Exam. Code: 1033
Sub. Code: 7569

2054

M. E. (Bio-Technology)

Second Semester

ME-BIO-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.***

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1. Attempt the following:-

a. Express the major difference between flow patterns produced by radial flow and axial flow impellers in a baffled tank.
b. Define impeller flooding and its consequence on the bioreactor performance.
c. Explain the term-Mixing time.
d. What is Fick's law of diffusion?
e. How does bubble size affect the oxygen transfer in fermenter?
f. What is aseptic operation? What measures would you suggest to materialize this in a fermenter industry?
g. Draw velocity distribution for flow in pipes a) Plug flow b) Laminar flow.
h. Express the analogy between heat, mass & momentum transfer.
i. Justify why fermentation industry has not adopted the continuous culture for the manufacture of microbial products.
j. What is the purpose and principle behind tracer studies? **10**

Section-A

2. (A) Describe the criteria for suggesting the Model organisms. Give at least two examples of micro-organisms that have been referred as "Model" cells for bioreactor research.
(B) Discuss how microbial characteristics influence the bioreactor selection a) Oxygen demand b) Growth rate c) culture pH d) growth temperature. **6+4**

3. 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. **2+4+4**

4. (A) A stirred fermenter of diameter 5 m 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 $\mu_b = 5 \times 10^{-3}$ Pa s; $\rho = 1000$ kg m^{-3}; $C_p = 4.2$ kJ kg^{-1} $^oC^{-1}$; $k_{fb} = 0.70$ W m^{-1} $^oC^{-1}$. Neglecting viscosity changes at wall, calculate the heat transfer coefficient for the liquid film on the outside of the coil.
(B) A liquid stream is cooled from 70 ^oC to 32 ^oC in a double-pipe heat exchanger. Fluid flowing counter-currently with this stream is heated from 20 ^oC to 44 ^oC. Calculate the log-mean temperature difference. **6+4**

<u>P.T.O.</u>

Section-B

5. (A) Considering process water as one of the bioreactor system supplies, describe the required qualities, means of generating and distribution and methods for calculating the quantities needed for bioreactor operations.
(B) With the help of a diagram, explain the air compression system. Also, give a brief account on phage control.
(C) Justify bioreactors used in animal cell fermentations require extremely high quality water such as WFI. **4+3+3**

6. (A) Giving reasons for non-ideality in flow reactors, describe the various non-ideal flow behaviour characteristics in bioreactors with neat diagrams.
(B) 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**

7. (A) Discuss the dynamic-gassing out method for k_La assessment. Include relevant expressions and plots to explain its merits and demerits.
(B) In high oxygen demanding microbial process, the dissolved oxygen concentration of the broth was found to be approximately zero for the most part of the fermentation process. Which method will you use for determination of volumetric oxygen transfer coefficient? Justify. **7+3**

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