The Importance of Flame Retardant

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- In order for fire to occur its three basic elements (fuel, heat, and oxygen) must exist.
- The science of flame retardant uses chemical reactions to moderate one or more of these attributes.
Flame Retardants: Preventing Fires and Protecting Consumers

As consumer products continue to evolve and improve, from lighter and faster computers to energy-saving building materials and construction methods to more fuel-efficient cars, fire safety technology allows these products to comply with domestic safety standards and laws.

- Flame retardants are materials that can be used in products, made from plastics, textiles, foams or wood, to reduce the chances of a fire starting and to delay the spread of fire once it starts.

- Flame retardant compounds help mitigate fire danger
  - Increase plastic’s ignition resistance
  - Reduce the speed of flame spread
  - Reduce heat release
  - Reduce smoke & fume generation
How Flame Retardants can INCREASE ESCAPE TIME IN FIRES

- Flame retardants reduce the risk of ignition and fire spread of many plastic and textile materials which results in more available escape time for occupants.
- Time to flashover can increase from 5 minutes to 15 minutes which can make the difference between escape and fatalities.
- Bear in mind that the escape time includes the time to discover the fire, alert other people, take the decision to call the fire brigade, take own actions to extinguish or take the decision to evacuate the building.

THE 3 PHASES OF FIRE AND THE PROTECTING FEATURES OF FLAME RETARDANTS

IGNITION SOURCE
- Prevent ignition
- Possibly self-extinguish

FLAME SPREAD (REACTION TO FIRE)
- Slow down flame spread
- Reduce heat release
- Delay flash-over

FIRE PENETRATION (RESISTANCE TO FIRE)
- Prevent the collapse of structures, e. g. steel columns protected by intumescent coatings
- Prevent fire moving to adjacent room or building compartment
What are flame retardants?

- Flame retardants are a key component in reducing the devastating impact of fires on people, property and the environment.
- They are added to treat potentially flammable materials, including textiles and plastics.
- Flame retardant plastics are essential to devices we use every day, providing a valuable tool in fire prevention.
- The term “flame retardant” refers to a function, not a family of chemicals. A variety of different chemicals, with different properties and structures, act as flame retardants and these chemicals are often combined for effectiveness.
What are the most common elements in flame retardants?

- Bromine, phosphorus, nitrogen and chlorine are commonly used in flame retardants.

- Inorganic compounds are also used in flame retardants, either alone or as part of a flame retardant system in conjunction with bromine, phosphorus or nitrogen.

- It is important to note that flame retardants are not readily interchangeable. Their areas of application are often specific and substitution can be difficult.
How do flame retardants work?

- Flame retardants are added to different materials or applied as a treatment to materials (e.g., textiles, plastics) to prevent fires from starting, limit the spread of fire and minimize fire damage.

- Some flame retardants work effectively on their own; others act as “synergists” to increase the fire protective benefits of other flame retardants.

- A variety of flame retardants is necessary because materials that need to be made fire-resistant are very different in their physical nature and chemical composition, so they behave differently during combustion.

- The elements in flame retardants also react differently with fire. As a result, flame retardants have to be matched appropriately to each type of material. Flame retardants work to stop or delay fire, but, depending on their chemical makeup, they interact at different stages of the fire cycle.
What types of products use flame retardants?

- While an ever-evolving list of new products—from hair dryers and small appliances to laptops and flat-screen televisions—is incorporated into our homes, offices and commercial environments, we seldom think about how the products are made.
- Flame retardants provide consumers with a critical layer of fire protection and are vital to reducing the risks associated with fire.

Today, flame retardants are used predominantly in four major areas:

- Electronics and Electrical Devices
- Building and Construction Materials
- Furnishings
- Transportation (Airplanes, Trains, Automobiles)
The global flame retardants market is expected to reach USD 11.96 billion by 2025, according to a new report by Grand View Research, Inc. Non halogenated flame retardants emerged as the leading product segment and accounted for 57.7% of total market volume in 2015. The product segment is also expected to witness the highest growth of 5.7% over the forecast period. The global flame retardant market demand was 2.49 million tons in 2015 and is expected to exceed 4.0 million tons by 2025, growing at a CAGR of 4.9% from 2016 to 2025. Aluminum hydroxide had the highest penetration within the non halogenated segment, in terms of demand in 2015 and is expected to grow at an estimated CAGR of 5.7% over the forecast period. Epoxy resins were the largest application segment and accounted for 24.1% of total market volume in 2015. Electrical & electronics was the leading end-use industry consuming flame retardants with a demand share exceeding 40% in 2015. Asia Pacific was the leading consumer and accounted for 47.9% of total market volume in 2015.
Plastic combustion can be stopped by:
(1) Inhibit combustion at flame front.
(2) Remove heat from polymer.
(3) Prevent polymer decomposition / fuel release.

Each of these approaches can be used alone, or combined to generate flame retardancy in a polymeric material.

Each type of flame retardant falls into a category that fits one or more of the above approaches.
1. **Gas Phase Flame Retardants** (ex. Halogen, Phosphorus)
   - Reduce heat in gas phase from combustion by scavenging reactive free radicals, thus inhibiting combustion.

2. **Endothermic Flame Retardants** (ex. Metal Hydroxides, Carbonates)
   - Function in Gas Phase and Condensed Phase by releasing non-flammable gases ($\text{H}_2\text{O}, \text{CO}_2$) which dilutes the fuel and cools the polymer.

3. **Char Forming Flame Retardants** (ex. Intumescentes, Nanocomposites)
   - Operates in Condensed Phase by preventing fuel release and providing thermal insulation for underlying polymer.
Halogenated Flame Retardants

- Halogenated FR additive benefits:
  - Very effective at lowering flammability in a wide range of polymers.
  - Provide good fire performance even after repeated recycling of polymer + FR resin.

- Halogenated FR additive drawbacks:
  - Always generate more smoke and carbon monoxide during burning.
  - Can be overwhelmed in high heat flux fires (little to no FR effectiveness).
  - Under regulatory scrutiny due to perceived environmental problems.

- Overall an old technology (since 1930s) but proven to work.
Phosphorus Flame Retardants

- Phosphorus FR additive benefits:
  - Can be both vapor phase and condensed phase flame retardants.
  - Can be very effective at lowering heat release rate at low loadings of additive.

- Phosphorus FR additive drawbacks:
  - Tend to generate more smoke and carbon monoxide during burning.
  - Not effective in all polymers.
  - Starting to be under regulatory scrutiny.

- Newer technology (1950s). A mature technology but lots of other possible chemical structures to explore and use for flame retardancy.
Intumescent Flame Retardants

- **Intumescent FR additive benefits:**
  - Very robust fire safety and flame resistance performance.
  - One of the few systems that can use select polymer structures to actively participate in flammability reduction.

- **Intumescent FR additive drawbacks:**
  - Can have water pickup issues.
  - Can be expensive.
  - Can have low temperature limits that limit processing ranges.

- Intumescents are often used for applications requiring high levels of flame retardancy. Building and construction, firewall/firedoor barriers, aerospace, military, wire & cable, mass transport, etc.
Additives Vs. Reactive Flame Retardants

- Additives widely used because they are cheap and easy to use.
  - Can leach out or lead to other polymer property drawbacks.

- Reactive Flame Retardants are newer materials with react directly into the polymer.
  - Eliminate all of the issues with additives, but can lead to significant changes in the polymer properties (both positive and negative).

- New additives and reactives take time to discover, scale-up, register, and make economically viable.

- No matter how good the new FR compounds are, if they cannot be made cost effective no one will use them.
Introduction:
Flame Retardant Performance
Of 3M Insulation Tape

1350F-1 Yellow

1388Y-1
Insulation Tape Select Guide

- Dielectric Breakdown
- Temperature Rating
- Adhesion
- Conformability
- Solvent Resistance
- Electrical Insulation System
- CTI
- ECF
- Flame Retardant
Why Insulation Tapes Can Be Flame Retardant?

1. Backing is Flame Retardant
2. Add Flame Retardant into Adhesive
   - Chlorides
   - Bromides
   - Nitrides/ Phosphides
   - Al(OH)$_3$

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Flame Test Method For Insulation Tape

UL 510 Flame Test

- TAPE: 38 mm
- Flag: 254 mm
- Burner: 20°
- Cotton
The insulation tape is to be judged as flame retardant:

1. Can not continue to flame longer than 60s after any of five 15s applications of test flame.

2. Can not ignite the cotton on the burner, wedge or floor of the enclosure.

3. Less than 25% of the indicator flag burned away after any of five 15s applications of test flame.
Why some “Flame Retardant” insulation tapes can not pass UL 510 flame test?

1. RoHS directive banned PBBs & PBDEs.

2. Changed formulation for cost saving.
Thanks !!!

Any questions, please contact with us directly.

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