Exam. Code: 0909
Sub. Code: 6309

2122

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 importance of critical dilution rate.

b) Justify the need of scale-down.

c) Define specific growth rate.

d) What is an apparent viscosity and its role in bioreactor design?

e) Explain the anlogy between heat and filter sterilization.

f) Define turbidostat.

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

h) Obtain an expression for cell-concentration in continuous culture as a function of time.

i) Differentiate between defined and complex media.

j) Explain the significance of Arrhenius law in heat sterilization. (10)

Section-A

2. (a) Elaborate 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. (4,6)

3. Bacterial cells are cultured to high density for production of polysaccharide gum. The reactor used is a stirred tank, containing initially 100 l medium. The maximum specific rate of the culture is 0.18 d^{-1} and the yield of biomass from substrate is 0.5 g/g. The concentration of growth-limiting substrate in the medium is 3% (w/v). The reactor is inoculated with 1.5 g/l cells and operated in batch until the substrate is virtually exhausted; medium flow is then started at a rate of 4 l per day. Fed-batch operation occurs under quasi-steady state conditions.

   i) Estimate the batch culture time and final biomass concentration.

   ii) Fed-batch operation is carried out for 40 d. What is the final cell mass in the reactor? (10)

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

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(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. A) Stirring speed N_{II}/N_I B) Power imparted per volume fluid $(P/V)_{II}/(P/V)_I$ C) state reasons whether scaling up in this manner is a good or bad idea.

(5,5)

Section-B

5. a) Elaborate the design of a continuous sterilization process.
   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 pneumatically agitated bioreactors with neat diagrams.
   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) With the help of suitable dimensionless numbers express the relation between power consumption and operating variables with discussion on the outcomes obtained.
   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 20 seconds. If the characteristic time for the oxygen consumption in the system is 15 sec, will there be oxygen limitation? If the value of k_La is halved, will there be oxygen limitation? Justify. (5,3,2)

x-x-x