# Engineering Chemistry – Unit 4 Premium Notes

# Polymer & Polymerization

## RGPV Engineering Chemistry Notes

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# 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.

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# Examples of Polymers

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

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# Monomer

## Definition

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

Example:

Ethylene → Polyethylene

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# Polymerization

## Definition

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

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# Types of Polymerization

There are two main types:

1. Addition Polymerization
2. Condensation Polymerization

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# 1. Addition Polymerization

## Definition

Polymerization in which monomers combine without elimination of small molecules.

# Example

$n(CH_2=CH_2) \rightarrow (—CH_2—CH_2—)_n$

Polyethylene

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# Characteristics

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

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# Examples

- PVC
- Teflon
- PMMA

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# 2. Condensation Polymerization

## Definition

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

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# Characteristics

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

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# Examples

- Nylon 6:6
- Polyester

- Bakelite

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# Classification of Polymers

Polymers are classified on different bases.

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# 1. Classification Based on Source

## Natural Polymers

Obtained naturally.

Examples:

- Rubber
- Cellulose
- Protein

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## Synthetic Polymers

Artificially prepared.

Examples:

- Nylon
- PVC
- Teflon

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# 2. Classification Based on Structure

## Linear Polymers

Straight chain structure.

Example:

Nylon

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### Branched Polymers

Contain side chains.

Example:

Low density polyethylene

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### Cross-linked Polymers

Three-dimensional network.

Example:

Bakelite

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# Mechanism of Polymerization

Main mechanisms are:

1. Free Radical Polymerization
2. Ionic Polymerization

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# 1. Free Radical Polymerization

### Definition

Polymerization initiated by free radicals.

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# Steps Involved

### 1. Initiation

Free radicals are generated.

Example:

ROOR → 2RO•

### 2. Propagation

Monomer units add repeatedly.

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### 3. Termination

Chain growth stops.

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## Applications

- PVC
- Polyethylene
- PMMA

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# 2. Ionic Polymerization

### Definition

Polymerization initiated by ions.

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## Types

### Cationic Polymerization

Initiated by positive ions.

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### Anionic Polymerization

Initiated by negative ions.

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## Applications

- Synthetic rubber

- Special plastics

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# Thermoplastic Polymers

## Definition

Polymers which soften on heating and harden on cooling repeatedly.

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# Characteristics

- Reusable
- Recyclable
- Linear structure

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# Examples

- PVC
- PMMA
- Nylon

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# Uses

- Pipes
- Toys
- Containers

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# Thermosetting Polymers

## Definition

Polymers which become permanently hard on heating.

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# Characteristics

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

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# Examples

- Bakelite
- Urea formaldehyde

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# Difference Between Thermoplastic & Thermosetting Polymers

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

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# Biodegradable Polymers

## Definition

Polymers which decompose naturally by microorganisms.

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# 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.

$n(CH_2=CHCl) \rightarrow (—CH_2—CHCl—)_n$

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# Properties

- Strong
- Chemically resistant
- Waterproof

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# Uses

- Pipes
- Insulation
- Flooring

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# 2. PMMA (Plexiglass)

## Preparation

Prepared from methyl methacrylate.

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# Properties

- Transparent
- Lightweight
- Weather resistant

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# Uses

- Aircraft windows
- Lenses
- Sign boards

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# 3. Teflon

## Preparation

Prepared from tetrafluoroethylene.

$n(CF_2=CF_2) \rightarrow (—CF_2—CF_2—)_n$

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# Properties

- Heat resistant
- Chemically inert
- Non-stick

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# Uses

- Non-stick utensils
- Electrical insulation

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# 4. Nylon 6

## Preparation

Prepared from caprolactam.

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# Properties

- Strong
- Elastic
- Wear resistant

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# Uses

- Fibers
- Ropes
- Textiles

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# 5. Nylon 6:6

## Preparation

Prepared from hexamethylene diamine and adipic acid.

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# Properties

- High strength
- Toughness
- Chemical resistance

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# 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

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# 9. Buna-N

## Properties

- Oil resistant
- Tough

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# Uses

- Fuel pipes
- Gaskets

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# 10. Buna-S

## Properties

- Abrasion resistant
- Elastic

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# Uses

- Tyres
- Footwear

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# Vulcanization of Rubber

## Definition

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

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# 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

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# 1. Explain Polymerization and Its Types

## Definition

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

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