Chemical Engineering

4.2 HEAT TRANSFER – I

L	P
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RATIONALE

Heat transfer is very important subject. Aim of this subject is to provide good understanding to students about the heat transfer mechanism such as conduction, convection and radiation. These methods can then be used for understanding the performance of heat transfer equipments used in the chemical and allied industries.

DETAILED CONTENTS

1. Introduction : . (08 hrs)

   Heat, Heat Energy, Heat Transfer, Driving Force for Heat Transfer, Modes of heat transfer such as conduction, convection, radiation, concept of steady state and unsteady state heat transfer.

2. Conduction (22 hrs)

   Fourier's law, thermal conductivity of materials – solids, liquids and gases and one dimensional steady state heat conduction through plain wall, composite wall, steady state heat conduction through the cylinder, insulation and insulating materials, critical thickness of insulations, physical properties of insulating materials.

3. Convection (18 hrs)

   Convective Heat Transfer and concept of local heat transfer coefficient, overall heat transfer coefficient. Free and forced convection, Fins, types of fins, use of fins, Fin effectiveness/efficiency, Forced convection over plate, inside pipe and across tube bank significance of Reynolds's number, Prandtl number, and Nusselt numbers, Empirical correlation for free and forced convection, brief introduction about boiling, condensation and evaporation.

4. Radiation (16 hrs)

   Concept of thermal radiation, laws of radiation, absorptivity, reflectivity, transmitivity, Definition of black body, black body radiation, Planck's law, Wein's displacement law, Stefan Boltzman's law, Kirchoff's law, Grey body.

LIST OF PRACTICALS

1. To determine the heat transfer rate between hot and cold fluids – double pipe
2. To determine the overall heat transfer co-efficient for an open pan evaporator
3. To determine the amount of steam required in evaporating the solution in open pan evaporator
4. Measurement of emmissivity of test surfaces
5. To determine the heat transfer in extended surfaces
6. To determine heat transfer coefficient for forced convection
7. To determine heat transfer coefficient for free convection

INSTRUCTIONAL STRATEGY

A field visit may be conducted to expose the students to various types of heat transfer equipment. Practicals should be conducted to give an idea about modes of heat transfer, effect of insulation on heat transfer.

RECOMMENDED BOOKS

1. Heat Transfer by Chapman, MacMillan Publication
2. Principles of Heat Transfer by Kreith, Harper and Row Publication
3. Process Heat Transfer by Kern, McGraw Hill Publication
4. Heat Transfer by McAdams, McGraw Hill Publication
5. Heat ad Mass Transfer by D.S. Kumar
6. Solved examples in chemical Engineering by G.K. Roy.
7 Heat Transfer by K.A. Gavahne, Nirali Publications

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	08	10
2	22	40
3	18	30
4	16	20
Total	**64**	**100**

4.3 MASS TRANSFER – I

L	P
4	4

RATIONALE

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipments like distillation column, gas absorption columns, dryers, cooling towers and extraction columns etc which are used in industries for purification of products

DETAILED CONTENTS

1. Introduction to Mass Transfer Operations and Classification (04 hrs)

2. Diffusion (15 hrs)

   Definition of diffusion and its classification viz diffusion under concentration, pressure and thermal gradient, forced diffusion and eddy diffusion.

   Role of diffusion in mass transfer, fick's law, diffusion in the gas phase equimolecular counter diffusion, diffusion through stationary gas, Mass transfer coefficient, film theory and penetration theory of mass transfer, diffusion in solids, relation between film and overall mass transfer coefficient.

   Simple numerical problems based on Flick's law definition and physical meaning of mass transfer coefficient. Important correlations (no derivation), meaning of each term

3. Gas Absorption and Desorption (18 hrs)

   Condition of equilibrium between gas and liquid, mechanism of absorption, material balance and design equation, operating line. Concept of transfer unit (HTU and NTU) height of column based on condition-gas film, based on condition-liquid film, height of column based on overall coefficient. HETP for packed column of distillation, equipment used, types of tower packing, properties of tower packing, problems encountered like flooding, channeling, and weeping, loading, choice of solvent, Raoult's law and Henry's law.

4. Humidification and Dehumidification (15 hrs)

   Definition of humidity, saturated gas, relative humidity, percentage humidity, humid heat, humid volume, dew point, total enthalpy, Dry bulb and wet bulb temperature, meaning and principle only

Gas liquid contact operation: names of adiabatic and non-adiabatic equipment – natural draft cooling tower, humidifier and dehumidifier, different cooling tower arrangements, spray chambers, spray ponds

5. Leaching and Extraction (12 hrs)
Importance of leaching and extraction, leaching equipment, boll man extractor, plate tower, packed tower, spray tower, mixer settler extraction system

LIST OF PRACTICALS

1. Diffusion coefficient measurement in liquids
2. Diffusion coefficient measurement in solids
3. Wetted wall column experiment
4. Experiment on packed bed absorption tower
5. Experiment on humidification
6. Experiment on liquid-liquid extractor
7. Experiment on dry bulb and wet bulb temperature

INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of column (packed/tray) and different types of packings/trays used in the column. This will also make the students aware of auxiliary equipment/models/supports used for the columns. Along with the theoretical part, emphasis should be given to problem solving and practices especially for distillation column, absorption and humidification.

RECOMMENDED BOOKS

1. Mass Transfer Operations by Trey bal, Kogakusha Publication
2. Introduction to Chemical Engineering by Badger and Banc hero, McGraw Hill Publication
3. Unit Operation of Chemical Engineering by Mc Cab and Smith; McGraw Hill Publication
4. Mass Transfer by Sherwood Pigford and Wilke, McGraw Hill Publication
5. Chemical Engineers Handbook by Perry and Chilton, McGraw Hill Publication
6. Mass Transfer Operations by Kiran D. Patil, Nirali Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	04	05
2	15	20
3	18	35
4	15	20
5	12	20
Total	64	100

4.4 CHEMICAL ENGINEERING THERMODYNAMICS

L	P
4	-

RATIONALE

It is a core subject of Chemical Engineering and is essential for understanding basic concepts, thermodynamic properties of fluids and performance of thermal system used in industry.

DETAILED CONTENTS

1. Introduction and Basic Concepts (12 hrs)

   Systems, processes and surroundings, homogenous and heterogeneous systems, closed, open and isolated, extensive, and extensive properties, state and path functions. Concept of internal energy, enthalpy, entropy, free energy and equilibrium equation of state, ideal gas law, Vander Waals equation. Amagat's law, Dalton's law, Henry's law, Raoult's law, zeroth law of thermodynamics.

2. First Law of Thermodynamics for Open and Closed Systems (12 hrs)

   Statement of first law of thermodynamics, use of steam tables, calculation of internal energy, enthalpy, heat and work for ideal gas undergoing reversible, isothermal, adiabatic and polytrophic processes. Isobaric T-V, P-V and P-T diagrams

3. Second law of Thermodynamics (18 hrs)
   - Statement of second law of thermodynamics: Kelvin plank statement and carnot statement, carnot cycle and its efficiency, concept of entropy and entropy change for closed and open system.
   - Heat pump and heat engine (coefficient of performance and efficiency).
   - Reversible and irreversible process. Thermodynamic temperature scale.

4. Third law of Thermodynamics, Statement only (02 hrs)

5. Application of Second law of thermodynamics (12 hrs)

   Refrigeration, vapor compression and absorption refrigeration, types of compressors, reciprocating air compressors, single stage compressor, isentropic efficiency of compressor.

6. Phase Equilibrium (08 hrs)

   Raoult's law, Gibb's phase rule, vapor liquid equilibrium, dew point and bubble point, calculations for two component systems.

INSTRUCTIONAL STRATEGY

Lot of stress should be given to numerical aspect to give in-depth knowledge of the subject. This will make the subject interesting and improve student's involvement in the subject.

RECOMMENDED BOOKS

1. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness, Mc Graw Hill.
2. Chemical Engineering thermodynamics by K.V. Narayanan, Prentice Hall India.
3. Chemical Engineering Thermodynamics by Dodge, Mc Graw Hill.
4. Chemical Engineering Thermodynamics by YVC Rao
5. Engineering Thermodynamics by PK Nag
6. Thermal Engineering by Balleny
7. Chemical Engineering Thermodynamics by K.A. Gavhane, Nirali Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	20
2	12	20
3	18	25
4	02	05
5	12	20
6	08	10
Total	**64**	**100**

4.5 CHEMICAL PROCESS INDUSTRIES

L	P
4	4

RATIONALE

A Chemical Engineer, during his/her professional career is primarily working in industries manufacturing various chemical products. It is therefore necessary to provide information to Chemical Engineering student about the new materials, the chemical involved and manufacturing process of some important and frequently used chemical products.

DETAILED CONTENTS

1. Oils and Fats (08 hrs)
   - Introduction, Extraction of oils, Hydrogenation of oils.
2. Sugar: (08 hrs)
   - Introduction, Juice extraction, defacation, concentration, refining
3. Paper & Pulp (06 hrs)
   - Introduction, Criteria for getting good quality paper, Types of pulp and Manufacture of paper by fourdrinier machine
4. Sulphuric Acid (06 hrs)
   - Introduction, Grades of sulphuric acid,
   - Manufacture of sulphuric acid by contact process.
5. Soda Ash Industry (06 hrs)
   - Manufacture of Soda ash by Solvay Process and Modified Solvay process.
6. Glass : (04 hrs)
   - Introduction, Different types of glasses, raw materials required by glass industry, Manufacture of glass.
7. Cement Industry (04 hrs)
   - Types of Portland cement, Manufacture of Portland cement.
8. Fertilizer Industry (08 hrs)
   - Introduction, NPK, Manufacture of urea, superphosphate and triple superphospate, Mixed fertilizers, complex and compound fertilizers.
9. Polymer Industry (08 hrs)
   - Definition of Polymerisation, Types of polymerization, Manufacture of polyethylene, polyvinylchloride .
10. Industrial Gases (06 hrs)
    - Manufacture of Carbon-dioxide, Nitrogen and Oxygen

LIST OF PRACTICALS

1. To determine the acid value of the given oil sample.
2. To determine the saponification value of the given oil.
3. To determine the iodine value of the given oil.
4. To determine the amount of reducing and non reducing sugar by Pavy's solution.
5. Determination of micronutrients
6. Determination of nitrogen content of given fertilizer
7. Determination of phosphoric content of the given fertilizer

INSTRUCTIONAL STRATEGY

Field visit is must to give details about the various unit operations and processes involved in chemical industries.

RECOMMENDED BOOKS

1. Chemical process Technology by Shreeve, Mc Graw Hill Publication.
2. Outlines of Chemical Technology by Dryden, East west press publication
2 A text book of Chemical Technology, Vol I & II by G.N. Pandey, Vikas Publication.
4. Fertilizer Industry in India, part I and II by Pritam Singh and VS Awasthi, 1992

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	08	10
2	08	10
3	06	10
4	06	10
5	06	10
6	04	08
7	04	07
8	08	15
9	08	10
10	06	10
Total	**64**	**100**

4.6 COMPUTER APPLICATIONS IN CHEMICAL INDUSTRY

L	P
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RATIONALE

In today's environment almost all the processes in chemical industry are computerized. In order to prepare diploma holders to work in this environment, this subject has been kept as a core subject. This subject will ensure the students to have proficiency in handling different types of software used in chemical industries.

DETAILED CONTENTS

1. C^{++} Fundamentals
   - C^{++} Programming Basics, C^{++} Program Structure Variable, Inputs/Output statements, Arithmetic operators, Assignment and Increment operators.
   - Control statements
   - Loops and Decisions: Relational operators, Iterations: While loop, For loop, do loop, Decisions: If statement, If else statement, switch statement; logical operators
   - Programming and compiling Exercises
2. Simple programmes related to Chemical Engineering in C++
   i) Calculation of area of Heat Exchanger
   ii) Calculation area of cylinder
   iii) Conversion of Units (^{o}F to ^{o}C)_ and vice- versa
   iv) Calculation of flow rate from velocity and area
3. Solution of Material and Energy Balance problems involving use of various functions of MS-Excel.
4. Plotting of graphs of experimental data using MS-Excel

RECOMMENDED BOOKS

1. Learning C++ by Robert Lafore
2. C++ by Ravichandran
3. Object Oriented Programing with C++ by E. Balaguruswamy
4. Learning M.S. Office XP by Ramesh Bangia, Khanna Publishing Co.(P) Ltd. New Delhi