Exam. Code: 0909
Sub. Code: 6708

1129

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 Unit.*

x-x-x

I. Attempt the following:-

a) Define the term dilution factor.

b) What are the distinct advantages of fed-batch systems in bioprocessing?

c) What are the essential requirements of a fermentation medium?

d) What is meant by specific oxygen uptake rate?

e) What is the significance of critical oxygen concentration during fermentations?

f) Draw a relationship between shear stress and shear strain?

g) How are biochemical reactions different from chemical reactions?

h) Define yield factor.

i) Define limiting substrate.

j) What is X90? Write an expression for it. (10x1)

UNIT – I

II. a) Briefly discuss essential factors for a successful design and operation of a fermenter.

b) What is Newton's law of viscosity? Define coefficient of viscosity. Explain the rheology of non-Newtonian fluids. (4+6)

III. 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)

IV. Bacterial cells are cultured to high density for production of polysaccharide gum. The reactor used is a stirred tank, containing initially 100 | 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/1 cells and operated in batch until the substrate is virtually exhausted; medium flow is then started at a rate of 4 | per day. Fed-batch operation occurs under quasi-steady state conditions.

P.T.O.

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?

iii) The fermenter is available 275 d per year with a downtime between run of 24 h. How much plant cell biomass is produced annually? (10)

UNIT – II

V. a) Describe the various methods for measuring k_La. Compare and contrast the static method and dynamic method for the measurement of k_La.

b) Describe the process of oxygen transfer from the air bubble to the cell or cell cluster in fermentation broths. (6+4)

VI. The number of viable spores of a new strain of *Bacillus subtilis* is measured as a function of time at various temperatures. The values for death rate constant at these temperatures are k_d (85°C) = 0.012 min^1; k_d (90°C) = 0.032 min^{-1}; k_d (110°C) = 1.60 min^{-1}; k_d (120°C) = 9.61 min^{-1};

i) Determine the activation energy for the thermal death of spores.

ii) What is the specific death rate constant at 100° C?

iii) Estimate the time required to kill 99% of spores in a sample at 100°C? (10)

VII. a) Why foaming should be controlled in fermentation broths? Discuss various methods available for controlling foam.

b) Describe the criteria for the choice of a bioreactor for immobilized systems. What are the various types of bioreactors suitable? (5+5)

x-x-x