

# Content

## 1 Antioxidants

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### 3 PVC Stabilizers

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#### **4 Acid Scavengers**

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#### **5 Lubricants**

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## 6 Polymer Processing Aids

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## 15 Colorants

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## 16 Fluorescent Whitening Agents

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## 18 Nucleating Agents for Semi-crystalline Polymers

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## 21 **Analytics**

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# 1 Antioxidants

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## 1.1 Introduction

Organic materials, both of synthetic and natural origin, readily undergo reactions with oxygen [1]. Such oxidation reactions are of vital interest if the organic material is a polymer, because important properties often change at very low conversion ratio. For example, if the oxidation reaction leads to the chain scission of a linear polymer with 10000 monomer units, a conversion rate of 100 ppm is sufficient to halve the molecular weight of the polymer. When polymers oxidize, they lose mechanical properties, e.g., tensile strength, and rougher surface appearance and discoloration of the plastic article may result. Oxidation can occur in every stage of the life cycle of a polymer: during manufacture and storage of the polymer resin, as well as during processing and end use of the plastic article produced. Plastic materials are very different from each other in terms of their inherent sensitivity to oxidation. The oxidative sensitivity of polypropylene is apparent at room temperature while polystyrene and poly(methyl methacrylate) are quite stable even at processing temperatures. Highly unsaturated polymers, such as rubbers or copolymers derived from butadiene or isoprene, are extremely sensitive to oxidation.

The typical technical manifestations of oxidation are referred to as "aging phenomena"; the effects of oxidation on a polymer's chemical structure are collectively termed "degradation". Degradation and aging can be inhibited or retarded; methods of achieving this are the main topics of this chapter.

One method of inhibiting or slowing down thermal oxidation is to structurally modify the polymer, but by far more common is the use of suitable stabilizers. In this chapter, the behavior of plastics under thermomechanical (processing of polymer melt) as well as thermo-oxidative (long term stability during end use) conditions is discussed. Modern plastics parts and articles are complex systems that generally contain, along with the polymer, fillers, pigments, flame retardants, reinforcing materials, as well as a variety of other additives that can influence oxidative degradation reactions.

## 1.2 Economic Situation

The growth in volume and the economic importance of plastic additives have followed the growth of the plastics industry. Higher demands concerning the service life and quality (ISO 9000 series) of plastic goods and to increase manufacturing productivity by raising processing temperatures and speeds has led to greater needs for high performance stabilizers and additives.