301 (1)

Exam. Code: 0909
Sub. Code: 6309

2123
B.E. (Biotechnology) Fifth Semester
BIO-512: Bio-Process Engineering

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Section. Assume any missing data.

x-x-x

1. Attempt the following:-

a) Discuss the significance of critical biomass concentration.
b) Express the importance of *Luedking-Piret* model.
c) Define specific growth rate.
d) Define apparent viscosity and its role in bioreactor design.
e) Explain the analogy between heat and filter sterilization.
f) Discuss how antifoam agents work in a large scale fermentation medium?
g) "There is a periodic shift-up in the growth rate of the process organism followed by gradual shift-down", identify the culture system and state how this is achieved.
h) Obtain an expression for cell-concentration in continuous culture as a function of time.
i) Differentiate between interception from impaction as the mechanism behind filtration.
j) Explain the significance of HTST. (10)

Section-A

2. a) 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.
b) Keeping scale-up in consideration, discuss how does poor mixing affects the performance of a fermentation process. (6+4)

3. a) Deduce Newton's law of viscous flow. Describe various modifications of the Newton's law.
b) Suggest a kinetic model for a substrate-limited growth. Justify its essence in the batch culture and express substrate utilization constant. (5+5)

4. a) The *zymomonas mobilis* cells are used for a chemostat culture in a 50 m^3 fermenter. The feed contains 12 g glucose L^{-1}. Other constants are k_s for organism is 0.2 g L^{-1}, Yx/s = 0.06 g g^{-1}; Y p/x = 7.7 g g^{-1} μ_{max} = 0.3 h^{-1}, what flow rate is required for a steady state substrate concentration of 1.5 g L^{-1}?
b) Explain the quasi-steady state for a fed-batch culture. Support your answer with the help of suitable expressions and plots. (4,6)

P.T.O.

Section-B

5. a) It is required to supply air through a depth filter to a 10 m^3 fermenter with air at a rate of 5m^3 min^{-1} for a fermentation lasting 5 days. The technical literature of filter material shows the optimum linear air velocity to be 0.15 m sec^{-1} at which K was 1.54 cm^{-1}. If the microbial load of air inlet was 200 microorganisms m^{-3}, determine the dimensions of the air filter.

   b) What are CIP and SIP design requirements in fermenter design? Justify the significance of these requirements in the bio-therapeutics manufacturing through fermentation? (6+4)

6. What factors need to be considered while designing a fermentation medium? How important is the quality of water used for medium preparation? Briefly discuss the simplex method for optimization of medium. (10)

7. a) In a high oxygen demanding microbial process, the dissolved oxygen concentration of the broth was found to be negligible for the most part of the fermentation. Recommend a method for the determination of volumetric oxygen transfer coefficient. Justify your recommendation.

   b). A value of k_La has been determined for a fermenter at its maximum operational rotational speed with air being sparged at 0.50 vvm. *E. coli* with a q_{O2} of 10 mmol O_2/g-dry wt-h are to be cultured. C_{crit} is 0.2 mg/l. The solubility of oxygen from air in the fermenter broth is 7.3 mg/l at 30 °C. What maximum concentration of *E. coli* can be sustained in this fermenter under aerobic conditions? (5+5)

x-x-x