FIRE RETARDANT MATERIALS AND SAFETY: PAST, PRESENT, FUTURE -NEW TYPES OF ECOLOGICALLY FRIENDLY FLAME RETARDANTS

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Contents

Summary

The contributors have attempted to discuss modern trends in polymer flame retardancy. They have also tried to reflect the interest that exists in the creation of new forms of ecologically friendly flame retardants for polymers. This interest will give rise to a solution of many practical and political problems in the future. The chapter contains modern ideas and studies focused attention on five trends in polymer flame retardancy: intumescent systems, low-melting glasses systems, polymer nanocomposites, organic char forms, silicon inorganic systems and preceramic additives.

1. Introduction

Our environment has mostly polymeric nature and all polymers burn whether natural or synthetic. The use of polymer flame retardants has an important role in saving lives. There are four main families of flame-retardant chemicals: Inorganic flame retardants including aluminum trioxide, magnesium hydroxide, ammonium polyphosphate and red phosphorus. This group represents about 50% by volume of the global flame retardant production [1].

Halogenated flame retardants, primarily based on chlorine and bromine. The brominated flame retardants are included in this group. This group represents about 25% by volume of the global production [1].

Organophosphorus flame retardants are primarily phosphate esters and represent about

20% by volume of the global production [1]. Organophosphorus flame retardants may contain bromine or chloride.

Nitrogen-based organic flame retardants are used for a limited number of polymers. The flame retardant chemicals' industry has historically been driven by regulations and standards. The normal fire-, smoke-, and toxicity-related standards have been joined by environmental standards caused by the alleged environmental impact of halogens and the alleged toxicity of antimony. Although suitable replacements have not been found for these materials in all cases, the environmental concern has served to depress their growth levels from what it would otherwise have been and/or channel the growth into alternative chemical products. In connection with the amendment of the Ordinance on Dangerous Substances, the federal government of German passed a new Ordinance on the ban and restriction of certain chemicals, compounds and products (Chemikalien-Verbots-Verordnung) which became effective on 1-st November 1993 (BGB1 I, 1720) and has been amended the first time on 6th July 1994 (BGBL I, 1493). The ordinance has replaced the following Ordinances:

1. An ordinance on the Ban of PCB and PCT of 1989
2. An ordinance on the Ban of Pentachlorophenol of 1989
3. First Ordinance on Chloroaliphates of 1991
4. An ordinance on "Dioxins" and "Furans"

In addition to Tetra- up to Hexachlorodibenzo-p-dioxins/furans with Chlorine atoms at position 2,3, 7, 8 (8 substances transferred from the Ordinance on Dangerous Substances, App. V, 3), the amendment of 6-th July 1994 extends the number of congeners of this type by some additional Penta- up to Octachlorodibenzo-p-dioxins/furans. Now the total number of restricted chlorinated PCDD/PCDF-Congeners amounts to 17 substances. The threshold concentrations for these chemicals in substances preparations and products were decreased considerably, depending on theirs toxic potentials. However, plant treatment agents, intermediates, and a few more products were excluded from this regulation. For the first time, 2, 3, 7, 8 - brominated dioxins and furans are restricted now as well; 8 PBDC/PBCF-.

Congeners were added to the list of the regulation. This was the result of an approximation process to the scientific progress concerning the appearance, environmental fate, toxicity and analytical methodology of these substances.

In December 1992, the European Commission granted Germany an exception under Article 100 (A) (4) of the treaty from EU-legislation issued in 1991 restricting the marketing and use of substances and preparations containing PCP and its compounds (Council Directive 91/173 EEC amending for the ninth time Directive 76/769/EEC). This consent was necessary because the German legislation imposed, differing from the EU-directive, wider restrictions and lower concentrations limits of PCP. After an action of France against the consent, in May 1994 the European Court of Justice annulled the decision by the Commission on the grounds that no adequate reasons had been given for it and thereby Article 190 of the treaty had been violated. In September 1994, the Commission pronounced a new decision and confirmed the German legislation again.

The Commission verifies now the possibility to propose a total ban of PCP for the EU. In this connection one can expect in a near future some new unexpected steps in this direction. It doesn't necessarily mean the total ban of halogenated flame retardants in the next 5 - 10 years. But it actually means a complete reconsideration in a direction of polymers' flame retardancy development. It is obviously, the new efforts will be directed on the ecologically-friendly flame retardant systems. This review is devoted to some new directions in this area.

The main flame retardant systems for polymers currently in use are based on halogenated, phosphorous, nitrogen, and inorganic compounds (Figure 1). All of these flame retardant systems basically inhibit or even suppress the combustion process by chemical or physical action in the gas or condensed phase. To be effective, the flame retardants must decompose near the decomposition temperature of the polymer in order to do the appropriate chemistry as the polymer decomposes, yet be stable at processing temperatures.

Conventional flame retardants, such as halogenated, phosphorous or metallic additives have a number of negative attributes. An ecological issue of its application demands the search of new polymer flame retardant systems. Among the new trends of flame retardancy it can be noticed the use of intumescent systems, polymer nanocomposites, preceramic additives, low-melting glasses, different types of char-formers and polymer morphology modification [1]. However, it should be assumed the close interactions between the different flame retardant types in order to achieve a synergistic behavior. The block scheme of polymer flame retardant systems is given on Figure 1.

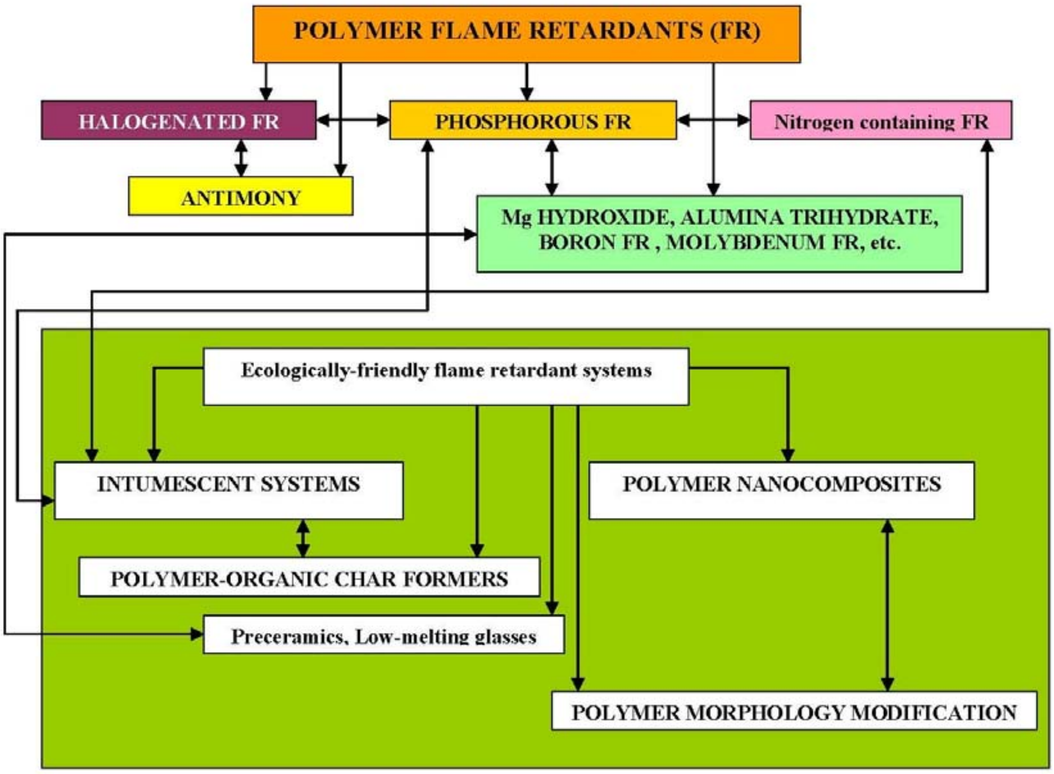

Figure 1. Block-scheme of polymer flame retardant systems

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