FIRE RETARDANT

What is it?

A fire retardant is a substance applied to materials to reduce their flammability and slow the spread of fire. These products are used in various applications, from protecting structures and building materials to ensuring safety in textiles and plastics. Fire retardants can function in several ways:

- **Cooling:** Some retardants release water or substances that vaporize, absorbing heat and reducing the material´s temperature.
- **Formation of a Protective Layer:** They can create a charred layer or a physical barrier that isolates the material from oxygen and heat, preventing it from igniting easily.
- **Fuel Dilution:** They may release non-flammable gases that dilute the flammable vapors around the material.
- **Interruption of the Chemical Reaction:** Some retardants interfere with the chemical reactions in combustion, inhibiting the formation of flammable products.

What types of retardants are there?

There are several types of fire retardants, each with specific mechanisms and applications. Below are the main types of retardants:

1. Halogenated Retardants These include compounds containing chlorine or bromine. They work by releasing halogen gases during combustion, which interfere with the fire's chemical chain reactions.

- **Advantages:** Effective in small quantities, widely used in plastics and electronic products.
- **Disadvantages:** Can release toxic and corrosive gases during a fire, and some have been restricted or banned due to environmental concerns.

2. Phosphorus-Based Retardants These contain phosphorus and act by promoting the formation of a charred layer that insulates the material from heat.

- **Advantages:** Effective in a wide range of materials, including textiles and plastics.
- **Disadvantages:** Can be more expensive and some compounds may have negative environmental impacts.

3. Inorganic Retardants These include compounds like aluminum and magnesium hydroxides, which decompose endothermically (absorbing heat) and release water.

- Advantages: Non-toxic, do not generate corrosive gases, used in plastics and coatings.
- Disadvantages: Require high loadings to be effective, which can affect the material´s mechanical properties.

4. Nitrogen-Based Retardants Based on nitrogen compounds, they work by forming non-flammable gases that dilute flammable products.

- **Advantages:** Effective in polymers, often used in combination with other retardants.
- **Disadvantages:** Can be less effective on their own and are

sometimes combined with phosphorus compounds.

5. Intumescent Retardants These expand when heated, forming a foamy
charred layer that protects the underlying material.

- **Advantages:** Highly effective in various applications, especially in
  paints and coatings for steel structures.
- **Disadvantages:** Can be more expensive, and their effectiveness can
  depend on proper application.

6. Foam Retardants Specifically used in fighting wildfires, they are applied to
create a physical barrier that slows fire advancement.

- **Advantages:** Provide quick and effective coverage, easy to apply.
- **Disadvantages:** May require large volumes and repeated
  applications in large fires.

Fire retardants are essential for enhancing safety and protecting both human lives
and property, but it is important to select the right type for the specific application
and consider their potential environmental and health impacts.

How is fire resistance measured?
Fire resistance is measured through standardized tests that evaluate the ability of a
material or assembly of materials to withstand fire exposure for a specific period
without losing their structural or functional properties. The following are common methods and standards for measuring fire resistance:

- **Fire Resistance Test:**
  - **Standards:** ASTM E119, ISO 834, EN 1363-1.
  - **Procedure:** A construction specimen (such as a wall, ceiling, or
    column) is exposed to a standardized temperature curve in a test furnace. The temperature curve gradually increases, simulating a real Fire.

Evaluation Criteria:

- **Integrity:** Assesses if the material allows the passage of flames or
  hot gases.
- **Thermal Insulation:** Measures if the temperature on the unexposed
  side exceeds a specific limit.
- **Load-Bearing Capacity:** For structural elements, assesses if the
  material maintains its load-bearing capacity during exposure.

Flammability Test:

- **Standards:** UL 94, ASTM D635.
- **Procedure:** A direct flame is applied to the material to see if it ignites
  and how long it takes to stop burning once the ignition source is
  removed.

Evaluation Criteria:

- **Burn Time:** Time the material continues to burn.
- **Flame Spread:** The distance the flame travels through the material.

Reaction to Fire Test:

- **Standards:** ASTM E84 (Steiner Tunnel Test), EN 13823 (Single
  Burning Item Test).
- **Procedure:** Evaluates how a material contributes to the fire's
  development and spread, including the amount of heat and smoke
  generated.

Evaluation Criteria:

- **Flame Spread Index:** The speed at which the fire spreads.
- **Smoke Development Index:** The amount of smoke generated during combustion.

Equipment and Procedures

- **Test Furnaces:** Used for fire resistance tests, where materials are subjected to controlled temperatures simulating fire conditions.
- **Flammability Chambers:** Used for flammability and reaction to fire tests.
- **Thermocouples and Sensors:** To measure temperature and evaluate thermal performance during tests.

These tests and classifications are essential for ensuring fire safety in buildings and products, helping to design materials and structures that provide enough time for evacuation and fire control, thus reducing the risk of damage and loss of life.

NFPA 251

One of the most important standards for measuring fire resistance is NFPA 251, as it provides a methodology for evaluating the fire resistance of materials and construction systems, including those treated with fire retardants. Here´s how NFPA 251 applies to fire retardants:

- **Preparation of Treated Specimen:**
  - Materials treated with fire retardants are prepared following the specific instructions of the retardant manufacturer. This may include the application of intumescent paint layers, the impregnation of with chemical solutions, or the incorporation of retardant additives in plastics and other materials.
- **Mounting and Conditioning:**
  - The treated material is mounted in a configuration representative of its final use in construction. For example, gypsum boards treated with retardants would be installed in a support frame.
  - Treated materials are allowed to dry or cure completely according to the manufacturer´s recommendations before testing.
- **Fire Exposure in Test Furnace:**
  - The mounted specimen is introduced into a test furnace where it is exposed to a standard temperature curve that simulates real fire conditions. The temperature curve typically follows a predetermined increase, such as that established by the time-temperature curve of the test.
  - The temperature in the furnace increases gradually following a standardized curve (e.g., 538°C in the first 5 minutes, 704°C at 10 minutes, 843°C at 30 minutes, and 927°C at 60 minutes).
- **Monitoring and Recording:**
  - During the test, various parameters are monitored, including the temperature at different points of the specimen, its structural behavior under load, and any signs of flame or hot gas penetration.
  - Data on structural stability, heat transfer, and the integrity of the treated material are recorded.