E/L/TX

Reg. No:

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BBIT301L - Principles of Bioprocess Engineering

Class NBR(s): 4151 / 4155 Slot: E1+TE1

Time: Three Hours Max. Marks: 100

➢KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE

➢DON'T WRITE ANYTHING ON THE QUESTION PAPER

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Demonstrate the bubble-driven bioreactors.

2. Enumerate the significant monitoring variables with their sensors used in bioreactor operation and analyze the control approaches for any two variables in detail.

3. Derive the equation for the reaction time for an enzyme-catalysed batch process.

4. In a fed-batch culture operating with intermittent glucose solution addition, values of the following parameters are given at time t = 2h, when the system is at a quasi-steady: V = 1000 ml; F = dV/dt= 200 ml/h; S_0 = 100 g/l; μ_{max} = 0.3 /h; K_s = 0.1 g/l; $Y_{x/s}$ = 0.5 g/g; X_0 =30 g. (a). Find V_0 (initial volume of the culture). (b).Determine the concentration of the growth-limiting substrate in the vessel at quasi-steady state. (c).Determine the concentration and total amount of biomass in the vessel at t = 2h (at quasi-steady state).

5. a) Differentiate between an unsteady state and a steady state process. [2]

   b) Using a mass balance, derive the expressions for the steady-state biomass (x), substrate (s), and product (p) concentrations for the chemostat continuous process. [8]

6. A 5 m^3 fermenter operates continuously with a feed substrate concentration of 20 kg/m^3 for the biomass production in a chemostat bioreactor. The microorganism in the reactor has the following characteristics: μ_{max} = 0.45 /h; Ks = 0.8 kg/m^3; $Y_{x/s}$ = 0.55 kg/kg. (a). What feed flow rate is required to achieve 90% substrate conversion? (b). How does biomass productivity at 90% substrate conversion compare with the maximum possible?

7. The dynamic method measures k_{La} in a fermenter operated at 30°C. Data for dissolved–oxygen concentration as a function of time during the re-oxygenation step is as follows:

Time (s)	10	15	20	30	40	50	70	100	130
C_{AL} (%air saturation)	43.5	53.5	60	67.5	70.5	72	73	73.5	73.5

The equilibrium concentration of oxygen in the broth is 7.9×10^{-3} kg/m^3. Determine k_{La}.

8.a) Write on the factors affecting oxygen transfer in the operation of a fermenter.

OR

8.b) "In aerobic fermentation, oxygen molecules must overcome a series of transport resistances before being utilized by the cells." Elaborate on the statement.

9.a) Enlist scale–up parameters and explain about their independency.

OR

9.b) Consider the scale–up of a fermentation from a 10 litres to 10000 litres vessel. The small fermenter has a height –to- diameter ratio of 3. The impeller diameter is 30% of the tank diameter. Agitation speed is 500 rpm and three Ruston impellers are used. Assume the vessel is a cylinder. Determine the dimensions of the large fermenter and agitation speed for: (i) Constant P/V (ii) Constant impeller tip speed (iii) Constant Reynold number

10. *Bacillus Subtilis* is cultivated in continuous culture under aerobic conditions with a glucose limitation. When the system is operated at D= 0.2 /h, determine the effluent glucose and biomass concentrations by using Monad, Tessier, Moser and Contois equations (So=5 g/l). Given: μ_m =0.3 /h; K_s=100 mg/l; K=0.005 (mg/l)$^{-1}$; n =1.5; K_{sx} = 0.04; Yx/s =0.4 gX/gS. Also, comment on the results.

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