

CH584 Chemical Engineering Thermodynamics

Theory :100 Marks
Sessional : 50 Marks
Practicals: 50 Marks

L-T-P
3-1-3

Introduction :- Conservation of energy and first law of thermodynamics, application to steady state flow process, enthalpy, internal energy, equilibrium state, Phase rule, reversible vs irreversible process, heat capacity and specific heat.

Heat Effects: - Heat capacities of gases as a function of temperature, heat capacities of solids and liquids, concept of C_{pm} , heat effects accompanying phase changes of pure substances, standard heats of reactions, formation, combustion, effects of temperature on the standard heat of reaction, heat effects of Industrial reactions.

Second law of thermodynamics:- Second law of thermodynamics, thermodynamic temperature scale, ideal gas temperature scale, concept of entropy, entropy change and irreversibility, single and multistage compressor: various types and applications.

Thermodynamics Properties of fluids:-Relationships among thermodynamics properties – work function and free energy, thermodynamics properties of single phase and two-phase systems, effects of temperature and pressure on various properties and their evaluation, types of thermodynamics diagrams, generalized correlations of thermodynamic properties of ideal gas mixtures.

Phase_ Equilibria :-Criteria of equilibrium, the Fugacity, Duhem's theorem, vapor –liquid equilibrium idealization, phase diagram for miscible systems, immiscible systems, partially miscible systems, testing of vapor –liquid equilibrium data, Gibbs –Duhem equation

Chemical _Equilibria :-Criteria of chemical equilibrium, equilibrium conversion X_{et} equilibrium constant, effect of temperature and pressure on K . evaluation of K by conditions, construction of equilibrium conversion charts. Calculation of X_e for exothermic, endothermic, reversible, irreversible reactions.

BOOKS:

1. Smith , J.M. and Van Ness, H.C. , Introduction to Chemical Engg.

Thermodynamics, McGraw-Hill

2. K V Narayanan, a Text book of Chemical Engg Thermodynamics, Prentice Hall India.

3. Dodge, Chemical Engg. Thermodynamics, McGraw-Hill.

4. Wilson and Ric, Principles of Chemical Engg. Thermodynamics, McGraw-Hill.

Practicals:

1. Experiment on chemical Equation
2. Experiments on 1st and 2nd law of thermodynamics
3. Determination of heat of reaction.

CH 582 CHEMICAL REACTION ENGINEERING-I

Theory : 100 marks
Sessional : 50 marks
Practicals: 50 marks

L-T-P
3-1-3

1. Classification of chemical reactions: single and multiple, elementary and nonelementary , homogeneous and heterogeneous reactions; Order and molecularity; Reaction rate and rate constant; Temperature dependency and Activation energy.

2. Interpretation of Batch Reactor Data :

Constant and variable volume batch reactor; Integral and differential methods of analysis of kinetic data; Half-life period; Test for zero order, first order, second order, auto catalytic reactions, reversible reactions using integral method.

3. Introduction to Reactor Design :

Mass and energy balance around a volume element, single ideal reactors under steady state conditions, development of design expression for Batch, Tubular and Stirred-tank Reactor.

4. Ideal Reactors for single reactions ; Comparison of single reactors.

Multiple Reactor Systems – plug flow reactors in series/in parallel, mixed flow reactors in series/in parallel, Combination of Reactors, Recycle Reactors and Autocatalytic Reactions.

5. Residence Time Distribution (RTD) for Chemical Reactors: Measurement of RTD, Characteristics of the RTD; RTD for Ideal Reactors; Diagnostics and Troubleshooting.

Practicals (Sessional) :

1. Determination of rate constants for saponification of ethyl acetate with NaOH in Single reactors and multiple reactor systems.

2. RTD study in PFR and CSTR using pulse tracer input

Books

1. Chemical Reaction Engineering by Levenspiel, Wiley Eastern.
2. Elements of Chemical Reaction engineering, Fogler, 3rd Ed., Prentice hall
3. Chemical Engineering Kinetics by D.M. Smith, McGraw Hill Publication.
4. Reaction Kinetics for Chemical Engineers by Wales, McGraw Hill Publication.

CH 583 MECHANICAL OPERATIONS

Theory : 100 Marks

L-T-P

Sessional : 50 Marks

3-1-3

Practicals: 50 Marks

1. **PARTICULATE SOLIDS** : Particle characterization – particle size distribution and mean particle size; Particulate solid in bulk-agglomeration, angle of repose and friction, flow of solids in hoppers, flow of solids through orifices, conveying of solids, measurement of solid flow rate; Classification of solid particles – gravity settling, centrifugal separators, sieves, magnetic separators, electrostatic separators, floatation.

2. **SIZE REDUCTION OF SOLIDS**: Mechanism of size reduction, Energy for size reduction – energy utilization, Methods of operating crushers, Nature of materials to be crushed, Types of crushing equipments-Coarse crushers, Intermediate crushers, Fine crushers, Vibration mills, Colloid mills, Fluid energy mills.

3. **MOTION OF PARTICLES IN A FLUID**: The drag force on a spherical particle – total force on the particle – effect of motion of the fluid – terminal falling velocities, Non-spherical particles – effect of shape & orientation on drag – terminal falling velocities, Motions of bubble and drops, Acceleration motion of a particle in the gravitational field, Motion of particles in a centrifugal field.

4. **SEDIMENTATION**: Gravitational sedimentation – Fine suspensions – Coarse suspensions – Solids flux in batch sedimentation – The Kynch theory of sedimentation – thickener, Centrifugal separation – behavior of liquids in centrifuge basket – fluid pressure – sedimentation in a centrifugal field – separation of two immiscible liquids – centrifugal equipment.

5. **FLUIDISATION**: Basic Introduction, Importance of fluidization, Types, Application of the fluidization technique in Chemical Process Industries

6. **PNEUMATIC AND HYDRAULIC CONVEYING**: Pneumatic conveying-vertical and horizontal, Hydraulic conveying-homogenous flow-horizontal transport of settling suspensions-vertical transport-industrial applications.

7. **GAS CLEANING**: Gravity separators, centrifugal separators, inertia or momentum separators, fabric filters, electrostatic precipitators, liquid washing, Agglomeration and coalescence.

8. **FILTRATION**: The theory of filtration – relation between thickness of cake and volume of filtrate-flow of liquid through the cloth-flow of filtrate through the cloth and cake combined, compressible filter cakes, Filtration practice-The filter medium-blocking filtration, effect of particle sedimentation on filtration-delayed cake filtration-preliminary treatment of slurries before filtration-washing of filter cake, Filtration equipment, Filtration in a centrifuge, Filtration calculations.

9. **MIXING AND AGITATION**: Agitation of liquids – Purpose of agitation-agitation equipment-Impellers-Flow patterns in agitation vessels-circulation rate- velocity

CH 586 PROCESS INSTRUMENTATION

Theory : 100 Marks

L-T-P

Sessional : 50 Mark

3-1-3

Practicals: 50 Marks

1. Fundamental : Elements of instruments, Static Characteristics, Dynamic characteristics, Application of Laplace transform in instrumentation, Response of 1st order and 2nd order instruments.
2. Temperature measuring instruments:- Thermometers, thermocouples, automatic potential recorders, radiation pyrometers, optical pyrometers, photoelectric pyrometers, thermistors, response of these instruments.
3. Composition measuring instruments:-Spectroscopic methods , thermal conductivity cells, Fuel gas analysis, humidity measurement, moisture in paper, pH meter, polarography, colorimetry, combustible gas analysis.
4. Measurement of pressure and vacuum :-Manometers, pressure Spring , Mcleod gauge, Pirani Gauge, Ionization gauge, Thermocouple gauge, Liquid seals, responses of these instruments.
5. Level measuring devices. Flow measuring devices. Measurement of displacement.
6. Process Instrumentation diagram: Piping and instrumentation design, Instrumentation symbols, Process flow diagrams, Transmission lines,

Practicals:

1. Determination of time constant of a first order and second order system
2. Calibration of thermocouples and pressure devices..
3. Composition analysis using GC.
4. Study of conductivity meter and pH meter.

BOOKS :

1. Donald P. Eckman – Industrial Instrumentation.
2. A. Suryanarayana, Instrumentation & Process Control , Khanna Publishers, New Delhi.
3. R. K. Jain , Mechanical and Industrial Measurements, Khanna Publishers, New Delhi.

gradients in agitated vessels-power correlations for specific impellers-effect of system geometry-calculation of power consumption.

Practicals:

1. Study of crushers and grinders
2. Verification of Rittinger's law
3. Experiment on batch sedimentation
4. Differential and cumulative screen analysis
5. Determination of screen effectiveness.
6. Experiment on plate and frame filter Press
7. Determination of minimum fluidization velocity

BOOKS :

1. Introduction to Chemical Engineering by Badger & Banchero.
2. Unit Operation in Chem. Engg. By McCabe & Smith.
3. Chemical Engineering Vol I & II by Coulson & Richardson.
4. G G Brown: Unit Operations, CBS Publishers and Distributors

CH 585 PROCESS UTILITIES

L – T -P
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Time : 3 hrs

Theory :100 Marks

Sessional : 50 Mark

1. Importance of process utilities in chemical industries and plants. Introduction to the use of various utilities.
2. Water as a utility in process industries, conservation and recycle of water, cooling tower, spray pond.
3. Compressor, Compressed air systems. Vacuum systems, boosters, air receivers, piping network, air leaks, and lubrication and oil removal.
4. Refrigeration systems and their characteristics, use of cryogenic temperatures.
5. Air condition and ventilation systems and their characteristics, air water systems, introduction to humidification and dehumidification equipments,
6. Generation distribution and utilization of steam, steam economy and handling steam engines, boiler and performance characteristics.
7. Internal combustion engine cycles – Otto, Diesel, Dual , Rankine cycles and their characteristics and performances.
8. Fire and safety in chemical industry :
 - (a) Chemical hazards, classification and threshold limits
 - (b) Chemical as a cause of poisoning and occupational disease.
 - (c) Engineering control of chemical plant hazards , ventillation and lighting , maintenance of pressure vessels, storage , handling and transportation of chemicals , electrical systems, instrumentation, personnel protection devices , maintenance procedure , laboratory safety, effluent disposal and checking of spillage.
 - (d) Properties of important flammable liquids and gases and their classification , threshold limits and maximum permissible concentration of these chemicals. Concept of Spontaneous combustion with remedial measures.
 - e) Rules and Acts governing explosive and flammable materials . Colour codes for safety color codes for pipe lines and gas cylinders. An exposure to Indian standards.

BOOKS :

1. Heat Engines – Pandya and Shaha
2. Heat Engines – Patel and Karamchandani (Vil II, III)
3. Air conditioning & Refrigeration – Stephen & Elonka
4. Efficient use of Steam – HMSO, London.