



POLYMER ADDITIVES

Outline

- Introduction
- Fillers
- Plasticizer
- stabilizers,
- Colorants
- flame retardants.

Introduction

- Many times it is necessary to modify the **mechanical**, **chemical**, and **physical** properties to a much greater degree than is possible by the simple alteration of the fundamental molecular structure.
- Foreign substances called **additives** are intentionally introduced **to enhance or modify** many of these properties, and then render a polymer more serviceable.
- Beside the above functions, additives are also added to
 - Prevent degradation (both during fabrication and in service)
 - To reduce material costs
 - To improve the processability

Fillers


- Fillers are normally added in polymeric materials for economical or technical reasons
- **Filler materials** are most often added to polymers **to improve tensile and compression strengths, abrasion resistance, toughness, dimensional and thermal stability** and other **properties**.

Fillers

- Materials used as particulate fillers include *wood flour* (finely powdered sawdust), silica flour and sand, glass, clay, talc, limestone, and even some synthetic polymers.
- Particle sizes range all the way from 10 nm to macroscopic dimensions
- Because these inexpensive materials replace some volume of the more expensive polymer, the **cost of the final product is reduced.**

Plasticizers

- Can be in *liquid, half solid* or *solid form*.
- It must be compatible with the polymeric materials and other compounding ingredients → incompatibility will results in poor processing properties.
- Plasticizers were used for:
 1. 'extender' (large amount) → to make the end products cheaper
 2. Processing aid (small amount) → to make the processing easier
 3. Modifier → to modifies some polymeric properties.

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- The aid of additives called plasticizers can :
 - ❖ improved the flexibility, ductility, and toughness
 - ❖ produces reductions in hardness and stiffness
 - ❖ lowers **the glass transition temperature** → at ambient conditions the polymers may be used in applications requiring some degree of flexibility and ductility.

 - These applications include thin sheets or films, tubing, raincoats, and curtains.

Stabilizers

- Some polymeric materials under normal environmental conditions → are subject **rapid deterioration** in mechanical properties.
- Most often this deterioration is a result of **exposure to light** → in particular **ultraviolet radiation** and **oxidation**
 - Ultraviolet radiation →
 - causes a severance of some of the covalent bonds along the molecular chain
 - also result in some crosslinking.
 - ***Oxidation deterioration*** is a consequence of the chemical interaction between ***oxygen atoms*** and the ***polymer molecules***.
- Additives that counteract these deteriorative processes are called **stabilizers**.

Colorants

- **Colorants** impart a specific color to a polymer
- They may be added in the form of:
 - **dyes**
 - The molecules in a dye actually dissolve and become part of the molecular structure of the polymer.
 - **pigments**
 - Pigments are filler materials that do not dissolve → but remain as a separate phase;
 - have a small particle size, are transparent, and have a refractive index near to that of the parent polymer.
 - Others may impart opacity as well as color to the polymer.

Flame retardants

- ❖ The flammability of polymeric materials is a major concern, especially in the manufacture of **textiles** and **children's toys**.
- ❖ Most polymers are flammable in their pure form → exceptions include those containing **significant contents of chlorine and/or fluorine** such as **polyvinyl chloride (PVC)** and **polytetrafluoroethylene (PTFE)**.
- ❖ The flammability resistance of the remaining combustible polymers enhanced by additives called **flame retardants**.
- ❖ These retardants may function by
 - interfering with the combustion process through the gas phase, or
 - by initiating a chemical reaction that causes a cooling of the combustion region and a termination of burning.

Special purpose additives

Additives	Function
Blowing agents	Gas generating chemicals that are necessary for manufacturing sponge or micro porous products
Odorants	Strongly scented substances added in small amounts that are capable of imparting a pleasant scent
Antistatic agents	Added to reduce the accumulated of dust or dirt on surface and also to minimize possibility of sparking resulting from the discharge of accumulated static electricity
Retarders	Substances that used to reduce the tendency of rubber mix to scorch → avoid premature vulcanization during processing
Antioxidants	Protects products from oxidation of heat
Antiflex cracking	Agents that retard cracking caused by cyclic deformations