Exam. Code: 0909
Sub. Code: 33369

2124
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) Define and justify HTST concept.

b) Justify the need of scale-down.

c) Define limiting substrate.

d) Define apparent viscosity and its role in bioreactor design

e) Explain the analogy between heat sterilization and filter sterilization.

f) Define interception as the filtration mechanism.

g) Discuss the role of precursors in a fermentation medium.

h) Define critical dilution rate.

i) Differentiate between defined and complex media.

j) Explain impeller flooding. (10)

Section-A

2. a) Elaborate major shortcoming of a continuous culture and justify why fermentation industry has not adopted continuous culture for manufacturing of microbial products.

b) Deduce Newton's law of viscous flow. Describe various modifications of the Newton's law with relevant examples. (4,6)

3. a) *Tetrahymenathermophilla* protozoa have a minimum doubling time of 6.5 hours when grown using bacteria as the limiting substrate. The yield of protozoal biomass is 0.33 g per g of bacteria and the substrate constant is 12 mg l^{-1}. The protozoa are cultured at the steady-state in a chemostat using a feed-stream containing 10 g l^{-1} of nonviable bacteria. i) What is the maximum dilution rate for the operation of chemostat? ii) What is the concentration of *T. thermophilla* when operating dilution rate is one-half of the maximum?

b) Describe the growth-associated product formation in batch culture. (6,4)

4. a) List main factors involved in scale-up. Discuss how sterilization process is scale dependent and how it results in the nutrient degradation.

b) To scale up an aerobic microbial culture from the well-characterized 50L pilot scale to the 1500 L process scale, calculate the following ratios based on the constant Reynold's number where scale II is 1500 L and scale I is 50 L. if you are not able to answer one or more parts, at least state whether the ratio will be greater than less than or equal to one. i) Stirring speed N_{II}/N_{I} ii) Power imparted per volume fluid $(P/V)_{II}/(P/V)_{I}$ iii) state reasons whether scaling up in this manner is a good or bad idea.

(5,5)

P.T.O.

Section-B

5. a) What is the importance of sterilization in bioprocessing? Describe the process of batch sterilization / continuous sterilization. Write short note on sterilization of the fermenter.

   b) Define aseptic operation and containment. Explain how you would classify a process organism an appropriate level of containment. (6,4)

6. a) Give a detailed account on any one of the pneumatically agitated bioreactors with neat diagram.

   b) List major sources of carbon and nitrogen used in fermentation media. Also discuss important factors that may influence their final selection. (5,5)

7. a) A value of $k_La = 30\ h^{-1}$ has been determined for a fermenter at its maximum practical agitator rotational speed and with air being sparged at 0.5 l gas/l reactor volume-min. *E.coli* with a Q_{O2} of 10 mmol O_2/g-dry wt-h are to be cultured. The critical dissolved oxygen concentration is 0.2 mg/ml. The solubility of oxygen from air in the fermenter broth is 7.3 mg/l at $30^{O}C$. What maximum concentration of *E.coli* can be sustained in this fermenter under aerobic conditions?

   b) Which method/methods of k_La assessment would you use for determination under actual process conditions if dissolved oxygen concentration of broth remained very low throughout the process? Justify your answer.

   c) The characteristic time for oxygen transfer into a chemostat is estimated to be 15 seconds. If the characteristic time for the oxygen consumption in the system is 20 sec, will there be oxygen limitation? Justify.

   (6,2,2)

x-x-x