

PBT6I101 BIOREACTOR DESIGN & ANALYSIS

Module- I: Principles and concepts

Recapitulation of the principles of Kinetics for chemical and Bio-chemical Reactions.

Fundamentals of homogeneous reactions for batch / semi-batch, plug flow reactor (PFR), continuous stirred tank reactors (CSTR), fluidized bed reactor bubble column, air lift fermenter etc, stirred tank/mixed reactors, adiabatic and programmed reactors. Unconventional bioreactors: Hollow fiber reactor, membrane reactor, perfusion reactor for animal and plant cell culture.

Module- II: Bioreactor Analysis

Analysis of ideal bioreactors: Fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with Recycle and wall growth, Ideal Plug-Flow Tubular reactor. Analysis of Non-ideal Reactor Analysis: Concept of ideal and non-ideal reactor; residence time distribution; models of non-ideal reactors – plug flow reactor for microbial processes; Mass transfer in biochemical processes; Multiphase bioreactors – packed bed with immobilized enzymes or microbial cells; three – phase fluidized bed trickling bed reactor; Design and analysis of the above reactor systems; Gas liquid reactors, Reactor stability.

Module- III: Bioreactor Design

Design considerations: oxygen transfer, heat transfer, rheology, mixing. Scale up and scale down concepts. Bioprocess control and computer coupled bioreactors; Growth and product formation by recombinant cells. Mechanical fittings in a bioreactor: vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology. Instrumentation and control of bioprocesses: Bioreactor sensor, online sensors for cell properties, off-line analytical methods; Biosensors. Bioreactor design calculation.

Text Books

1. Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.
2. Bailey & Ollis, Biochemical Engg. Fundamentals, MGH.,1990
3. Atkinson, B., Biological Reactors, pion Ltd., London,1974.
4. Coulson, Richardson, Sinnott, An introduction to chemical engineering design, Pergamon
5. Alba S., Humphrey E and Milli N.R., "Bio Chemical Engineering" Academic Press, 1973.
6. Scragg.A.H "Bioreactors in Biotechnology"- A Practical approach
7. Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.). 1986. Press.
8. Lydersen, D'Elia, Nelson, Bioprocess engineering: Systems and equipment.

BIOREACTOR DESIGN & ANALYSIS LAB (UNDER REVISION)

1. Bioreactor operation – Demonstration
2. Batch, fed batch and continuous cultures a) Estimation of Monod parameters b) Pure and mixed cultures.
3. Temperature effect on growth-estimation of energy of activation and Arrhenius constant for micro-organisms.
4. Determination of Oxygen transfer rate
K_{La} determination by sulphite oxidation method
K_{La} determination by dynamic gassing method
K_{La} determination by power correlation analysis
5. Packed bed bioreactor: study of process parameters
6. Fluidised bed reactor: study of process parameters
7. Screening of process variables single dimensional search, Blackett Burman design, design expert etc.
8. Study of rheology of fermentation broth and power determination.
9. Bioprocess control using software
10. Production of secondary metabolites by feed batch culture.