

CHE-221-VSC-T: Industrial Chemistry-I

Course Type: VSC (Theory)

No. of Credits: 2

Course Outcomes

At the end of the course, student will be able to

1. Remember the definitions, industrial processes, pollution norms, raw materials, and key chemical manufacturing techniques used in large- and small-scale industries.
2. Understand the principles behind unit operations, pollution control technologies, green chemistry approaches, and the roles of industrial and plant chemists.
3. Apply knowledge of industrial processes like distillation, crystallization, and polymerization to real-world chemical production systems
4. Compare unit operations and unit processes, renewable vs. non-renewable resources, and heavy vs. fine chemical manufacturing.
5. Assess the environmental impact of industrial processes by interpreting pollution control standards (CPCB, EPA) and recommending improvements through green chemistry.
6. Design sustainable chemical production workflows that incorporate energy-efficient unit operations and eco-friendly purification methods for fine chemicals.

Course Contents

Chapter 1: Introduction to Industrial Chemistry

[4 Hours]

Definition, scope, and significance of industrial chemistry, Classification of industries: large-scale, medium-scale, small-scale, Importance of the chemical industry in daily life and national economy, Types of raw materials: minerals, fossil fuels, air, water, agricultural materials, Difference between renewable and non-renewable raw materials, Role of industrial chemists and plant chemists.

Reference 1 (pp.1-35), 2 (pp.3-30), 3(pp.5-15), (pp.29-35)

Chapter 2: Industrial Pollution Control

[4 Hours]

Overview of Industrial Pollution, Pollution Control Technologies: Scrubbers, Electrostatic Precipitators (ESP), Bag filters. Water: Effluent Treatment Plant (ETP), Reverse Osmosis (RO), Zero Liquid Discharge (ZLD). Solid waste: Incineration, Landfilling, Composting, Waste to Energy. Cleaner Production and Green Chemistry Approaches: Principles of green chemistry, Waste minimization and solvent recovery, Energy-efficient processes.

Reference: 1(pp. 789–810), 3 (pp. 221–263), (pp. 325–345), 4(pp. 563–588)

Chapter 3: Unit Operations and Unit Processes**[11 Hours]**

Overview of chemical industries in India. Definition and distinction between Unit Operations and Unit Processes. Importance in industrial chemical manufacturing.

Unit Operations:

Distillation: Principle, Types of distillation, application in alcohol and petroleum industries. Drying: Drying principles, types of industrial dryers (rotary, spray, drum dryers), application in chemical industries. Filtration: Media types, equipment, example (sugar industry). Extraction: Liquid-liquid extraction, equipment, example (antibiotic extraction). Crystallization Supersaturation, nucleation, example (salt, sugar production).

Unit Processes:

Nitration: Concept, industrial method (nitrobenzene synthesis), Sulfonation: Concept, industrial method (detergent manufacturing), Halogenation: Mechanism, example (chloroform production), Polymerization: Introduction to addition and condensation polymerization processes, applications in plastics and fibers.

Reference: 1 (pp. 1–22), (pp. 175–178), 5 (pp. 1–12), (pp. 186–190) 6 (pp. 159–184), (pp. 213–240), (pp. 386–419), (pp. 658–688), (pp. 773–802), 7 (pp. 145–176)

Chapter 4: Heavy and Fine Chemicals**[11 Hours]**

Overview and significance of Heavy and Fine Chemicals in chemical industries. Distinction between bulk production (Heavy Chemicals) and high-purity specialty production (Fine Chemicals). Importance in sectors such as fertilizers, explosives, pharmaceuticals, and electronics.

Heavy Chemical Manufacturing Processes:

Contact Process: Manufacture of sulfuric acid. Haber Process: Synthesis of ammonia. Solvay Process: Production of sodium carbonate. Chlor-alkali Process: Electrolysis of brine for chlorine, hydrogen, and sodium hydroxide production. Importance of Catalysts: Catalytic roles in sulfuric acid and ammonia production for energy-efficient processes.

Fine Chemical Manufacturing:

Batch manufacturing: Penicillin production in fermentation reactors. Continuous manufacturing: Large-scale paracetamol intermediate production.

Physicochemical principles and their application of Heavy Chemical and Fine Chemical. Purification Techniques for Fine Chemicals: Recrystallization, chromatography, high-vacuum distillation for high-purity products. Reference: 1 (pp. 125–141), 5 (pp. 45–52), 7 (pp. 24–37), 8 (pp. 12–16)

References

1. Industrial Chemistry, B. K. Sharma, Goel publishing House, 18th Ed. (2014)
2. Sharma, B.K., & Gaur, H.K. (2016). Industrial Chemistry (8th ed.). Meerut: Goel Publishing House.
3. Pandey, G.N. (2015). Engineering Chemistry (9th ed.). Meerut: Vikas Publishing House Pvt. Ltd.
4. Shukla, S.D., & Pandey, G.N. (2014). A Textbook of Chemical Technology (2nd ed.). Meerut: Vikas Publishing House Pvt. Ltd.
5. Outline of Chemical Technology, 3rd Edition, Dryden (Edited by Gopala Rao and M. Sitapathi Rao)
6. Unit Operations of Chemical Engineering, 7th Edition, Warren L. McCabe, Julian C. Smith, Peter Harriott
7. Shreve's Chemical Process Industries, 5th Edition, George T. Austin
8. Green Chemistry and Engineering: A Pathway to Sustainability, Anne E. Marteel-Parrish and Martin A. Abraham
9. C.S. Rao, Environmental Pollution Control Engineering, 2nd Edition, New Age International Publishers.