Exam. Code: 0909
Sub. Code: 6708

2021
B.E. (Biotechnology) Fifth Semester
BIO-512: Bio-Process Engineering

Time allowed: 3 Hours

Max. Marks: 50

NOTE: *Attempt <u>five</u> questions in all, including Question No. I which is compulsory and selecting two questions from each Section. Make suitable assumptions wherever necessary.*

x-x-x

1. Attempt the following:-

   a) Which all reactions can be accommodated to account for the loss of nutrient qualitythat take place during sterilization?

   b) Explain how sterilization at high temperature for a short time is significant for any fermentation process.

   c) Develop an expression to link specific growth rate and doubling time t_d.

   d) What is the importance of critical dilution rate?

   e) Explain the concept of cyclic fed-batch culture.

   f) Device a method to assess mixing effectiveness of a bioreactor.

   g) Differentiate between medium formulation and optimization.

   h) Write any two major requisites crucial for implementing SIP.

   i) What are kinetic models? Give any example.

   j) Define the significance of scale-down experiments. (1 x 10)

Section-A

2. A batch culture is inoculated with 12 g of cells into a 100-litre bubble column fermenter containing 10 g L^{-1} glucose. The culture does not exhibit a lag phase. The maximum specific growth rate of the cells is 0.9 h^{-1}; the biomass yield from glucose is 0.575 g g^{-1}. i) Estimate the time required to reach stationary phase. ii) What will be the final cell density if the fermentation is stopped after only 70% of the substrate is consumed? (10)

3. Bacterial cells are used for chemostat culture in a 60-m^3 fermenter. The feed contains 12 g l^{-1} of glucose; k_s for the organism is 0.2 g l^{-1}. a) What flow rate is required for a steady-state substrate concentration of 1.5 g l^{-1}? At the flow rate of a), what is the cell density? (10)

P.T.O.

4. What do you understand by scale up of fermentation processes? What are the various factors affected by the scale? Give your recommendations on Scale-up of mixing systems. (10)

Section-B

5. a) Explain the inherent advantages of the air-lift bioreactors along with a brief description about their construction using neat sketch.

   b) Briefly describe the factors that affect oxygen transfer coefficient and interfacial area per unit volume in a fermentation system. (6+4)

6. Describe the basic principle of dynamic gassing-out technique for assessment of volumetric mass-transfer coefficient for a fermenter. Elaborate your discussion using relevant expressions and plots. (10)

7. A steam sterilizer is used to sterilize liquid medium for fermentation. The initial concentration of contaminating organisms is 10^8 per liter. For design purposes, final acceptable level of contamination is usually taken to be 10^{-3} cells.

   For how long should 1 m^3 medium be treated if the temperature is i) 80^0C ii) 121 ^{0}C? Assume that the contaminants present are the spores of *Bacillus stearothemophilus*, for which the activation energy for thermal death is 283 kJ $gmol^{-1}$ and the Arrhenius constant is $10^{36.2}$ s^{-1}. (10)

x-x-x