T.E.-V- Sem- Biotechnology

Bioreactor Analysis & Technology

01/12/15

TE/V/CBGS/BT/BAT

**QP Code : 5752**

(3 HOURS) (24) (MAX. MARKS : 80)

Note:

1. Question No. 1 is compulsory.
2. Attempt any three questions out of remaining five questions.
3. Assume suitable data wherever necessary.
4. Figures to right indicate full marks.

Q. 1 Answer the following

a. Differentiate between elementary and non-elementary reactions. 20

b. What is Arrhenius law? Explain how is rate of reaction is dependent on temperature?

c. If pyrolysis of ethane proceeds with an activation energy of about 300kJ/mol how much faster is the decomposition at 650°C than at 500°C?

d. Define rate of reaction, order and molecularity of reaction.

Q.2 a. Liquid A is decomposed to 50% in 10 min. Find the time required for 80% conversion when the reactor obeys; 10

i) first order kinetics

ii) second order kinetics.

b. Derive the equation for concentration profile of first order reaction using a spherical biocatalyst. 10

Q.3 a. Derive the model equation for cell culture for fed batch reactor. 8

b. At room temperature sucrose is hydrolyzed by the catalytic action of the enzyme sucrose as follows: 12

$$\text{Sucrose} \xrightarrow{\text{sucrase}} \text{Products}$$

Starting with a sucrose concentration $C_{A0}$ = 1.0 millimol/lit and an enzyme concentration $C_{E0}$ = 0.01 millimol/lit, the following kinetic data are obtained in a batch reactor (Concentrations calculated from optical rotaion measurements):

| $C_A$, millimol/lit | 0.84 | 0.68 | 0.53 | 0.38 | 0.27 | 0.16 | 0.09 | 0.04 | 0.018 | 0.006 | 0.0025 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| t, hr | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

[P.T.O.]

Determine whether these data can be reasonably fitted by a kinetic equation of the Michaelis- Menten type, or $-r_A = \frac{k_3 C_A C_{E0}}{C_A + C_M}$

Where $C_M$ = Michaelis constant. If the fit is reasonable, evaluate the constants $k_3$ and $C_M$. Solve by the integral method.

Q.4a. Explain the step by step method of differential method of interpretation of batch reaction data. 10

b. An aqueous phase reaction A ⟶ R proceeds as follows; 10

| t (sec) | 780 | 2080 | 3540 | 7200 |
|---|---|---|---|---|
| $x_A$ (%) | 11.2 | 25.7 | 36.7 | 55.2 |

Find the reaction rate constant and the order of reaction. Determine the time required for 50% conversion of A. Assume $C_{A0}$ = 0.05mol/lit.

Q.5a. A + B ⟶ C takes place in a two stage CSTR one of volume 100$m^3$ and the other 25$m^3$. The volumetric feed rate is 20 lit/min. $C_A = C_B$ = 1.5 gm mol/lit and the overall rate constant is 0.010 lit/gm mol.min. Calculate the overall conversion. 10

b. Derive dispersion model for non-ideal reactors. 10

Q.6 Write a note on ( Any four) 20

a. Series and parallel reactions

b. Effectiveness factor and Thiele modulus

c. Perfusion reactor

d. E curve, F curve and C curve for non-ideal reactors

e. Air lift reactor

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