M.Tech. Second Semester (Chemical Engineering) (CBS)

13011 : Chemical Reaction Engineering : 2 CE 1

P. Pages : 2 | **AW - 3721**

Time : Three Hours | Max. Marks : 80

Notes :
1. Question No. **one** is compulsory.
2. Assume suitable data wherever necessary.
3. Illustrate your answer necessary with the help of neat sketches.
4. Answer **any five** questions from remaining questions.
5. Use of pen Blue/Black ink/refill only for writing the answer book.

1. Following liquid phase homogeneous reaction was carried out in laboratory at temperature 30°C. **15**

$$A + B \rightarrow 2R$$

Reaction was started with initial concentration of A and B as $C_{A_0} = C_{B_0} = 5$ mol / lit . The concentration of R was recorded during the course of reaction, as given in table below. Find the rate equation for this reaction. Reaction is irreversible

Time (min)	C_R (mol/lit)
0	0
41	1.2
75	2.2
127	3.4
162	3.8
194	4.3
267	4.9
368	5.4
410	5.5

2 Substance A reacts according to second order kinetics and conversion is 95% from single flow reactor. We buy second unit identical to first. For the same conversion by how much is the capacity increased if we operate these two units in parallel or in series. The reactors are both mixed flow. **13**

3. At room temperature aqueous second order reaction proceeds as follows **13**

$$A \rightarrow R$$

$$-r_A = (1\,\text{lit} / \text{mol} \cdot \text{hr}) C_A^2$$

$$C_{A_0} = 1\,\text{mol} / \text{lit}$$

We plan to make this product day and night batch after batch in a vat. How should we operate the unit.

i) For maximum production rabe of R.

ii) For maximum rate of profit if unreacted A is discarded.
Data : shut down time between the batches is 1 hr. Cost of reactant is ₹100/Batch, and value of product fluid is given by ₹ 200 X_A / batch.

4. Give in detail the design aspects of **13**

i) Fluidized bed reactor.

ii) Slurry reactor

5. i) What is deactivation of catalyst. Explain in detail the deactivation mechanism. **13**

ii) How can it (catalyst) be regenerated? Explain in detail.

iii) Discuss the BET method of surface area determination of catalyst.

6. For the following fluid-solid reaction **13**

$A(g) + bB(s) \rightarrow Product(s)$

develop the kinetic expression when

i) Diffusion through gas film controls

ii) Diffusion through ash layer controls

7. A sample of tracer sodium hydroxide was injected as a pulse into a vessel and its effluent concentration is measured. Following data are obtained. **13**

t (min)	0	1	2	4	6	8	10
NaOH concentration (g/m^3)	0	5	8	10	3	1	0

construct the C and E curves and determine the fraction of material leaving the vessel that have spent time between 2 and 6 min in the vessel.

8. Explain with neat sketch the operation of moving bed reactor used in catalytic cracking of petroleum oil and derive the design equation for the same. **13**

9. Air at pressure 1 bar (10^5 Pa) contain 0.1% impurities. it is to be reduced to 0.02% by absorption in pure water. Find the height of tower required in counter current operation. Given data. **13**

$K_{Ag}\,a = 0.32\,mol/hr \cdot m^3 Pa)$

$K_{A\ell}\,a = 0.09\,hr^{-1}$

$H_A = P_{Ai}/C_{Ai} = 12 \cdot 0\ Pa \cdot m^3/mol$

$F_{(g)}/A_{Cs} = 1 \times 10^5\ mol/hr \cdot m^2$

$F_\ell/A_{Cs} = 6 \cdot 5 \times 10^5\ mol/hr \cdot m^2$

density of liquid is constant at $C_T = 56\,mol/lit$.

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