Exam.Code:1033
Sub. Code: 35399

2056

M.E. (Bio-Technology) Second Semester

MEBIO-202: Bioprocess and Bioreactor Engineering

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

NOTE: Attempt <u>five</u> questions in all, including Question No. 1 which is compulsory and selecting two questions from each Section. Assume any missing data.

x-x-x

1.

a. Design the preference of later and early mixing for a given RTD as per reaction kinetics.
b. Justify the use of WFI in animal cell fermentations.
c. Explain the importance of dispersion number in non-ideal bioreactors.
d. Give a pictorial representation of aeration in shake flasks fermentations.
e. Differentiate the working principle of different gassing-out techniques used for k_La assessment.
f. Explain importance of critical dissolved oxygen concentration.
g. Define chemostat.
h. Justify the significance of a thermally stable bioreactor operation.
i. Define Fouling factor and give reasons.
j. Contrast points of difference between empty and full-sterilization. **10**

SECTION-A

2. i) During exponential phase in batch culture, the growth rate of a culture is proportional to the concentration of cells present. When *Streptococous lactis* bacteria are cultured in milk, the concentration of cells doubles in 45 min, if this rate of growth is maintained for 12 h, what is the final concentration of cells relative to the inoculum level?

   ii) Deduce the expression for maximum cell concentration supported by heat-transfer system. **4,6**

3. i) Explain types of heat-transfer configurations for bioprocessing. Describe the general equipment used for heat-transfer. With the help of plots, depict temperature changes for countercurrent and cocurrent flow in double-pipe heat exchangers.

   ii) A stirred fermenter of diameter 5m contains an internal helical coil for heat transfer. The fermenter is mixed using a turbine impeller 1.8 m in diameter operated at 60 rpm. The fermentation broth has the following properties: $\mu_b = 5 \times 10^{-3}$ Pa s;

Contd.....P/2

ρ= 1000 kg $m^{-3;}$ C_p= 4.2 kJ kg^{-1} $°C^{-1}$; k_{fb} = 0.70 W m^{-1} $°C^{-1}$. Neglecting viscosity changes at the wall of the coil, calculate the heat-transfer coefficient. **5,5**

4. Enlist various problems associated with scale-up. Explain how scale-up based on

i) constant mixing-time criterion is impractical

ii) equal P/V leads to employment of higher tip speeds. **10**

SECTION-B

5. i) Giving reasons for non-ideality in real flow reactors, describe the various non-ideal flow behaviour characteristics in bioreactors with neat diagrams.

ii) Write a note on fermenter dynamics indicating the conditions of stability including the stability criteria for a Monod Chemostat model under steady state with a total washout condition. **6,4**

6. i) Write the brief note on process water quality. Explain different components of any water pretreatment operation.

ii) Elaborate the phage control procedure for the process air. **6,4**

7. i) Give a pictorial representation of various resistances involved in a gas-liquid mass-transfer during any aerobic fermentation.

ii) Enumerate various drawbacks associated with sulphite oxidation method for k_La assessment.

iii) *Serratia marcescens* bacteria are used for production of threonine. The maximum specific oxygen uptake rate of *S. marcescens* in batch culture is 5 mmol O_2 g^{-1} h^{-1}. The bacteria are grown in a stirred fermenter to a cell density of 40 gl^{-1}. k_La under these circumstances is 0.15 s^{-1}. At the fermenter operating temperature and pressure, the solubility of oxygen in the culture liquid is 8×10^{-3} kg m^{-3}. Is the rate of cell metabolism limited by mass-transfer, or dependent solely on metabolic kinetics? **3,3,4**

x-x-x