

CHEMICAL PROCESS CALCULATION II

ENCH 253

Lecture : 3
Tutorial : 1
Practical : 0

Year : II

Part : II

Course Objectives:

The objective of this course is to enable students to learn and apply material balances for multistage processes and multiphase equilibrium processes. It also aims to develop a comprehensive understanding of steady-state energy balances in chemical processes and equip students with the skills to solve simultaneous material and energy balance problems effectively.

- 1 Material Balance without Reaction (8 hours)**
 - 1.1 Primary concepts about industrial processes
 - 1.2 Material balance involving evaporation, crystallization, leaching, liquid-liquid equilibrium, absorption, and distillation

- 2 Material Balance with Reaction (7 hours)**
 - 1.3 Stoichiometry, conversion, excess/limiting reactant, yield, selectivity, extent of reaction
 - 1.4 Species mole balances on steady state systems involving single unit and single reaction
 - 1.5 Processes involving single unit and multiple reactions
 - 1.6 Elemental material balances on steady state systems involving single unit and single reaction

- 3 Multi-Unit Material Balance (8 hours)**
 - 1.7 Primary concepts about industrial processes, process flowsheet
 - 1.8 Sequential multi-unit systems
 - 1.9 Balances with and without reaction
 - 1.10 Recycle with and without chemical reaction
 - 1.11 Bypass and purge streams

- 4 Energy Balance with Reaction (8 hours)**
 - 1.12 Standard heat concepts
 - 1.13 Heat of formation, reaction, and combustion
 - 1.14 Adiabatic reaction temperature, Hess's law of constant heat summation, Heat of reaction at constant pressure and constant volume
 - 1.15 Effect of temperature on standard heat of reaction

5 Simultaneous Material and Energy Balances (8 hours)

- 1.16 Drying process
- 1.17 Coal analysis, Orsat analysis, proximate and ultimate analysis of coal, complete and partial combustion, air/fuel ratio, theoretical and excess air, heating value of coal
- 1.18 Combustion process
- 1.19 Air conditioning and condensation
- 1.20 Transient process balances

6 Humidity and Saturation (6 hours)

- 1.21 Vapor pressure, saturation, humidity, relative humidity
- 1.22 Dew point, bubble point, wet bulb and dry bulb temperature
- 1.23 Humidity (Psychrometric) Chart and its application in Engineering calculations

Assignments

- 1. Steam reforming of natural gas
- 2. Flue gas scrubbing
- 3. Sulfuric acid plant
- 4. Blast furnace

Tutorial (15 hours)

- 1. Material balance for crystallization process
- 2. Material balance for multiple reactions
- 3. Material balances of reaction involving recycle operations
- 4. Energy balance for heat of reaction and combustion
- 5. Material and energy balance for drying and combustion processes
- 6. Calculation regarding humidity chart

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	8	11
2	7	9
3	8	11
4	8	11
5	8	11
6	6	7
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Himmelblau D. H. (2012). Basic principles and calculations in chemical engineering. PHI.
2. Felder R. M., Rousseau R. W. (2005). Elementary Principles of Chemical Processes. Wiley.
3. Hougen. O. A, Watson K. M. and Ragatz R. A. (1963). Chemical Process Principles, Part - I, Material and Energy Balance. John Wiley and Sons Inc, New York.