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Research Status and Development Trend of Flame Retardant

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Abstract

The paper introduces the application and research progress of halogen flame retardant, phosphorus flame retardant, nitrogen flame retardant, expansion type flame retardant and metal hydroxide flame retardant, and it prospects the development trend of flame retardant.

Keywords

Flame Retardant; Development Trend; Research Status.

1. Introduction

Flame retardant materials are widely used, flame retardant materials play a decisive role in preventing or reducing the loss caused by fire, especially in high-rise buildings[1]. There are many types of flame retardant materials. Most of the flame retardant materials currently used can achieve flame retardant effects after adding flame retardants in polymer materials. The application of polymer synthesis materials is widely used, but due to its flammable, applications in many aspects are limited[2-3]. Commonly used flame retardants include aluminum hydroxide, magnesium hydroxide and etc. During the preparation of polymer materials, it is treated with flame retardants, so that polymer materials have flame retardant performance, avoiding high -molecular materials from burning at high temperatures, thereby preventing the spread of the fire, so that polymer materials can be applied to high -rise buildings, and high -rise buildings, and high -rise buildings. [4] Textiles, transportation, aerospace and other fields. With the continuous development of modern science and technology and the increasingly progressive, people pay attention to their safety, so the requirements for flame retardant, insulation, fire prevention, and environmental protection of flame retardants have become higher and higher. [5-6] The research of flame retardant materials and flame retardants has gradually become a hot spot, resulting in more and more types of flame retardants, and the output of flame retardant increasingly increased.

2. Research Status of Flame Retardant

The development of flame retardants has a long history, mainly including halogen, phosphorus flame retardant, nitrogen flame retardant, expansion flame retardant, metal hydroxide flame retardant, etc.

2.1 Halogenic Flame Retardant

Halogenic flame retardant refers to a flame retardant containing halogen components (such as bromine and chlorine). Because of its low price, strong effect, small amount of dosage, and good compatibility with polymer, it has been widely used for decades. On the one hand, its flame retardant mechanism is to suppress the free radical response. When the halogen is heated, the halogen component is uniformly cracked and the reaction is terminated with the chain of the substrate combustion. On the other hand, it will produce high -density and difficulty burning gases. It can not only dilute the combustible gas in the burning environment, but also achieve the purpose of isolation, and eventually extinguish the flame. However, the generated hydrogen hydrogen is toxic. For people, the toxic gases produced when high -rise buildings are on fire are the threat of death, so they should

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be used with caution in high -rise buildings. The halogen flame retardant and polymer materials are well compatible, so it is mainly used in thermoplastic materials, thermosetting materials, and is also widely used in the automotive, packaging, textile and other industries. At present, halogen flame retardants are widely used and have good market prospects.

2.2 Phosphorus Flame Retardant

The phosphorus flame retardant has high flame retardant performance and meets the requirements of environmental protection. It has been widely used in plastic and fiber. During the combustion process, phosphorus flame retardants will release acidic substances such as scorch phosphate, and form a layer of curing charcoal layer on the surface of the substrate to condense the flame retardant effect; In addition, the phosphorus -containing compound can generate phosphorus free radicals during the combustion process, and the termination reaction of the free radicals generated by the combustion can reduce the combustion strength and play a flame retardant effect. The phosphorus flame retardant can overcome the shortcomings of fibrous fiber -resistant fiber -resistant fiber -resistant fiber, increased brittleness, and toxicity. It can also improve the color and dyeing performance of the fiber. Red phosphorus flame retardant has the highest phosphorus content and low price, which is a high efficiency inorganic flame retardant. But the red phosphorus flame retardant is easy to be oxidized at high temperature or combustion, and it will release toxic and harmful gases, therefore, the application of the red phosphorus flame retardant is limited to a certain extent. However, the red phosphorus flame retardant and metal hydroxide have good compatibility, so the appropriate amount of metal hydroxide can be added to the red phosphorus flame retardant to improve its performance, which solves the toxicity problem of red phosphorus flame retardant polymer materials.

2.3 Nitrogen Flame Retardant

Currently nitrogen flame retardant mainly refers to melamine, melamine cyanuric acid and its derivatives, its flame retardant mechanism for its heat decomposition under high temperature, on the one hand, it absorbs heat to reduce the surface temperature of polymer materials, On the other hand, it releases a large amount of non -combustible gases to separate polymer materials from air to achieve the effect of flame retardant, such as ammonia, nitrogen, etc. Although the nitrogen flame retardant has excellent flame retardant performance and weak toxicity and corrosion, it has poor compatibility with the polymer matrix. Therefore, nitrogen flame retardants are often used as co-acting agents, which are combined with other flame retardants to enhance the effect.

2.4 Expansion Flame Retardant

Expansion flame retardant is a new type of green environmental protection flame retardant with no halogen, melting drop resistance, low smoke and low toxicity. It is composed of chemical expansion flame retardant with phosphorus and nitrogen and graphite physical expansion flame retardant. Chemical expansion type flame retardant is composed of acid source, carbon source and gas source. It reacts chemically at high temperature to forming a stable foam carbon layer between the combustible and the ignition source. The acid source produces acid upon heating, promoting the removal of the matrix. Carbon source is a substance that can esterify with the acid source, which promotes the matrix to become carbon, and plays a role in blocking and coating, It is generally carbon-rich polyhydroxyl compounds, which largely determines the effect of flame retardant. The gas source is a foaming agent, which is a substance that can produce non-toxic, non-flammable gas and can dilute the concentration of combustible gas. The thermal stability of the gas source should be matched with the carbon source and acid source. If the decomposition temperature is low, it may not be able to expand the carbon layer, but if the decomposition temperature is too high, it will destroy the stability of the carbon layer.

The other is the graphite expansion flame retardant. The molecules between the intercalated graphite decompose at high temperature to produce gas, which increases the thickness of the carbon layer and forms a foam carbon layer. This kind of flame retardant has the advantages of high flame retardant efficiency, no melting drop, low smoke non-toxic, and it overcomes the chemical expansion of flame

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retardant easy to migrate, easy to absorb moisture and other disadvantages, it has strong application potential.

2.5 Metal Hydroxide Flame Retardant

Metal hydroxide flame retardant is mainly represented by magnesium and aluminum metal hydroxide, which has the characteristics of safety, environmental protection, non-toxicity and high temperature resistance. Its flame retardant mechanism is the generation of water vapor after flame retardant decomposition in heat, which absorbs a lot of heat outside, reduces the actual temperature, releases non-combustible gas, and dilutes the combustible oxygen contacted in the combustion process.

Magnesium hydroxide is a good inorganic flame retardant, with high melting point and non-flammable characteristics. Magnesium hydroxide raw materials come from a wide range of sources, simple preparation process, and has excellent flame retardant and smoke suppression effect at high temperature. In addition, magnesium hydroxide and other flame retardants, various materials have good compatibility performance, making magnesium hydroxide flame retardant in plastic, rubber, construction, transportation and other industries are widely used.

Aluminum hydroxide is an early application of inorganic flame retardant. Aluminum hydroxide has the advantages of non-combustible and low price. At present, aluminum hydroxide plays a dominant role in various building materials, elastomers, rubber, coatings and plastic products. When aluminum hydroxide is added to some polymers, the polymer has the functions such as smoke elimination and flame retardant. Aluminum hydroxide flame retardant material can generate water vapor when burning at high temperature. In the presence of water vapor, combustible gas and oxygen reduce the contact opportunity, so as to prevent the fire spread of the effect.

3. The Development Trend of Flame Retardant

The flame retardant performance of flame retardant is closely related to the amount of addition, and if the amount of flame retardant added increases, the flame retardant effect of polymer will also increase rapidly. However, the high amount of addition will have a deteriorating effect on the processing and mechanical properties of the substrate, and will also reduce the compatibility between materials. Therefore, the main requirement of the application is to improve the flame retardant performance of the flame retardant, while reducing the influence of the flame retardant on the body properties of the material.

3.1 No Halogen, No Phosphorus-flame Retardant

Halogen flame retardant is the main product of flame retardant materials in the market today, which has good flame retardant performance. However, halogen flame retardant will produce toxic, harmful and corrosive gases such as hydrogen halide at high temperature or combustion, which can lead to environmental pollution, short circuit and corrosion of metal objects. Red phosphorus flame retardant is favored in many industries, with high flame retardant efficiency and low dosage. However, the stability of red phosphorus flame retardant needs to be further studied and strengthened. In addition, red phosphorus is easy to explode and catch fire, and it will also produce a large number of toxic and harmful gases when burning. It is understood that the United Kingdom, Australia and other countries clearly stipulate that plastic products must be tested for combustion toxicity, which requires the development of new halogen-free, phosphorus-free flame retardant materials.

3.2 Cooperative Combination of Flame Retardant

The synergistic compound technology of flame retardants is to give full play to the advantages of various materials and overcome their main defects by adding various materials. There are two main methods: one is the flame retardant compound, various flame retardant is added to the same substrate, so that the flame retardant components can play a synergistic effect, so as to achieve better flame retardant performance or reduce the additive effect; Another is the compound of the base material, base material using a variety of ingredients, so as to overcome the effect of flame retardant on the physical and mechanical properties of the material or processing properties, or by adding various

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additives, emulsifier, plasticizer, thermal stabilizer, coupling agent, etc. which is to overcome the flame retardant and substrate or during the incompatibility. A large number of practice shows that a single flame retardant with good flame retardant performance for polyolefin is not necessarily suitable for other materials such as coatings or rubber. Therefore, for many substrate to explore suitable flame retardant or flame retardant system and the substrate aid is especially important, although a flame retardant can apply for a variety of substrate, a substrate also has a variety of flame retardant, but the appropriate collocation and special usage scenarios makes the optimal choice is of great significance, the right choice can greatly reduce the cost or improve the performance of other aspects.

3.3 Surface Treatment

Surface treatment is a common modification method, which has both hydrophilic and hydrophobic groups, so it can effectively reduce the interfacial tension between the modification agent and the substrate, and it can moisten and emulsify at the interface, thus playing a dispersion and foaming role. Common surface modifiers is divided into cationic, anionic and nonionic, the most commonly used anionic surfactants have advanced fatty acid salt, commonly used fatty acid hydrocarbon chain usually between C11~ C18, stearic acid, lauric acid is common, or bivalent and trivalent metal salt system, bivalent salt system including magnesium salt, zinc salt, trivalent salt system is the most commonly used for aluminum salt.

3.4 Hyperrefined Flame Retardant

Hyperrefined flame retardant particles can reduce the interface with the substrate, so that it has a small impact on the mechanics and processing properties of the substrate or play a reinforcing role, and can effectively improve its flame retardant performance.

If the particles of flame retardant are too large, there will have a large gap, which will cause mechanical defects and affect the mechanical properties of the substrate. The literature shows that the flame retardant performance of aluminum trioxide shows an inverse relationship with its particle size.The super refinement of the flame retardant particle size, even micro and nanometers, it can effectively increase the contact area of the flame retardant and the material, reduce the gap and other defects, so as to reduce the amount of flame retardant.

4. Conclusion

With the progress of science and the deepening of research, new flame retardant is bound to emerge constantly, and the development of flame retardant has made great progress. An important trend of the future development is to develop high flame retardant effect, reduce the impact of flame retardant materials on the physical properties of the substrate, and reduce environmental pollution, reduce the production cost, product performance of multi-functional flame retardant.

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