Swami Ramanand Teerth Marathwada University, Nanded

Industrial Chemistry

B.Sc. Second Year

B.O.S in Chemistry
Semester III & IV

Syllabus
June 2014

B.Sc. IInd Year (Industrial Chemistry)

SEMESTER - III					
Paper	Course no	Course name	Period/Week	Total Periods	Marks
VI	CHIC-201	Unit Operation-III	03	45	50
VII	CHIC-202	Chemical Reaction Engineering	03	45	50
SEMESTER - IV					
VIII	CHIC-203	Unit Operation-IV	03	45	50
IX	CHIC-204	Pollution Monitoring & Control	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. II Year Industrial Chemistry(Semester – III)

Unit Operations – III (CHIC – 201) Paper: VI

Hours:45

Unit - I

1.1 Overview of Mass Transfer Operations — 04 Periods

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

1.2 Distillation — 12 Periods

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 — 09 Periods

Terminology, Introduction to liquid-liquid extraction, Applications of Liquid-Liquid Extraction, Principles of liquid-liquid equillibria, 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, Mullti Stage Cross Current Operation, Continuous multistage counter current operations.

Unit – III

3.1 Gas Absorption — 08 Periods

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 — 12 Periods

Importance of Crystal Size, Crystal Geography, Crystallographic systems, Invariant Crystals, Principles of Crystallization, Purity of Product, Equillibria & 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
(Nirali Prakashan, Pune)
5. Unit Operations-I & II – K.A.Gavhane
(Nirali Prakashan, Pune)
6. Industrial Chemistry – B.K. Sharma(Goel Publishing House, Meerut)

Semester – III
B.Sc. II Year Industrial Chemistry

Paper: VII - Chemical Reaction Engineering (CHIC – 202)

Hours: 45

Unit – I

1.1 Ovierview of Chemical Reaction Engineering

Typical Chemical Process, Classification of reactions, Variable Affecting the Rate of Reaction, Definition of Reaction Rate. **05 Periods**

Unit - II

2.1 **Kinetics of Homogeneous Reactions**

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. **13Periods**

Unit – III

3.1 Interpretation of Batch Reactor Data

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. **13 Periods**

Unit - IV

4.1 Introduction to Reactor Design & Design for Single Reactions.

Broad Classification of Reactor Types, Material balance for an element of Volume of the reactor, Energy balance for an element of Volume. 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. **14 Periods**

Reference Books:

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

Semester – IV

Paper - VIII - Unit Operation IV (CHIC – 203)

Hours : 45

Unit – I

1.1 Drying of Solids 13 **Periods**

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 Equillibra-equillibrium 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

2.2 Evaporation **12 Periods**

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 **08 Periods**

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 **12 Periods**

Introduction, Occurrence of Metals, Ore dressing, Ion Exchange method in metallurgy, Solvent Extraction Method in Metallurgy. Metallurgy of Iron: Occurrence Manfacturing of Cost Iron, Vertities of Cost Iron, Physical and Chemical Properties, uses. Metallurgy of Copper: Occurrence, Extraction of Copper, Properties, Alloys of Copper, Uses.

Reference Books:

5. Unit Operations of Chemical Engineering – W.L.McCabe, J.C. Smith, Pter Harriott
6. Mass Transfer Operations- Robbert E. Treybal
7. Chemical Engineering Vol.2 – J.M.Coulson & J.F.Richardson
8. 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 (Pollution Monitoring and Control)

Unit 1: Regulatory aspects*:* **(15 Hours)**

Industrial emission, liquids and gases, pollution caused by various chemical industries and its overall effect on quality of human life and environment, environmental legislation, water (prevention and control of pollution) Act 1974 its implication application
and effectiveness in industrial pollution control, water quality management in India. . Air (Prevention and control of pollution) Act 1981,

Unit 2: Pollution and its measurements: **(15 Hours)**

Nature of industrial effluents, gaseous and liquid effluents, methodsof gas analysis, analysis of CO, SO_2, NO_x, S, Cl_2 in the gaseous effluents. Methods of removal of pollutants
from gaseous effluents, particulate matter, particle size analysis. AAS applications process
for waste water, particle size analysis in waste water, analysis of waste water the free acids
and bases, dissolved organic and inorganic compounds like alkali and alkaline salts, SO_x,
PO_x, NO_x . Determination of iron and calcium, suspended solids, total cations and anion, estimation of industrial metals recovery techniques: Organic trace chemicals in waste water, volatile carcinogens matter in waste water, recovery and recycling techniques,

Unit 3: Waste Water Treatment: **(05Hours)**

Biodegradable materials and removal of pollutants by microorganisms, methods of waste water treatments, analytical studies, food for microorganisms in waste water, BODand its measurement, activated sludge process.

Unit 4: Removal of Heavy toxic metals **(10 Hours)**

Chromium, mercury, lead, cadmium, arsenic, analytical methods of determination of small amounts of metal pollutants, copper recovery, treatment of waste water to remove heavy metals, recovery technique

Reference Books

1. S P Mahajan: Pollution control in process industry
2. M Sitting: Resources recovery recycling handbook and industrial waste (N D S
3. R B Pojasele: Toxic and hazardous waste disposal Vol. I and II(AAS)
4.A K Dey: Environmental chemistry
5. W Handley: Industrial safety handbook
6. A.C. Stern: Air pollution : Engineering control Vol (IV) A.P.
7. P.N. Cheremsioff and R.A. Young: Air pollution control and design

8. Liptak: Air pollution
9.Wark & Warner: Air pollution origin and control
10. S.M. Khopkar: Environmental pollution analysis
11. R.S. Ramalho: Introduction to waste water treatment process (A.P.0

B.Sc.II Year Industrial Chemistry (Sem IV)
Laboratory Course: II (CHIC – 205)
Paper : X **Marks : 50** **Hours : 120 (4 Hrs./week)**

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 CCl_4
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 Succunic acid or phthalic acid by vacuum sublimation method.
13. Determine the rate of evaporation of given liquid Sample.
14. Determination of copper in brass
15. Determination of Iron In Plain Carbon steel
16. Preparation of Lactose and Casein in from milk.
17. Preparation of Paracetamol.
18. Preparation of m- Dinitrobenzene From Nitrobenzene& Calculate % Yield.
19. Preparation of P- Nitro aniline From Aniline & Calculate % Yield.
20. Estimation of Cane Sugar.
21. Estimation of Lime in Cement.

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 Seperation, 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.II Year Industrial Chemistry(Sem IV)
Laboratory Course: II Experiments on - CHIC - 206

Paper : XI **Marks : 50** **Hours : 120 (4 Hrs./week)**

Experiments to be conduct in the academic year.

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 thereotical & 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 thereotical & 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 Permangnate & Oxalic acid.
8. To Study the Rate of reacation (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 prewence of NaOH.
14. To determine the **Energy of Activation (E_a)** of the reaction pbtween Potassium Persulphate & Potassium Iodide.
15. To Determine The Rate Constant of Decomposition of H_2o_2 In Presence of acidified KI solution
16. Determination of fluoride in given water sample.
17. Determination of Sodium, Potassium, Cadmium in given water sample.

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