

Engineering Chemistry – Unit 4 Premium Notes

Polymer & Polymerization

RGPV Engineering Chemistry Notes

Unit Overview

This unit is one of the highest scoring units in Engineering Chemistry.

Questions related to:

- Polymerization
- Thermoplastic & Thermosetting polymers
- Nylon
- Teflon
- PVC
- Rubber
- Vulcanization

are repeatedly asked in RGPV examinations.

This unit is important for:

- Semester Exams
 - Viva Questions
 - Industrial Applications
 - Competitive Exams
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Introduction to Polymers

Definition

A polymer is a high molecular weight compound formed by repeated joining of small molecules called monomers.

Examples of Polymers

- PVC
 - Nylon
 - Teflon
 - Rubber
 - Bakelite
 - Polyester
-

Monomer

Definition

Small molecules that combine repeatedly to form polymers are called monomers.

Example:

Ethylene → Polyethylene

Polymerization

Definition

The process of formation of polymers from monomers is called polymerization.

Types of Polymerization

There are two main types:

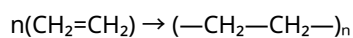
1. Addition Polymerization
 2. Condensation Polymerization
-

1. Addition Polymerization

Definition

Polymerization in which monomers combine without elimination of small molecules.

Example



Polyethylene

Characteristics

- No by-product formed
 - Fast reaction
 - Unsaturated monomers used
-

Examples

- PVC
 - Teflon
 - PMMA
-

2. Condensation Polymerization

Definition

Polymerization in which small molecules like water or HCl are eliminated.

Characteristics

- By-products formed
 - Stepwise reaction
 - Bi-functional monomers used
-

Examples

- Nylon 6:6
- Polyester

- Bakelite
-

Classification of Polymers

Polymers are classified on different bases.

1. Classification Based on Source

Natural Polymers

Obtained naturally.

Examples:

- Rubber
 - Cellulose
 - Protein
-

Synthetic Polymers

Artificially prepared.

Examples:

- Nylon
 - PVC
 - Teflon
-

2. Classification Based on Structure

Linear Polymers

Straight chain structure.

Example:

Nylon

Branched Polymers

Contain side chains.

Example:

Low density polyethylene

Cross-linked Polymers

Three-dimensional network.

Example:

Bakelite

Mechanism of Polymerization

Main mechanisms are:

1. Free Radical Polymerization
 2. Ionic Polymerization
-

1. Free Radical Polymerization

Definition

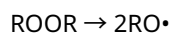
Polymerization initiated by free radicals.

Steps Involved

1. Initiation

Free radicals are generated.

Example:



2. Propagation

Monomer units add repeatedly.

3. Termination

Chain growth stops.

Applications

- PVC
 - Polyethylene
 - PMMA
-

2. Ionic Polymerization

Definition

Polymerization initiated by ions.

Types

Cationic Polymerization

Initiated by positive ions.

Anionic Polymerization

Initiated by negative ions.

Applications

- Synthetic rubber

- Special plastics
-

Thermoplastic Polymers

Definition

Polymers which soften on heating and harden on cooling repeatedly.

Characteristics

- Reusable
 - Recyclable
 - Linear structure
-

Examples

- PVC
 - PMMA
 - Nylon
-

Uses

- Pipes
 - Toys
 - Containers
-

Thermosetting Polymers

Definition

Polymers which become permanently hard on heating.

Characteristics

- Cannot be remolded
 - Strong cross-linking
 - Hard and rigid
-

Examples

- Bakelite
 - Urea formaldehyde
-

Difference Between Thermoplastic & Thermosetting Polymers

Thermoplastic	Thermosetting
Softens on heating	Permanently hard
Recyclable	Non-recyclable
Linear structure	Cross-linked structure
Example: PVC	Example: Bakelite

Biodegradable Polymers

Definition

Polymers which decompose naturally by microorganisms.

Advantages

- Environment friendly
 - Reduce pollution
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Examples

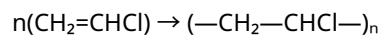
- PHBV
 - PLA
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Important Polymers

1. PVC (Poly Vinyl Chloride)

Preparation

Prepared by polymerization of vinyl chloride.



Properties

- Strong
 - Chemically resistant
 - Waterproof
-

Uses

- Pipes
 - Insulation
 - Flooring
-

2. PMMA (Plexiglass)

Preparation

Prepared from methyl methacrylate.

Properties

- Transparent
 - Lightweight
 - Weather resistant
-

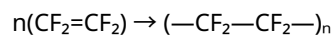
Uses

- Aircraft windows
 - Lenses
 - Sign boards
-

3. Teflon

Preparation

Prepared from tetrafluoroethylene.



Properties

- Heat resistant
 - Chemically inert
 - Non-stick
-

Uses

- Non-stick utensils
 - Electrical insulation
-

4. Nylon 6

Preparation

Prepared from caprolactam.

Properties

- Strong
 - Elastic
 - Wear resistant
-

Uses

- Fibers
 - Ropes
 - Textiles
-

5. Nylon 6:6

Preparation

Prepared from hexamethylene diamine and adipic acid.

Properties

- High strength
 - Toughness
 - Chemical resistance
-

Uses

- Tyres
- Machine parts
- Fabrics

6. Polyester

Properties

- Strong
- Wrinkle resistant
- Lightweight

Uses

- Clothes
- Bottles
- Packaging

7. Phenol Formaldehyde (Bakelite)

Properties

- Hard
- Heat resistant
- Electrical insulator

Uses

- Switches
- Electrical goods
- Handles

8. Urea Formaldehyde

Properties

- Hard
 - Scratch resistant
-

Uses

- Decorative items
 - Adhesives
-

9. Buna-N

Properties

- Oil resistant
 - Tough
-

Uses

- Fuel pipes
 - Gaskets
-

10. Buna-S

Properties

- Abrasion resistant
 - Elastic
-

Uses

- Tyres
 - Footwear
-

Vulcanization of Rubber

Definition

Process of heating rubber with sulphur to improve strength and elasticity.

Advantages

- Increases elasticity
 - Improves strength
 - Heat resistant
 - Water resistant
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Uses

- Tyres
 - Tubes
 - Industrial rubber goods
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Most Important 14 Marks Questions

1. Explain polymerization and its types.
 2. Explain free radical polymerization.
 3. Explain ionic polymerization.
 4. Differentiate thermoplastic and thermosetting polymers.
 5. Explain preparation, properties and uses of PVC.
 6. Explain preparation, properties and uses of Teflon.
 7. Explain Nylon 6 and Nylon 6:6.
 8. Explain Bakelite and Urea Formaldehyde.
 9. Explain Buna-N and Buna-S.
 10. Explain vulcanization of rubber.
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Detailed 14 Marks Important Questions with Answers

1. Explain Polymerization and Its Types

Definition

The process of formation of polymers from small molecules called monomers is known as polymerization.
