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| Department of Chemical Engineering | | LP: CH18601 |
| B.E/B.Tech/M.E/M.Tech : Chemical Engineering | Regulation: 2018 | Rev. No: 00 |
| PG Specialisation : NA | | Date: 27/12/2023 |
| Sub. Code / Sub. Name : CH18601 / Mass Transfer II | | |
| Unit : I | | |

Unit Syllabus: Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations

Objective: To define the basics of absorption and design of various columns used

| Session No * | Topics to be covered | Ref | Teaching Aids |
|-------------------------------------------|-------------------------------------------------------------------|---------------------------|---------------|
| 1 | Gas absorption - Introduction | T1-Ch.8; pg.275 - 275 | BB, PPT |
| 2 | Stripping – equilibrium concept | T1-Ch.8; pg.276 - 282 | BB, PPT |
| 3 | Basics of material balance | T1-Ch.8; pg.276 - 282 | BB, PPT |
| 4 | limiting gas-liquid ratio | T1-Ch.8; pg.276 - 282 | BB, PPT |
| 5 | Classification on absorber tower | T2-Ch 18; Pg.568 - 570 | BB, PPT |
| 6 | Introduction to tray tower absorber | T2-Ch 18; Pg.568 - 570 | BB, PPT |
| 7 | Calculation of number of theoretical stages in absorber | T2-Ch 18; Pg.546 - 556 | BB, PPT |
| 8 | Tray efficiency | T2-Ch 18; Pg.546 - 556 | BB, PPT |
| 9 | Calculation on Tower diameter | T2-Ch 18; Pg.546 - 556 | BB, PPT |
| 10 | Introduction to packed tower absorber | T2-Ch 18; Pg.546 - 556 | BB, PPT |
| 11 | Rate based approach on absorption tower | T2-Ch 18; Pg.546 - 556 | BB, PPT |
| 12 | Determination of height of packing using HTU and NTU calculations | R1-Ch.8; pg.309 - 312 | BB, PPT |
| 13 | Problems on limiting gas – liquid ratio | R3 – Ch.8 Pg.203-232 | BB, PPT |
| 14 | Problems on total tower height | R3 – Ch.8 Pg.203-232 | BB, PPT |
| 15 | Problems on total tower height | R3 – Ch.8 Pg.203-232 | BB, PPT |
| Content beyond syllabus covered (if any): | | | |



Sub. Code / Sub. Name: CH18601 / Mass Transfer II

Unit : II

Unit Syllabus: Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by McCabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to azeotropic and extractive distillation- Case Study: Multicomponent distillation of Petroleum crude

Objective: To study the principle involved in the separation of liquid mixture by distillation and columns used for separation.

| Session No * | Topics to be covered | Ref | Teaching Aids |
|-------------------------------------------|----------------------------------------------------------------------------------------|--------------------------|---------------|
| 16 | Vapour – liquid equilibria a thermodynamic concept | T1-Ch.9; pg.342 - 347 | BB, PPT |
| 17 | Raoult's law and vapor-liquid equilibrium diagrams for ideal and non-ideal systems | T1-Ch.9; pg.348 - 349 | BB, PPT |
| 18 | Enthalpy concentration diagrams | T1-Ch.9; pg.363 - 364 | BB, PPT |
| 19 | Principle and types of distillation | T1-Ch.9; pg.363 - 374 | BB, PPT |
| 20 | Flash distillation – theory, design and problems | T1-Ch.9; pg.402 - 413 | BB, PPT |
| 21 | differential distillation – theory, design and problems | T1-Ch.9; pg.374 - 382 | BB, PPT |
| 22 | Steam distillation – theory, design and problems | T1-Ch.9; pg.382 - 388 | BB, PPT |
| 23 | Multistage continuous rectification & Number of ideal stages by McCabe - Thiele method | R3 – Ch .9 pg.286-310 | BB, PPT |
| 24 | Number of ideal stages by McCabe - Thiele method | R3 – Ch .9 pg.286-310 | BB, PPT |
| 25 | Number of ideal stages by McCabe - Thiele method | R3 – Ch .9 pg.286-310 | BB, PPT |
| 26 | Number of ideal stages by Ponchan - Savarit method | R3 – Ch .9 pg.286-310 | BB, PPT |
| 27 | Concepts of total reflux, minimum reflux ratio, optimum reflux ratio | R3 – Ch .9 pg.286-310 | BB, PPT |
| 28 | Introduction to azeotropic and extractive distillation | T1-Ch.9; pg.390 | BB, PPT |
| 29 | Case Study: Multicomponent distillation of Petroleum crude | - | BB, PPT |
| 30 | Case study on present industrial scenario | - | BB, PPT |
| Content beyond syllabus covered (if any): | | | |



Sub. Code / Sub. Name: CH18601 / Mass Transfer II

Unit : III

Unit Syllabus: Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction. Industrial Applications: Case Study Extractors with reflux

Objective: To know the basic and design of LLE

| Session No * | Topics to be covered | Ref | Teaching Aids |
|-------------------------------------------|---------------------------------------------------------------------------------|---------------------------|---------------|
| 31 | Introduction - Liquid - liquid extraction | T1-Ch.10; pg.477 - 479 | BB, PPT |
| 32 | Solvent characteristics for LLE | T1-Ch.10; pg.490 - 506 | BB, PPT |
| 33 | Equilibrium stage wise contact calculations for batch and continuous extractors | T1-Ch.10; pg.490 - 506 | BB, PPT |
| 34 | Differential contact equipment for LLE operation | T1-Ch.10; pg.542 - 547 | BB, PPT |
| 35 | Spray type extractor - introduction, design and problems | T1-Ch.10; pg.542 - 547 | BB, PPT |
| 36 | Packed and mechanically agitated contactors and their design calculations | T1-Ch.10; pg.541 - 553 | BB, PPT |
| 37 | Packed bed extraction with reflux - introduction, design and problems | T2-Ch.23; Pg.766-768 | BB, PPT |
| 38 | Pulsed extractors & centrifugal extractors - introduction, design and problems | T2-Ch.23; Pg.766-768 | BB, PPT |
| 39 | Supercritical extraction. Industrial Applications | RI | BB, PPT |
| 40 | Case Study Extractors with reflux | - | BB, PPT |
| Content beyond syllabus covered (if any): | | | |



Sub. Code / Sub. Name: CH18601 / Mass Transfer II

Unit : IV

Unit Syllabus: Leaching-Theory, Mechanism, Types of leaching, Solid - Liquid equilibria- Design of Batch and continuous extractors- Equipments and industrial applications.

Objective: To know the basic and design of SLE

| Session No * | Topics to be covered | Ref | Teaching Aids |
|-------------------------------------------|--------------------------------------------------------|---------------------------|---------------|
| 41 | Leaching-Theory, Mechanism | T1-Ch.13; pg.717 - 719 | BB, PPT |
| 42 | Types of leaching process – dispersion and percolation | T1-Ch.13; pg.758 - 760 | BB, PPT |
| 43 | Concepts on Solid - Liquid equilibria | T1-Ch.13; pg.720 - 722 | BB, PPT |
| 44 | Design of Batch extractors | T1-Ch.13; pg.723 - 724 | BB, PPT |
| 45 | Design of continuous extractors | T1-Ch.13; pg.749 - 754 | BB, PPT |
| 46 | Equipments for SLE types | T1-Ch.13; pg.763 - 764 | BB, PPT |
| 47 | Countercurrent operation – shank's system | R3-Ch.11; Pg.358-364 | BB, PPT |
| 48 | Rotocell & Kennedy extractor | R3-Ch.11; Pg.358-364 | BB, PPT |
| 49 | Bollman extractor | R3-Ch.11; Pg.358-364 | BB, PPT |
| 50 | industrial applications | | |
| Content beyond syllabus covered (if any): | | | |



Sub. Code / Sub. Name: CH18601 / Mass Transfer II

Unit : V

Unit Syllabus: Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

Objective: To understand the concepts of adsorption and advanced separation process.

| Session No * | Topics to be covered | Ref | Teaching Aids |
|-------------------------------------------|------------------------------------------------------------------|---------------------------|---------------|
| 51 | Adsorption - introduction | T2-Ch.25; pg.812 - 816 | BB, PPT |
| 52 | Types of adsorption, nature of adsorbents, adsorption equilibria | T2-Ch.25; pg.816 - 821 | BB, PPT |
| 53 | effect of pressure and temperature on adsorption isotherms * | T1-Ch.11; pg.585 - 588 | BB, PPT |
| 54 | Adsorption operations - stage wise operations | T1-Ch.11; pg.585 - 588 | BB, PPT |
| 55 | steady state moving bed and unsteady state fixed bed adsorbers | T1-Ch.11; pg.623 - 625 | BB, PPT |
| 56 | Break through curves | R4-Ch.3; pg.124 - 127 | BB, PPT |
| 57 | Principle of Ion exchange techniques and applications | R4-Ch.14; pg.763- 764 | BB, PPT |
| 58 | Solid and liquid membranes | R4-Ch.11; pg.533- 536 | BB, PPT |
| 59 | Concept of osmosis; reverse osmosis | R4-Ch.4; pg.168- 171 | BB, PPT |
| 60 | Dialysis; ultrafiltration | R4-Ch.4; pg.168- 171 | BB, PPT |
| Content beyond syllabus covered (if any): | | | |



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REFERENCES:**TEXTBOOKS:**

1. R.E.Treybal, Mass Transfer Operations, Third Edition, McGraw Hill, New Delhi, 1983.
2. W.L. McCabe, J. Smith and P. Harriot, Unit Operations in Chemical Engineering, Seventh Edition, Tata McGraw Hill, India, 2014.

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1. C. J. Geankopolis, "Transport Processes in Chemical Operations", Fourth Edition., Prentice Hall of India, New Delhi, 2004
2. M. Coulson and J. F. Richardson, "Chemical Engineering.", Vol - II, Fifth Edition., Pergamon Press, New York, 2002
3. N. Anantharaman and K.M.Meera Sheriffa Begum, "Mass Transfer Theory and Practice", Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
4. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
5. Henry Z.Kister, "Distillation Design", Tata McGraw Hill, 1992

| | Prepared by | Approved by |
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| Designation | Associate Professor | Professor and Head / CHE |
| Date | 27/12/23 | 28/12/2023 |
| Remarks *: | | |
| Remarks *: | | |

* If the same lesson plan is followed in the subsequent semester/year it should be mentioned and signed by the Faculty and the HOD