2015

Advances in Bioreactor Design, Development & Scale up
(BIOT 5204)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10×1=10**

(i) The kinetics of microbial growth in a batch culture system is represented by
    (a) Henry's equation   (b) Michaelis-Menten equation
    (c) Arrhenius equation   (d) Monod equation.

(ii) Without cell recycle D_{max} is always
    (a) Greater than μ_{max} (b) Equal to μ_{max}
    (c) Less than μ_{max} (d) Independent of μ_{max} .

(iii) The relation between power number (P) and Reynolds number (Re) is:
    (a) $P \alpha Re$ (b) $P \alpha (1/Re)$
    (c) $P \alpha Re^2$ (d) $P \alpha \sqrt{Re}$.

(iv) In Leudeking-Piret model for $\beta = 0$, the product is
    (a) Growth associated   (b) Non-growth associated
    (c) Mixed growth associated   (d) Cannot be determined.

(v) In K_La calculation, 'a' is
    (a) area per unit volume   (b) area
    (c) volume   (d) volume per unit area.

(vi) Non-ideal reactor are characterized by
    (a) Dispersion number   (b) Peclet number
    (c) Reynolds number   (d) Damkohlar number.

(vii) Maximum surface area can be obtained in
    (a) Hollow fibre reactor   (b) Packed Bed reactor
    (c) CSTR   (d) Airlift reactor.

(viii) Monod model is mathematically represented by an equation of the type:
    (a) Linear   (b) Hyperbolic
    (c) Parabolic   (d) Elliptical.

(ix) Unit of first order rate constant (K) is
    (a) Time   (b) Time^{-1} (c) Time^2 (d) $\sqrt{}$(Time).

(x) In a flow reactor in the SS accumulation rate is
    (a) Zero   (b) Negative   (c) Positive   (d) Infinite.

Group – B

2.(a) Define Schmidt number and Prandtl number and prove that both are dimensionless.

(b) The dynamic method is used to measure $K_L a$ in a fermenter operated at **30°C**. Data for DO concentration as a function of time during the re-oxygenation step is as follows:

Time (Sec)	10	15	20	30	40	50	70	100	130
C_{AL} (% air saturation)	73.5	53.5	60.0	67.5	70.5	72.0	73.0	73.5	70.5

The equilibrium concentration of oxygen in the broth is **7.9×10^{-3} kg/m³**. Determine **$K_L a$.**
5+7=12

3.(a) Discuss the different types of non-Newtonian fluids with example. Draw their shear stress and strain diagram on the basis of power law model.

(b) Describe the dynamic method of determination of $K_L a$ for aerobic fermentation.
6+6=12

Group – C

4.(a) Describe the scale-up criteria of a bioreactor.

(b) Consider the scale up of fermentation from a 10L to 10,000L vessel. The small fermenter has a height to diameter ratio of 3. The impeller diameter is 30% of the tank diameter. Agitator speed is 500 rpm and three impellers are used. Determine the dimensions of the large fermenter and agitator speed for constant P/V and constant impeller tip speed.
4+8=12

5.(a) Define autocatalytic reaction.

(b) Derive rate equation for an autocatalytic reaction.

(c) For the decomposition of A→R, C_{A0} = 1.0 mol/lit. In a batch reactor conversion is 75% after one hour, and is just complete after two hours. Find the rate equation.
2+4+6=12

Group – D

6. Write a short note on:
    (i) Animal cell bioreactor   (ii) Hollow fibre reactor .
6+6 = 12

7.(a) Describe different special type of bioreactors used in solid state fermenter.

(b) Which bioreactors are used for algal culture? Discuss any one of them.

6+6=12

Group – E

8.(a) What do you mean by impeller Reynold's number? How impeller Reynold's number related to power number?

(b) Cells are growing in a fermenter. A value of K_La = 30 hr^{-1} has been determined for a fermenter at its maximum rotational speed and with air being sparged at 0.5 lit gas per lit. medium volume per min (0.5 vvm) with a q_{O_2} of 10 m moles O_2 /gm dry wt. hr are to be cultured. The critical D.O conc. is 0.2 mg/lit. The solubility of oxygen from air in the fermenter broth is 7.3 mg/lit at 30 ˚C. What maximum conc. of cells can be sustained in the fermenter at aerobic condition?

(3+3)+6=12

9. Explain significance of D.O in bioreactors. Discuss types of D.O probes available. Explain in brief operating principles of each type of D.O probes. What is drift? What causes drift?
(2+2+3+3+2)=12