

BIOCHEMICAL ENGINEERING

Expected entry-level knowledge for TU-Delft MSc Life Science & Technology

The content listed below is taken from ‘Doran’ as an *example*. Similar content may also be found in other text books. You are expected to have an *understanding* of this or similar content when you arrive in Delft; you are not expected to have learned it by heart.

Book: Bioprocess Engineering Principles by P.M. Doran
Publisher: (2012) 2nd edition. Academic Press ISBN 978012208545 (paperback)

- Chapter 2 Introduction to Engineering Calculations
- Physical Variables, Dimensions and Units
 - Force and Weight
 - Measurement Conventions
 - Standard Conditions and Ideal Gases
 - Physical and Chemical Property Data
 - Stoichiometry
- Chapter 3 Presentation and Analysis of Data
- Errors in Data and Calculations
 - Presentation of Experimental Data
 - Data Analysis
 - Graph Paper with Logarithmic Coordinates
 - General Procedures for Plotting Data
 - Process Flow Diagrams
- Chapter 4 Material Balances
- Thermodynamic Preliminaries
 - Law of Conservation of Mass
 - Procedure for Material-Balance Calculations
 - Material Balance with Recycle, By-Pass and Purge Streams
 - Stoichiometry of Growth and Product Formation
- Chapter 5 Energy Balances
- Basic Energy Concepts
 - General Energy-Balance Equations
 - Enthalpy Calculation Procedures
 - Enthalpy Change in Non-Reactive Processes
 - Steam Tables
 - Procedure for Energy-Balance Calculations without Reaction
 - Enthalpy change due to reaction
 - Heat of reaction for processes with biomass production
 - Energy balance equation for cell culture
- Chapter 6 Unsteady-State Material and Energy Balances
- Unsteady-State Material-Balance Equations
 - Unsteady-State Energy-Balance Equations
 - Solving Differential Equations
 - Solving Unsteady-State Mass Balances
 - Solving Unsteady-State Energy Balances

- Chapter 7 Fluid Flow
- Classification of Fluids
 - Fluids in Motion
 - Viscosity
 - Momentum Transfer
 - Non-Newtonian Fluids
 - Viscosity Measurements
 - Rheological properties of fermentation broths
- Chapter 8 Mixing
- Functions of mixing
 - Mixing equipment
 - Flow patterns in stirred tanks
 - Impellers and stirrer power requirements
 - Power input
 - Mechanisms of mixing
 - Improving mixing in fermenters
 - Effect of rheological properties on mixing
- Chapter 9 Heat Transfer
- Heat transfer equipment
 - Mechanisms of heat transfer
 - Conduction
 - Heat transfer between fluids
 - Design equations for heat transfer systems
- Chapter 10 Mass Transfer
- Molecular diffusion
 - Role of diffusion in bioprocessing
 - Film theory
 - Convective mass transfer
 - Oxygen uptake in cell cultures
 - Factors affecting oxygen transfer in fermenters
 - Measuring dissolved oxygen concentration
 - Estimating oxygen solubility
 - Mass transfer correlations for oxygen transfer
 - Measurement of $k_L a$
 - Measurement of the specific oxygen uptake rate
- Chapter 11 Unit Operations
- Overview of downstream processing
 - Overview of cell removal operations
 - Filtration
 - Centrifugation
 - Cell disruption
 - The ideal stage concept
 - Aqueous two-phase liquid extraction
 - Precipitation
 - Adsorption
 - Membrane filtration
 - Chromatography
 - Crystallization
 - Drying