

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E Semester: 3 Rubber Engineering

Subject Code 132603

Subject Name THERMODYNAMICS OF ELASTOMERS & POLYMERS

Sr.No	Course contents
1.	Basic Concepts of Thermodynamics: Terminology of thermodynamics, Zeroth law, first law of thermodynamics, enthalpy, reversible isotherm, expansion of an ideal gas, Thermo chemical definition, Hess's law of constant heat summation, heat capacity, relation between C_v & C_p , adiabatic expansion of an ideal gas, Kirchhoff's equation, flame & explosion temperature, Joule-Thomson effect, Carnot's theorem Second Law of thermodynamics & Entropy, Second law of thermodynamics, Concept of entropy, entropy change in reversible & irreversible process, entropy of phase transition, entropy change for an ideal gases, entropy change during mixing of ideal gases, free energy & its change of an ideal gas in isothermal change, Gibbs-Helmholtz equation, Maxwell's thermodynamic relations, Clapeyron-clausius equation, Van't Hoff isotherm .
2.	Fundamental Principles: Balance Equations, Basic thermodynamics for Rubber Elasticity & Strain induced Crystallization., Basics of Devolatilization, Devolatilization of Particulate polymer, Devolatilization of Polymer Melts, Pipe Flow of Newtonian Fluid
3.	Heat of Polymerization: Heat of Polymerization (ΔH_P), Factors affecting ΔH_P . Variations in Heat of Polymerization. Estimation of Heat of Polymerization.
4.	Ceiling Temperature: Concept of Ceiling Temperature, Spontaneity, Conditions for Polymerization Reaction.
5.	Energy Balances: Introduction, energy & thermo chemistry, Energy balances, Heat capacity, Latent Heats, Absolute Enthalpy, Adiabatic reactions, dissolution of solids, Absorption, evaporation.
6.	Polymer Chain Flexibility: Internal rotation in Molecules, Rotation barrier, configuration & conformation of molecules & Macromolecules, internal rotation in macromolecules, dimensions of macromolecular coils, Thermodynamic Flexibility of a Chain, Kinetic Flexibility of a chain & factors determining it, Practical Importance of Chain flexibility in elastomers
7.	Theory of Polymer Solutions: Basic concepts solutions, Polymer solutions. Effect of Crosslinking on Solubility, Solubility Parameter, Flory-Huggins theory: Entropy of mixing on formation of an Athermal solution, change in Gibbs Free Energy on Dissolution of Polymers, Phase equilibrium in polymer solutions, theory of dilute polymer solution, statistical theory of swelling of network polymers, Merits of polymer solutions,

8.	Prigogine's Theory: pure liquids with chain molecules, law of principle of corresponding states, Thermodynamics of Mixtures of Liquids with Chain Molecules
9.	Thermodynamics of Polymer Solutions: Partial Molar (Specific) Functions, Methods of Calculating Partial Equations, Ideal & Nonideal Solutions, Thermodynamic Affinity of a solvent to a polymer or Thermodynamic Quality of a solvent, Vapor Pressure over Polymer solutions, Osmotic Pressure, Swelling Pressure, Second Virial Coefficient, Free Energy of Mixing of a polymer with a solvent, Thermodynamic Stability of Systems, Enthalpy or Heat of Mixing, Differential Heats of Solutions & Dilution, Entropy of Mixing, Change in Volume or Dissolution of Polymers, Internal energy of Mixing, Variation of Thermodynamic Affinity of a polymer to a solvent with temperature criteria of UCST & LCST, Thermodynamics of Dissolution of Polymers & their structure, Thermodynamics of Swelling of Cross linked Polymers
10.	Combustion: Introduction, Fuels, Calorific values of fuels, coal, liquid fuels, gaseous fuels, air requirement & flue gases, combustion calculations.
11.	Thermodynamics Investigation of Polymer-Polymer Systems. Three-component Systems
12.	Thermodynamics of Binary Polymer-Polymer Systems : Enthalpy of Mixing of Two Polymers, Free Energy of Mixing of Polymers, Entropy of Mixing of Two Polymers, Phase Diagrams of Polymer-Polymer Systems
13.	Thermodynamic Properties: Relationship between molecular weight and two fundamental thermodynamic properties(1) Thermal conductivity(2) Coefficient of Thermal Expansion., Thermodynamic forces favoring maximum potential crystallinity.

Reference Books:

1. Physical Chemistry of Polymers, by A. TAGER, MIR Publishers-Moscow
2. Engineering Chemistry by Jain & Jain
3. Polymer Extrusion by Chris Rauwendaal
4. Polymer Processing Principles and Design, by Donald G. Baird, Dimitris I. Collias
5. Polymer Structure, Properties and Applications by RUDOLPH D. DENIM
6. Thermodynamics of Polymerization', Hideo Sawada.