaseous A. For A → R at 5.747 atm and 427° C

$$-r_A = \frac{50C_A}{1+0.02C_A}.$$ 13

5. Two reactors are connected in series. Derive design equations for second reactor for :

(i) MFR and FO

(ii) MFR and SO

(iii) PFR and FO

(iv) PFR and SO. 13

6 Predict the conversion of glucose to sorbitol in a TPSR using pure H_2 of 200 atm and 150° C. Catalyst used is Raney Ni.

$$H_2(g \rightarrow l) + C_6H_{12}O_6(l) \xrightarrow{Ni} C_6H_{14}O_6(l)$$

$$-r_A = k' C_A^{0.6} C_B$$

$$k' = 5.96 \times 10^{-6} \frac{m^3}{kg.^3} \left(\frac{m^3}{mol}\right)^{0.6}$$

Gas stream :- $V_g = 0.2\ m^3/s$

$H_A = 277600\ pa.m^3/mol$

Liq stream :- $V_L = 0.1\ m^3/s$

$C_{BO} = 2000\ mol/m^3$

Reactor :- $V_r = 2m^3$

Catalyst :- $F_s = 0.6$

$d_p = 10\ \mu m$

$I_s = 8900\ kg/m^3$

$D_e = 2 \times 10^{-9}\ m^2/s$

Transport :- $(k_{Al9i})_{g+l} = 0.05\ s^{-1}$

$k_{AC} = 10^{-3}\ m/s.$ 14

7. Derive performance equation for PFR as recycle reactor. From it derive design equation for FO and SO Kinetics. 13

8. Develop an expression in terms of total conversion of A for the selectivity of prod B wrt. D for the consecutive reaction of FO in CSTR.

$$A \xrightarrow{k_1} B \xrightarrow{k_3} D$$

At $t = 0$, $C_A = C_{AO}$, $C_{BO} = C_{DO} = 0$

$k_1/k_3 = 2.$ 13

9. For Solid catalytic FO irr

reaction : $A \xrightarrow{cot} R$

show that : $\epsilon_A = \frac{\tanh M_T}{M_T}$

As an efficient chemical engineer you would wish to have high or low M_T ? What measures you will take to have such value of M_T ?

Discuss design norms to decide the value of ϵ_A based on M_T. 13

10. Acetic anhydride is to be hydrolised in 3 CSTR in series :

V of each = 1800 cc

V_o = 582 cc/min

Compute % hydrolysis achieved upto each reactor

k = 0.158 min^{-1}.

If you go for single CSTR having Volume equal to total Volume of earlier 3 CSTR, how much conversion you will get ? 13