

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.

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(Contd.)

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

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3. Derive kinetic expression for VVR for :

(i) Zero order

(ii) FO

(iii) SO.

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4. Calculate the amount of catalyst required in a PBR to achieve 80 % conv of 1000 m³/L of pure gaseous A. For $A \rightarrow R$ at 5.747 atm and 427° C

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

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

(i) MFR and FO

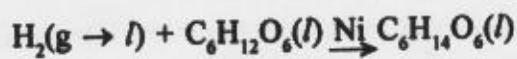
(ii) MFR and SO

(iii) PFR and FO

(iv) PFR and SO.

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



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

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

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

$$H_A = 277600 \text{ pa} \cdot \text{m}^3/\text{mol}$$

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

$$C_{B0} = 2000 \text{ mol/m}^3$$

Reactor :- $V_r = 2 \text{ m}^3$

Catalyst :- $F_s = 0.6$

$$d_p = 10 \mu\text{m}$$

$$I_s = 8900 \text{ kg/m}^3$$

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

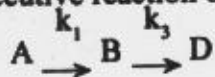
Transport :- $(k_{A9l})_{g+l} = 0.05 \text{ s}^{-1}$

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

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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. 13

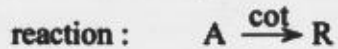


$$\text{At } t = 0, C_A = C_{A0}, C_{B0} = C_{D0} = 0$$

$$k_1/k_2 = 2.$$

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9. For Solid catalytic FO irr



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 .

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

V of each = 1800 cc

$V_0 = 582$ cc/min

Compute % hydrolysis achieved upto each reactor

$k = 0.158 \text{ min}^{-1}$.

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

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