

2.15 40136 BIOPROCESS PRINCIPLES AND CALCULATIONS

GENERAL EDUCATIONAL OBJECTIVES:

1. To study about the importance of Units and Dimensions
2. To study about the Basic chemical calculations concerned in Industry
3. To study about the Material Balances concept without chemical reactions in Industry
4. To study about the Material Balances concepts involving chemical reactions in Industry
5. To study about the Recycling operations dealt in Industries
6. To study about the Energy Balances

UNIT-1 UNITS AND DIMENSIONS

- 1.1 Introduction
- 1.2 Concept of Units and Dimensions
- 1.3 Systems of Units (fps, mks, cgs and SI)
- 1.4 Quantities: Fundamental and Derived
- 1.5 Conversions factors
- 1.6 Recommendations for use of units
- 1.7 Simple problems

UNIT-2 BASIC CHEMICAL CALCULATIONS

- 2.1 Introduction
- 2.2 Concept and problems on Atomic mass, molar mass and Mole
- 2.3 Methods of expressing the composition of mixtures and Solutions: Weight or Mass %, Mole%, Volume % for solids, liquids and gaseous matter – Concept and Problems
- 2.4 Gaseous Mixture – Dalton's Law, Amagat's Law, Raoult's and Henry's Law
- 2.5 Concentration – Concept and Problems Normality, Molarity, Molality, ppm, pH, pKa

UNIT-3 MATERIAL BALANCES WITHOUT CHEMICAL REACTIONS

- 3.1 Introduction
- 3.2 Law of conservation of mass
- 3.3 Process flow sheet
- 3.4 Classification of Material Balance problems
- 3.5 Guidelines for solving material balance problems without chemical reaction
- 3.6 Outline of procedures for material balance Calculations
- 3.7 Various operations carried out in industry: Concept and problems
- 3.8 Distillation, Evaporation, absorption, Extraction, Drying, Filtration, Mixing/Blending and Crystallization
- 3.9 Bypass operations: Concept and problems
- 3.10 Material Balances of unsteady state operations

UNIT-4 MATERIAL BALANCES INVOLVING CHEMICAL REACTIONS:

- 4.1 Introduction

4.2 Definition of Terms: Stoichiometry, Stoichiometric equation, Stoichiometric ratio, stoichiometric proportion, Limiting Component/ Reactant, Excess Reactant, Percentage Excess, Conversion, Selectivity and Yield.

4.3 Generalized approach for solving problems

4.4 Problems on all above topics

UNIT-5 RECYCLING OPERATIONS:

5.1 Introduction

5.2 Concept, Block Diagram

5.3 Purging operation.

5.4 Problems

UNIT-6 ENERGY BALANCES:

6.1 Introduction

6.2 Forms of energy, First Law of Thermodynamics

6.3 General Energy Balance Procedure

6.4 Heat Capacity- C_p and C_v Equations

6.5 Enthalpy changes accompanying chemical reactions:

6.5.1 Heat of Reaction [ΔH_R] and Standard heat of Reaction

6.5.2 Heat of Formation [ΔH_f] and Standard heat of Formation

6.5.3 Heat of Combustion [ΔH_C] and Standard heat of Combustion

6.6 Calorific values of fuels – GCV and NCV

6.7 Problems on all above topics

Reference Books:

1. Biochemical Calculations by I.H.Segel, second edition, Wiley India Pvt Ltd
2. Introduction to process calculations – Stoichiometry by K. A. Gavhane
3. Stoichiometry by Bhatt and Vora
4. Biochemical Engg. Fundamentals by J E Bailey & D. F. Ollis (McGraw Hill)
5. Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI
6. Bioprocess Engineering by Shule and Kargi 4. Bioprocess Engineering Principles by Pauline Doran