



Name :

Roll No. :

Invigilator's Signature :

CS / B.TECH (BT-NEW) / SEM-5 / BT-502 / 2010-11

2010-11

BIOREACTOR DESIGN & ANALYSIS

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$$10 \times 1 = 10$$

- i) The unit of 1st order reaction when partial pressure will be used in place of concentration is
- a) atm^{-2} b) $atm^{-2}time^{-1}$
- c) $time^{-1}atm^{-1}$ d) $time^{-1}$.
- ii) For completely mixed system, the dimensionless variance, $6\sigma^2$, for E-curve due to pulse input is
- a) 0 b) equal to 1
- c) less than 1 d) infinity.



- iii) The volumetric mass transfer coefficient, RL_a , is related to
- a) oxygen transfer
 - b) mass transfer unit
 - c) packed bed absorption
 - d) diffusion rate.
- iv) Air lift fermenter may be designed on the basis of
- a) plug flow
 - b) plug flow with dispersion
 - c) completely mixed system
 - d) segregated model.
- v) The growth curve of animal cell culture has no stationary phase due to
- a) exhaustion of substrate
 - b) presence of inhibitors
 - c) production of toxic metabolites
 - d) foam formation.



- vi) Penicillin-G is best produced in a reactor of the type
- a) CSTR with baffles
 - b) CSTR without baffles
 - c) fluidized bed
 - d) air lift fermenter.
- vii) The best choice of a reactor for the production of Monoclonal antibodies is
- a) Microcarrier
 - b) Microencapsulation
 - c) Hollow fiber reactor
 - d) Tubular membrane reactor.
- viii) The most important scale-up criterion for an aerobic CSTR is
- a) constant K_{La}
 - b) geometric similarity
 - c) hydrodynamic similarity
 - d) constant impeller based Reynolds number.



- ix) The design interior of a chemostat is
- a) residence time b) dilution rate
 - c) specific growth rate d) space time.
- x) Damköhler number is a measure of
- a) molecular diffusion
 - b) biochemical reaction
 - c) pore diffusion
 - d) combination of (a) and (b).
- xi) Thiele modulus is a measure of
- a) molecular diffusion
 - b) pore diffusion
 - c) chemical reaction
 - d) combination of (a) and (b).
- xii) Power number varies with impeller based Reynolds number, Re_i for turbulent flow
- a) varies inversely
 - b) varies directly
 - c) independent of Re_i
 - d) varies asymptotically.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Milk is pasteurized if it is heated to 63°C for 30 minutes, but if it is heated to 74°C it only needs 15 s for the same result. Find the activation energy of this sterilization process.
3. Describe the operation of perfusion reactor.
4. Liquid A decomposes by second order kinetics and in a batch reactor. 50% of A is converted in a 5 minute run. How much longer would it take to reach 75% conversion ?
5. Describe the operation of a bubble column bioreactor and develop a model if the oxygen transfer rate (k_{la}) is the controlling one.
6. Distinguish between a chemostat and turbidostat. Derive a model for a chemostat for sterile feed in terms of D , X , S & μ .



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. A simple, batch fermentation of an aerobic bacterium growing on methanol gave the results shown in the table.

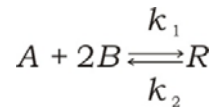
Calculate :

- Maximum growth rate (μ_{\max})
- Yield on substrate ($Y_{X/S}$)
- Mass doubling time (t_d)
- Saturation constant (K_S)
- Specific growth rate (μ_{net}) at $t = 10\text{h}$

Time (hr)	0	2	4	8	10	12	14	16	18
X(g/l)	0.2	0.211	0.305	0.98	1.77	3.2	5.6	6.15	6.2
S(g/l)	9.23	9.21	9.07	8.03	6.8	4.6	0.92	0.077	0



8. The elementary liquid-phase reaction



$$-r_A = -1/2r_B = (12.5 \text{ liter}^2 / \text{mol}^2 \cdot \text{Min}) C_A C_B^2 - (1.5 \text{ min}^{-1}) C_R, \\ [\text{mol/liter} \cdot \text{min}]$$

is to take place in a 6-liter steady-state mixed flow reactor.

Two feed streams, one containing 2.8 mol A/liter and the other containing 1.6 mol B/liter, are to be introduced at equal volumetric flow rates into the reactor, and 75% conversion of limiting component is desired. What should be the flow rate of each stream ? Assume a constant density throughout.

9. Write a short notes on

a) Dispersion model

b) Tank in series model

7½ + 7½



10. Substrate A and enzyme E flow through a mixed flow reactor (V=6 liter). From the entering and leaving concentrations and flow rate find a rate equation to represent the action of enzyme on substrate.



C_E mol/liter	C_{A0} mol/liter	C_A mol/liter	v, lit/hr.
0.02	0.2	0.04	3.0
0.01	0.3	0.15	4.0
0.001	0.69	0.60	1.2

11. Write short notes on any *three* of the following :

- Trickling filter for waste water treatment
- Production of vaccine in a Roller bottle
- Perfusion system for animal cell culture
- Fluidized bed reactor for animal cell culture
- Determination of K_{la} by the steady state method.

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