CHEMICAL PROCESS CALCULATION I

ENCH 203

Lecture : 3
Tutorial : 1
Practical : 0

Year : II
Part : I

Course Objectives:

The objective of this course is to develop systematic problem solving skills through learning of material balance and their formulation to the complex processes and problems.

1 Fundamental Concepts (6 hours)

1.1 Chemical engineering vs chemistry
1.2 Unit operations and unit processes
1.3 System of units, dimension, significant figures
1.4 Methods of expressing compositions of mixtures and solutions
  1.4.1 Mass fraction, mass percent, mass ratio
  1.4.2 Mole fraction, mole percent, volume fraction, volume percentage
1.5 Basic for calculation, gravity and specific gravity, flow rates

2 Behavior of Ideal and Real Gases (8 hours)

2.1 Ideal gases: Ideal gas equation, calculation of ideal gas
2.2 Mixtures of Ideal gases: Dalton's law, Amagat's law of additive volumes, average molecular weight, density and specific gravity.
2.3 Real gas: Critical properties, Equation of state, Compressibility charts.
2.4 Real gas mixtures: Equation of state, Mean compressibility factor, Pseudo-critical properties

3 Fundamental of Material Balance (9 hours)

3.1 Introduction to material balance
3.2 Total and component balances, steady and unsteady state processes
3.3 Batch and continuous processes, Tie element, basic for calculation
3.4 Independent material balance equations and degree of freedom
3.5 Steps for solving material balance problems

4 Mutiphase Equilibrium (8 hours)

4.1 Phase diagram and phase rule.
4.2 Dependence of vapor pressure on temperature
  4.2.1 Clapeyron equation, Clausius-Clapeyron equation, Antoine equation
  4.2.2 Vapour pressure from steam table and reference substance plots

4.3 Two component two phase system
4.3.1 Two component gas/single component liquid system
4.3.2 Two component gas/two component liquid system
4.4 Multicomponent equilibrium

5 Energy Balance-I **(9 hours)**

5.1 Terminology associated with energy balance
5.2 Types of energy in energy balance equation
5.3 Heat capacities: Mean heat capacities, heat capacity of mixtures of gases, prediction of heat capacities of solids and liquids
5.4 Energy balance without reaction
5.4.1 Unsteady state, closed systems
5.4.2 Steady state, closed systems

6 Computational Technique **(4 hours)**

6.1 Least square method linear equation fitting
6.2 Non-linear algebraic equation system
6.3 Numerical Integration: Trapezoidal rule, Simpson's rule

Tutorial **(15 hours)**

1. Sample problems related to methods of expressing composition of mixtures and solutions
2. Sample problems related to Real gas mixtures
3. Sample problems related to vapour pressure plot
4. Sample problems related to Heat capacities
5. Sample problems related to Simpson's rule

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below.

Chapter	Hours	Marks distribution*
1	6	7
2	8	12
3	9	12
4	9	12
5	9	12
6	4	5
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Himmelblau, D.H. (2001). Basic principles and calculations in chemical engineering. PHI.
2. Hougen, O.A, Watson, K.M., Ragatz, R.A. (1963). Chemical Process Principles, Part - I, Material and Energy Balance. New York: John Wiley and Sons Inc.
3. Narayanan, K.V., Lakshmikutty, B. (2017). Stoichiometry and Process Calculations. Delhi: PHI Learning Private Limited.
4. Felder, R.M., Rousseau R.W. (2000). Elementary Principles of Chemical Processes. Wiley.