WHITE PAPER

BACK TO BASICS:

Fire Retardants – explained.

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BACK TO BASICS: Fire Retardants – Explained.

We recently conducted a piece of research across Europe. Its primary focus was fire knowledge - basic knowledge of fire protection among construction industry professionals.

The level of knowledge, or more precisely, the lack of it, was staggering. So, in response to this, we are starting a series of short articles going back to basics. This piece is from our Chief Technology Officer and focuses on the core aspects of fire retardants.

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If you'd like to learn more about our research projects globally, please contact harriet.cooper@zeroignition.com

Flame Resistant vs Flame Retardant

Let's start with the difference between Flame Resistant vs Flame Retardant

- **Flame resistant** products are made from materials that are inherently non-flammable - these materials have flame resistance built into their chemical and physical structures. Products made with these types of materials are designed to prevent the spread of fire and will not melt or drip when in close proximity to flame. Because flame resistant products are not usually made from 100% flame resistant materials, **they will burn**, but will do so very, very slowly and are often self-extinguishing.
- **Flame retardant** products are made from materials that are chemically treated in order to be slow burning or self-extinguishing when exposed to an open flame. These products can be made from any material, but these materials **must be treated** with special formulations/additives to qualify as flame retardant and delay the effects of being exposed to open flame.

5 Categories of Flame Retardants:

1. Halogenated flame retardants
2. Inorganic Flame Retardants
3. Nitrogen Flame Retardants
4. Intumescent Coatings
5. Phosphorus Flame Retardants

Halogenated Fire Retardants:

Halogenated flame retardants include chlorine-based systems but perhaps the most well-known are Bromine flame retardants (BFRs). BFRs are commonly used within the electronics industry and also textiles, construction products, and coatings. Bromines are used because when heated the bromine atoms essentially quench the chemical reactions occurring within the flame. This quenching can prevent the burning process from initiating or can slow it such that other measures can be taken to extinguish the fire.

One major **issue** with this type of flame retardant is they are becoming increasingly **restricted for addition** to materials because of safety concerns. There exists a directive for the Restriction of Hazardous Substances that specifically limits the amount of polybrominated biphenyls and polybrominated diphenyl ethers that can be found within appliances, IT equipment, lighting equipment, medical devices, toys, and semiconductors.

Conventional halogenated flame retardants are suspected of being harmful to health and the environment: a number of these substances are extremely persistent, accumulate in the environment, have hormone-like effects and are even thought to be carcinogenic.

Non-harmful replacements are therefore called for in most countries and other countries ban these types of fire retardants. From a fire retardant perspective, this is the one category that industry should **completely move away from**, as the release of chemicals in a fire can be very toxic and detrimental to the health of individuals.

Inorganic Flame Retardants

Inorganic fire retardants are often found in paints, adhesives, wires and cables, and fabric coatings. A variety of inorganic compounds are used, but the most common are hydrated aluminum and magnesium oxide, **and** they are often combined with the other fire retardant classes. Inorganic fire retardants slow down the process of decomposition and release of flammable gases.

Many inorganic compounds are used as flame retardants or as catalysts within a flame retardant system. These materials often have to be used in large concentrations to achieve desired results.

Alternatively, these inorganic flame retardants must be used in conjunction with other types of flame retardants to be effective. For example, antimony oxides do not have flame retardant properties in and of themselves but when combined with bromine or chlorine based flame retardants they work together to give the effects of both.

This means the inorganic compounds act catalytically causing the bromine or chlorine to break down even faster, thus releasing active bromine atoms into the gas phase at a more rapid rate.

Inorganic flame retardants that can be used independently include aluminum and magnesium hydroxides. These compounds interfere with the burning process through: the release of inert gasses (such as water vapor); creating a protective char layer; or energy absorption (meaning the amount of energy available for the fire to spread is reduced).

Because these inorganic flame retardants need to be combined with other types of flame retardants such as Halogenated fire retardants, they can cause environmental and health issues.

It is my opinion that these types of flame retardants are the next least desirable due to the secondary type of flame retardants they are mixed with and thus again pose health and environmental risks.

Nitrogen Flame Retardants

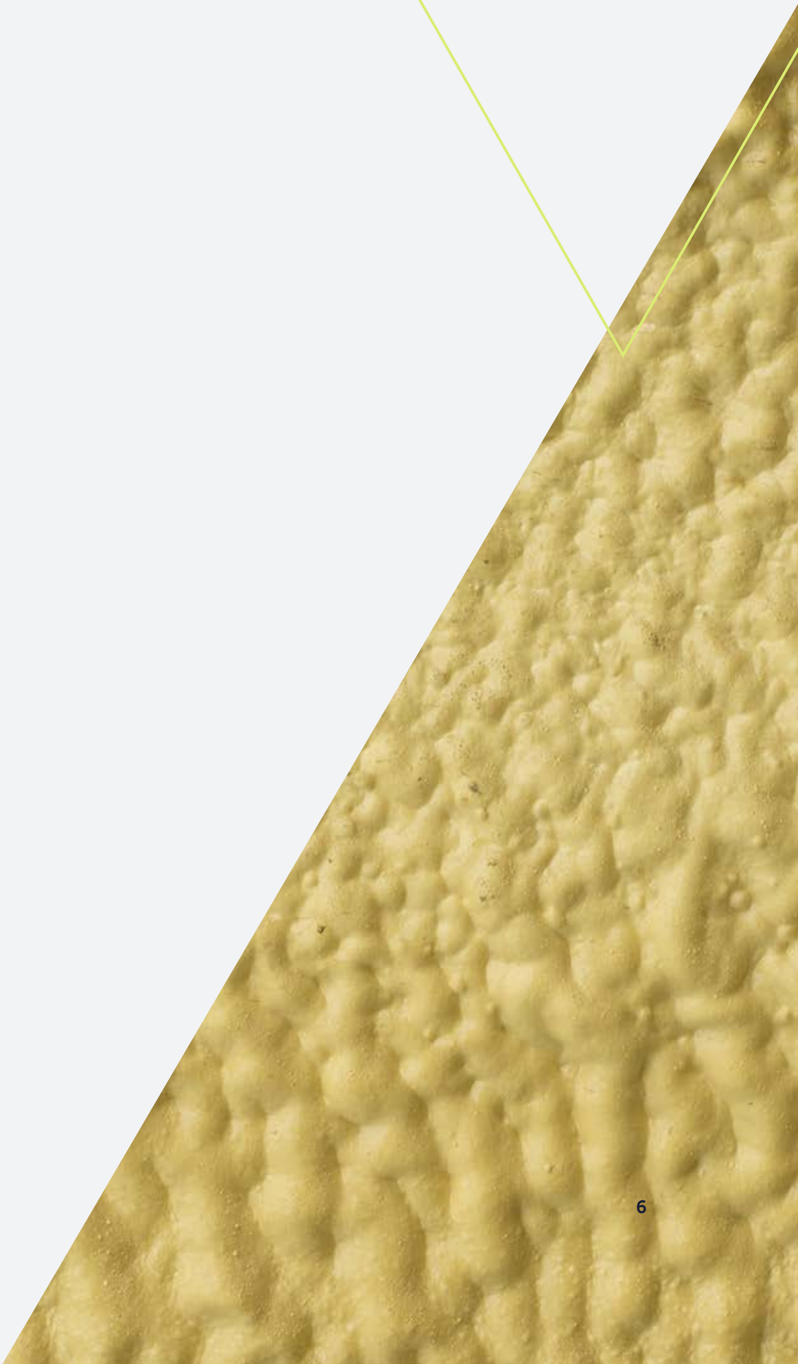
Melamine-based products are the most commonly used type of nitrogen flame retardants. When melamine is in the condensed phase the molecular structures transform into cross-linked structures. This transformation promotes the formation of char, which blocks the oxygen supply to feed the flame.

Their main common advantages of Nitrogen flame retardants are: their low toxicity; their solid state; and, in case of fire, the absence of dioxin and halogen acids as well as their low evolution of smoke. Their efficiency lies between that of halogenated flame retardants and that of inorganic flame retardants. The metallic hydroxides split off water and are environmentally friendly, but their low activity requires high concentrations to give adequate fire protection, which negatively impact the mechanical properties of the materials that they are added to. In contrast to many halogenated compounds, flame retardants based on nitrogen do not interfere with the set of stabilizers added to every plastic material.

Flame retardants based on nitrogen are environmentally friendly because they do not add any new element to those already present in the polymers such as polyurethanes and nylons

These types flame retardants are typically used in polyurethane flexible foams for upholstered furniture in homes, as well as in railway and aircraft seats. They are used in specific applications and thus limited in universal applicability.

Since high quantities of these types of flame retardants are added to give the required fire retardant performance, these addition levels change many of the characteristics of the material protected and thus not the optimum flame retardant for many applications.



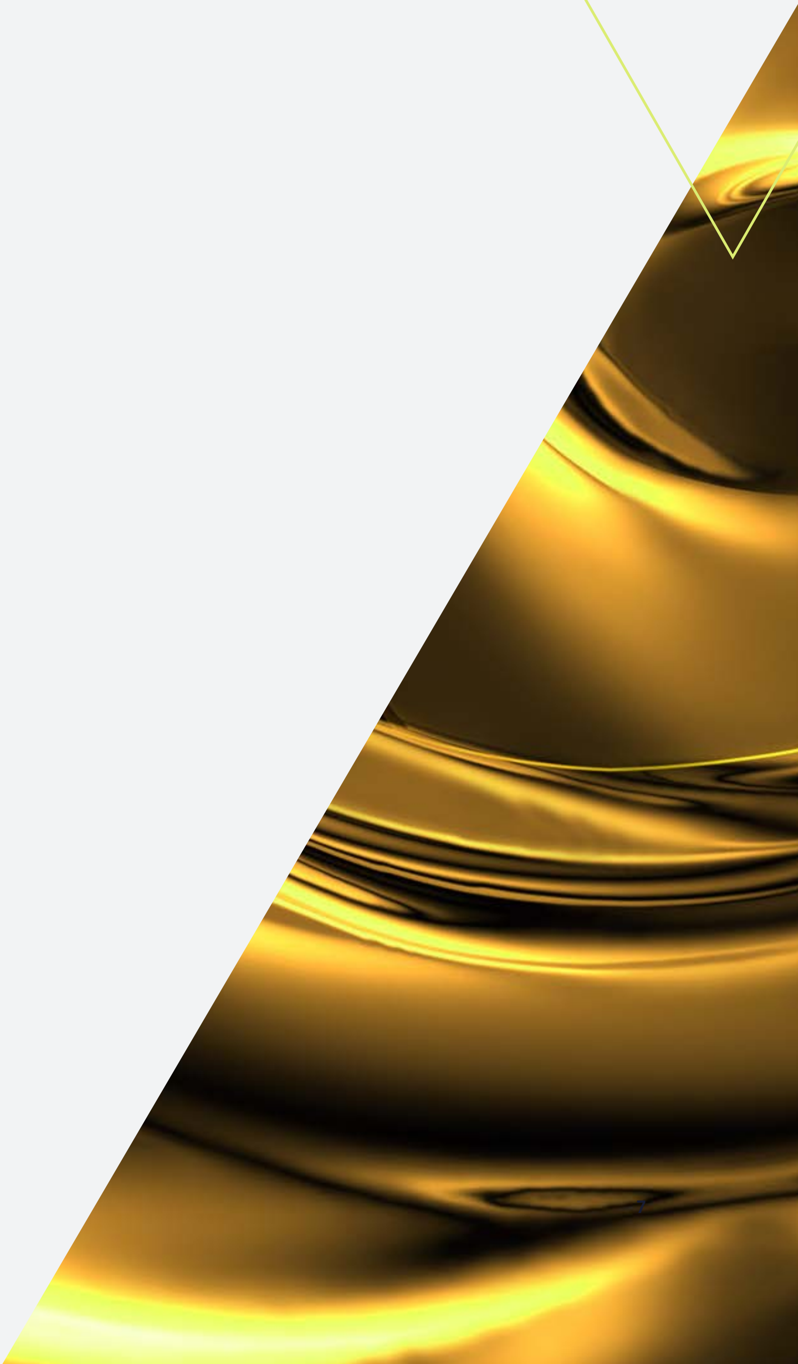
Intumescent Coatings

The aim of systems incorporating intumescent coatings is to protect materials from fire by preventing burning. They are often applied to materials as a coating, which makes them well suited for construction materials like steel beams or possibly wood surfaces.

When exposed to the heat from a fire, these coatings expand significantly to create a fire-resistant and insulating layer on the material surface. That layer protects the material from high temperatures, which can prevent or slow structural damage by deformation from the heat.

The effectiveness of intumescent flame retardants is due to the foamed char formed on the surface of the material that is exposed to a fire. The char acts as a physical barrier against heat transfer to the surface of the combustible material. Char formation lowers the rate of temperature increase of the surface beneath the char.

These types of flame retardants are developed for specific applications that provide fire retardancy but offer no room-temperature thermal protection or insulating properties. Again, these types of flame retardants have specific applications where they may be desirable but are not universally applicable.



Phosphorus Flame Retardants (PFR's)

Phosphorus flame retardants both chemically bond to materials and are also physically incorporated as an additive. A char is formed when the phosphorous compound is heated, thereby inhibiting the formation of combustible gas and inhibiting the pyrolysis process (process of chemically decomposing organic materials at elevated temperatures in the absence of oxygen). What is particularly interesting about the formation of char is it hinders the release of combustible gasses while also forming a protective layer that shields the protected material from the heat of the flame.

This class of flame retardants are typically environmentally friendly, are great at promoting a char formation when exposed to a flame source and produce much less smoke generation compared to all other fire retardant categories.

The Zeroignition formulation sits within this classification.

Get in touch

We are curious by nature and our continued education on all aspects of life that our technology affects is something that is fundamental to our company. This is why we are dedicated to producing papers, undertaking research and creating resources to educate and challenge the industries we work within.

Want to learn more?

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