

Swami Ramanand Teerth Marathwada University, Nanded



B. O. S. IN CHEMISTRY

**B. SC. SECOND YEAR
(INDUSTRIAL CHEMISTRY)
SEMESTER-III & IV**

IN FORCE FROM JUNE - 2010

B. Sc. Second Year (Industrial Chemistry)

SEMESTER - III					
Paper	Course No.	Course Name	Period / Week	Total Periods	Marks
VI	CHIC-201	Unit Operation-III rd	03	45	50
VII	CHIC-202	Chemical Reaction Engineering-I	03	45	50
SEMESTER - IV					
VIII	CHIC-203	Unit Operation-IV th	03	45	50
IX	CHIC-204	Chemical Reaction Engineering-II	03	45	50
Practical Course – Yearly					
X	CHIC-205	Laboratory Course – II	04	120	50
XI	CHIC-206	Laboratory Course – III	04	120	50

B. Sc. Second Year (Semester-III)
Paper-VI, [CHIC-201]
Industrial Chemistry (Unit Operations-III)

Marks: 50

Periods: 45

Unit - I

1.1 Overview of Mass Transfer Operations: 04P

General Overview: Introduction to Mass Transfer operations, Benefits, General Principles of Mass Transfer, Importance & Classification of Mass Transfer Operations.

1.2.1 Distillation 12P

Introduction, Flash Distillation, Simple Distillation, Steam Distillation, Rectification, Material Balances in Plate Columns, Number of Ideal Plates, McCabe Thiele Method, constant molal overflow, Reflux Ratio, Condenser and Top Plate, Bottom Plate and Reboiler, Feed Plate, Minimum Reflux, Optimum Reflux Ratio, Plate Efficiency, Types, Relations, Factors influencing plate efficiency, Rectification in packed towers, Batch Distillation.

Unit - II

2.1 Liquid Extraction 09P

Terminology, Introduction to liquid-liquid extraction, Applications of Liquid-Liquid Extraction, Principles of liquid-liquid equilibria, Triangular diagrams, Types of extraction system, I & II, Temperature effects on systems types, Solvent selection, Commercial extraction system, Typical extraction system, Extraction calculations- Single Stage Operations, Multi Stage Cross Current Operation, Continuous multistage counter current operations.

Unit - III

3.1 Gas Absorption 08P

Introduction, Design of Packed Towers, Contact between Liquid & Gas, Pressure drop & limiting flow rates, Principles of absorption material balances, Limiting gas-liquid ratio, Temperature variations in packed towers, Rate of absorption, Calculation of tower height, Number of Transfer units.

Unit - IV

4.1 Crystallization 12P

Importance of Crystal Size, Crystal Geography, Crystallographic systems, Invariant Crystals, Principles of Crystallization, Purity of Product, Equilibria & its yields, Enthalpy Balances, Super Saturation, Units of Super Saturation, Temperature differential as a potential, Nucleation-Origins of Crystals in crystallizers, Primary nucleation, Homogeneous nucleation, Equilibrium, Kelvin Equation, Rate of nucleation, Heterogeneous nucleation, Secondary nucleation, Contact nucleation, Crystal Growth-Individual & overall Growth Coefficients, Growth Rate, Mass Transfer Coefficient, Surface Growth Coefficient, ΔL law of crystal growth, Crystallization Equipment-variations in crystallizers, Vacuum Crystallizers, Draft Tube Baffle Crystallizer, Yield of Vacuum Crystallizer.

Reference Books:

1. Unit Operations of Chemical Engineering – W.L.McCabe, J.C. Smith, Pter Harriott
2. Mass Transfer Operations- Robbert E. Treybal
3. Chemical Engineering Vol.2 – J.M.Coulson & J.F.Richardson
4. Principles of Mass Transfer Operations- Kiran D. Patil (Niralı Prakashan, Pune)
5. Unit Operations-I & II – K.A.Gavhane(Niralı Prakashan, Pune)
6. Industrial Chemistry – B.K. Sharma, (Goel Publishing House, Meerut)

B. Sc. Second Year (Semester-III)
Paper-VII, [CHIC-202]
Industrial Chemistry (Chemical Reaction Engineering – I)

Marks: 50

Periods: 45

Unit – I

1.1 Overview of Chemical Reaction Engineering **05P**

Typical Chemical Process, Classification of reactions, Variable Affecting the Rate of Reaction, Definition of Reaction Rate.

Unit - II

2.1 Kinetics of Homogeneous Reactions **18P**

The rate equation, Concentration-Dependent Term of a rate equation, Single & multiple Reactions, Elementary & Non elementary reactions, Molecularity & Order of Reaction, Rate Constant(K), Representation of an Elementary Reaction, Representation of Non elementary Reaction, Kinetic Models for Non elementary Reactions-free radicals, ions & polar substances, Molecules, Transition Complex, Non Chain Reactions, Chain Reactions-Free radicals, Chain reaction mechanism, Molecular intermediates, non chain mechanism, Transition Complex, non chain mechanism. Temperature-Dependent Term of a Rate Equation-Temperature Dependency from Arrhenius Law, Comparison of Theories with Arrhenius law, Activation Energy and Temperature Dependency, (Example 2.3).

Unit – III

3.1 Interpretation of Batch Reactor Data **18P**

Introduction of Batch Reactor, Constant-Volume Batch Reactor, Analysis of Total Pressure data obtained in a Constant-Volume System, Integral Method of Analysis of Data, Irreversible Unimolecular-Type First Order Reactions, Irreversible Bimolecular-Type Second Order Reactions, Zero Order Reactions, Overall Order of Irreversible Reactions from the Half-Life $t_{1/2}$, Irreversible reactions in Parallel, Homogeneous Catalyzed Reactions, Autocatalytic Reactions, Irreversible Reactions in Series, First Order Reversible Reactions, Second Order Reversible Reactions, Reactions of Shifting Order, Differential Method of Analysis of Data, Varying-Volume Batch Reactor, Differential Method of Analysis, Integral Method of Analysis, Zero Order Reactions, First Order Reaction, Second Order Reactions, The Search for a Rate Equation.

Unit - IV

4.1 Introduction to Reactor Design **04P**

Broad Classification of Reactor Types, Material balance for an element of Volume of the reactor, Energy balance for an element of Volume.

Reference Books:

1. Chemical Reaction Engineering - Octave Levenspiel
(Wiley India Pvt. Ltd. Third Edn.)
2. Chemical Reaction Engineering - K.A.Gavhane
(Nirali Prakashan, Pune)
3. Principles of Reaction Engineering – S.D.Dawande
(Central Techno Publication)

B. Sc. Second Year (Semester-IV)
Paper-VIII, [CHIC-203]
Industrial Chemistry (Unit Operation IV)

Marks: 50

Periods: 45

Unit – I

1.1 Drying of Solids

13P

Introduction, Classification of Dryers, Solid handling in dryers, Principles of Drying- Temperature Pattern in dryers, Heat Transfer in dryers, Heat duty, Heat Transfer Coefficient, Heat Transfer Units, Mass Transfer in Dryers, Phase Equilibrium moisture and free moisture, Bound & unbound water, Cross circulating drying-constant drying conditions, Rate of drying, Constant rate period, Critical Moisture Content & Falling Rate Period, Calculation of Drying Time under constant drying conditions, Drying Equipments-Dryers for Solids & Pastes, Dryers for Solutions & Slurries.

Unit - II

2.1 Evaporation

12P

Introduction, Liquid Characteristics, Types of Evaporators, Performance of Tubular Evaporators, Evaporator Capacity, Boiling Point Elevation and Duhring Rule, Effect of liquid head & friction on temperature drop, Heat Transfer Coefficient, Overall Coefficient, Evaporator economy, Enthalpy balance for single effect evaporator, Enthalpy balance with negligible heat of dilution, Single effect calculations, Multiple effect evaporators, Methods of feeding, Capacity and economy of multiple effect evaporator, Effect of liquid head and boiling point elevation.

Unit – III

3.1 Size Reduction

08P

Introduction, Principles of Comminution, Criteria for comminution, Characteristics of comminuted products, Energy & Power requirements in comminution, Crushing efficiency, Empirical relationship-Rittingers & Kicks Law, Bond Crushing Law & Work Index, Size reduction equipments.

Unit - IV

4.1 Metallurgy

12P

Introduction, Occurrence of Metals, Ore dressing, Ion Exchange method in metallurgy, Solvent Extraction Method in Metallurgy.

Mettallurgy of Iron: Occurrence Manufacturing of Cost Iron, Vertities of Cost Iron, Physical and Chemical Properties, uses.

Mettallurgy of Copper: Occurrence, Extraction of Copper, Properties, Alloys of Copper, Uses.

Reference Books:

1. Unit Operations of Chemical Engineering – W.L.McCabe, J.C. Smith, Pter Harriott
2. Mass Transfer Operations- Robbert E. Treybal
3. Chemical Engineering Vol.2 – J.M.Coulson & J.F.Richardson
4. Principles of Mass Transfer Operations- Kiran D. Patil (Nirali Prakashan, Pune)
5. Unit Operations-I & II – K.A.Gavhane (Nirali Prakashan, Pune)
6. Industrial Chemistry – B.K. Sharma (Goel Publishing House, Meerut)

B. Sc. Second Year (Semester-IV)
Paper-IX, [CHIC-204]
Industrial Chemistry (Chemical Reaction Engg. – II)

Marks: 50

Periods: 45

Unit - I

1.1 Ideal Reactors for a Single Reaction 08P

Three types of Ideal Reactors, Ideal Batch Reactor, Space Time & Space Velocity, Steady State Mixed Flow Reactor, (Example 5.1, Example 5.3), Steady State Plug Flow Reactor, (Example 5.5), Holding Time & Space Time for flow reactors.

Unit - II

2.1 Design for Single Reactions 15P

Size Comparison of Single Reactors, Batch Reactor, Mixed versus Plug Flow Reactors, First & Second Order Reactions, Multiple-Reactor Systems-Plug flow reactors in series and or in parallel, (Example 6.1), Equal size Mixed Flow Reactors in Series, First Order Reaction, Mixed Flow Reactors of Different sizes in Series, finding the conversion in a given system, Determining the Best System for a given conversion, Maximization of Rectangles, Reactors of types in series, Recycle Reactor & its performance equation.

Unit - III

3.1 Design for Parallel Reactions 02P

Introduction to Multiple Reactions-Qualitative Discussions about Product Distribution.

3.2 Reactions Catalyzed by Solids 06P

Heterogeneous Reactions-The burning of a Carbon Particle in Air, Overall Rate for Linear Process, Overall Rate for Nonlinear Process, Contacting Patterns for Two-Phase Systems.

Unit - IV

4.1 Solid Catalyzed Reactions 06P

Representation of the action of a Catalyst, The rate Equation for Surface Kinetics, Pore Diffusion Resistance Combined with Surface Kinetics.

4.2 Biochemical Reactions Systems 08P

Enzyme Fermentation, Batch or Plug Flow Fermentor, Mixed Flow Fermentor, Inhibition by a Foreign Substance-Competitive and Noncompetitive Solid state from autam of enzyme. Inhibition-Kinetics of ompetitive Inhibition , Kinetics of NonCompetitive Inhibition.

Reference Books:

1. Chemical Reaction Engineering-Octave Levenspiel (Wiley India Pvt. Ltd. 3rd Edn.)
2. Chemical Reaction Engineering - K. A. Gavhane (Nirali Prakashan, Pune)
3. Principles of Reaction Engineering – S. D. Dawande (Central Techno Publication)

B. Sc. Second Year (Semester-IV)
Paper-X, [CHIC-205]
Laboratory Course-II

Marks: 50

Periods: 120

1. To Perform a expt. on **Simple Distillation** using binary mixture (Methanol + Water or Ethanol+Water)& Verify the Raleigh's Equation and Calculate the Material Balance for Simple distillation.
2. To Perform a expt. on **Steam Distillation** using Terpentine and Calculate Material Balance for Steam Distillation..
3. To Perform a experiment on **Distillation with total reflux** using Binary mixture (Methanol + Water or Ethanol+Water) and Calculate number of plates for fractionating column .
4. To study the experiment on Liquid-Liquid Extraction by using **Mixer Settler** System & Calculate Percentage of Extraction.
5. To study the Liquid-Liquid Equillibria for three component system (**Glacial Acetic Acid +Chloroform+ Distilled Water**) and Calculate the Percentage composition of each component at heterogeneous mixture
6. To Study the distribution of Iodine between Water and CCl₄
7. To study the **Rate of Drying of solid** substances (saw dust or Card Board)
8. To study the **Rate of Drying of Liquid** substances.
9. To Crystallise the given sample of Phthalic acid from hot water using fluted paper and stemless funnel.
10. To Crystallise the given sample of Benzoic acid from hot water using fluted paper and stemless funnel.
11. To purify the given sample of naphthalene or camphor by simple sublimation method.
12. To purify the given sample of Succinic acid or phthalic acid by vacuum sublimation method.
13. Determine the rate of evaporation of given liquid Sample.
14. Preparation of m-dinitrobenzene from nitrobenzene & Calculate % Yield.
15. Preparation of P-nitroaniline from aniline & Calculate % Yield.
16. Preparation of P-Bromoacetanilide from Acetanilide & Calculate % Yield.
17. Preparation of 2,4,6-tribromoaniline from Aniline & Calculate % Yield.
18. Preparation of o-chlorobenzoic acid from anthranilic acid & Calculate % Yield.
19. Preparation of Sulphanilic acid from aniline & Calculate % Yield.

Note: 1. 20 % weightage be given to the viva-voce in the practical examination.

2. To Arrange Industrial visit for giving demo experiments on Drying, Mechanical Separation, Size Reduction and various unit operations carried out in industry.

Reference Books:

- 1 Unit Operations-II - K.A.Gavhane
2. Systematic Experimental Physical Chemistry – S.W.Rajbhoj & T.K.Chondhekar
3. Practical Chemistry – S. Umar, J. Sardar & A. Muley
4. University Practical Chemistry, Vishal Publishing Co.Jalandhar-P.C.Kamboj

B. Sc. Second Year (Semester-IV)
Paper-XI, [CH-206]
Laboratory Course-II

Marks: 50

Periods: 120

1. To Study the Performance of **Batch Reactor** : To study the Saponification of Ethyl acetate with NaOH in order to determine Order of reaction (n) & Rate constant (K) using Batch reactor.
 2. To Study the Performance of **Constant Stirred Tank Reactor** by using Ethyl acetate & NaOH.
 3. To Study the Performance of **Plug Flow Reactor** : To study the Performance of plug flow reactor used and to calculate theoretical & practical conversion for a second order reaction between Ethyl acetate & NaOH.
 4. To Study the Performance equation of **Coil Tube Reactor** : To study the Performance of plug flow reactor used and to calculate theoretical & practical conversion for a second order reaction between Ethyl acetate & NaOH.
 5. To Study the **First Order Reaction**: Hydrolysis of an Ester (Methyl Acetate in presence of HCL).
 6. To Study the **Zero Order Reaction**: Investigate the kinetics of Iodination of Acetone.
 7. To Study the **Autocatalytic reaction**: Reaction between Potassium Permanganate & Oxalic acid.
 8. To Study the Rate of reaction (r_A) between Ethyl bromo acetate & Sodium thiosulphate kinetically using **Batch Reactor**.
 9. To determine the Order of reaction (n) of given reaction Kinetics by using **Substitution method, Fractional change method and Differential method**.
 10. To determine the Rate Constant (K) of the reaction between Potassium Persulphate & Potassium Iodide having equal concentration of reacting species (a=b) by using **Mixed Reactor**.
 11. To determine the Rate Constant (K) of the reaction between Potassium Persulphate & Potassium Iodide having un equal concentration of reacting species (a≠b) by using **Mixed Reactor**.
 12. To determine rate constant (K) of the reaction between Bromic acid and Hydroiodic acid having equal concentration of reacting species (a=b) using **Batch reactor**.
 13. To determine the **Energy of Activation (E_a)** of hydrolysis of Ethyl acetate in presence of NaOH.
 14. To determine the **Energy of Activation (E_a)** of the reaction between Potassium Persulphate & Potassium Iodide.
 15. Termantative production of bzi solid state Industrially Impatutr Enzymes (Amyllozes)
- Note:** 20 % weightage be given to the viva-voce in the practical examination.

Reference Books:

1. Chemical Reaction Engineering - K.A.Gavhane
2. Systematic Experimental Physical Chemistry – S.W.Rajbhoj & T.K.Chondhekar
3. University Practical Chemistry, Vishal Publishing Co.Jalandhar-P.C.Kamboj