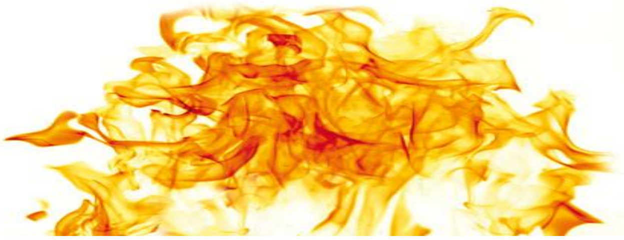
Flame Retardants

Increase resistance to ignition, reduce flame spread, supress smoke formation, and prevent polymer dripping with Ampacet Flame Retardants.

Summary

Since plastics are synthetic organic materials with carbon and often high hydrogen contents, they are combustible. For various applications in the construction, electrical, transportation, mining and other industries, plastics have to fulfill flame retardancy requirements. These are outlined in mandatory regulations and voluntary specifications. The objectives in flame retarding polymers are to increase ignition resistance and reduce rate of flame spread.



Product Overview

Polyolefins are flammable and will burn in air with a hot and clean flame, accompanied by melting with subsequent dripping or flowing of the molten polymer. The flammable nature of polyolefins is due to its long chain saturated hydrocarbon structure. This structure readily fragments at high pyrolysis temperatures, yielding highly volatile low molecular weight saturated and unsaturated hydrocarbons. These subsequently undergo free radical and oxidation reactions in the pre-ignition zone and flame zone.

Combustion is initiated by heating a plastic material to its decomposition point. The three most important sources required to sustain combustion process are ignition source, fuel and oxygen. The combustion cycle could be stopped by isolating any of those sources as represented by the triangle. Numerous combustible decomposition products like hydrocarbons, hydrogen and carbon monoxide are formed.

$$RH \longrightarrow R^* + H^* \quad \text{(Start)}$$
$$H^* + O_2 \longrightarrow HO^* + O^* \quad \text{(Branching)}$$
$$HO^* + CO \longrightarrow CO_2 + H^* \quad \text{(Propagation highly exothermic)}$$

The reaction of combustible gases with oxygen is an exothermic reaction, and when it exceeds the endothermic pyrolysis reaction it will initiate flame propagation. A flame retardant should inhibit or even suppress the combustion process.

Flame retardants can act physically or chemically:

Physical Action

- Cooling – additives cool the substrate to a temperature below the combustion temperature (e.g. ATH)
- Formation of a protective layer – a solid or gaseous protective layer which excludes the oxygen necessary for the combustion process (e.g. phosphorus compounds)
- Dilution – The inert gasses from the additive dilutes the fuel in the solid and gaseous phase (e.g. aluminum hydroxide)

Chemical Action

- Gas Phase – the mechanism of combustion is interrupted and exothermic reactions are stopped. The system cools down (e.g. halogenated flame retardants)
- Reaction in Solid Phase – forming a carbonaceous layer on the polymer surface (e.g. phosphorus compounds)

Types of Flame Retardants

Halogenated Compounds The effectiveness of halogen containing flame retardants increases in the order F<Cl<Br<I. Fluorine and iodine based flame retardants are not used in practice because neither type interferes with the combustion process at the right point. Fluorine due to its strong bond with carbon and iodine is loosely attached to carbon.

- **Bromine containing flame retardants** are the most effective flame retardant.
- **Chlorine containing flame retardants** are less expensive and offer good light stability, but require high amounts to achieve the required performance. They are thermally less stable and more corrosive to the equipment as compared to brominated compounds.
- **Halogenated compounds with Antimony synergist** – the antimony trioxide shows no flame retardant action on its own. However, it shows good synergistic effect with halogen containing compounds.

Phosphorus Compounds can be organic or inorganic (elemental) and can be active in the vapor phase, condensed phase, or both. The condensed phase mechanism arises as a consequence of thermal generation of phosphoric acids from the flame retardant e.g. phosphoric acid or polyphosphoric acid. These acids act as dehydrating agents altering the thermal degradation of the polymer and promoting char formation.

Inorganic Flame Retardants

- **Aluminum Hydroxide** is currently the most widely used flame retardant because it is relatively low cost and easy to incorporate into plastics. It starts to break down between 180˚C - 200˚C and conversion to aluminium oxide takes place via endothermic reaction.
- **Magnesium Hydroxide** acts in a similar way as aluminium hydroxide but with a decomposition temperature of 300˚C it is higher than aluminium hydroxide.
- **Zinc Borate** experiences an endothermic reaction where there is a stepwise release of water as well as the formation of a glassy coating which protects the substrate.

Representative Product Applications

- Transportation
- Building & Construction
- Furnishings
- Fibers
- Electrical & Electronics

Products/Codes

Production Code	Resin	Application	LDR
11371	LDPE	Off-white, long-term outdoor, least migratory, high-heat	60% Halogenated
11371-W	LDPE	Whiter version of 11371	60% Halogenated
101199	LDPE	White/milky, general purpose, good heat stability, some migration	55% Halogenated + Synergist
400183-A	LDPE	Can be added to color MB	40% Halogenated + Synergist
101888	LLDPE	Molding, thick parts only	60% Non-Halogenated
100465	PP	Non Halogenated	60% Non-Halogenated

Performance Data Details

Ampacet is not a certified testing facility.

UL-94 Vertical Burning Test: A flammability test for plastic materials for parts in devices and appliances. A specimen bar is mounted vertically in a draft free enclosure. A burner is held in place under the sample for 10 seconds and withdrawn and the duration of the flaming is timed. The test is repeated for 5 specimens. Any dripping which ignites a piece of surgical cotton placed 12” below the bar is noted. UL-94 encompasses three defined criteria’s for differing compliance, 94 V-0, 94 V-1, and 94 V-2.

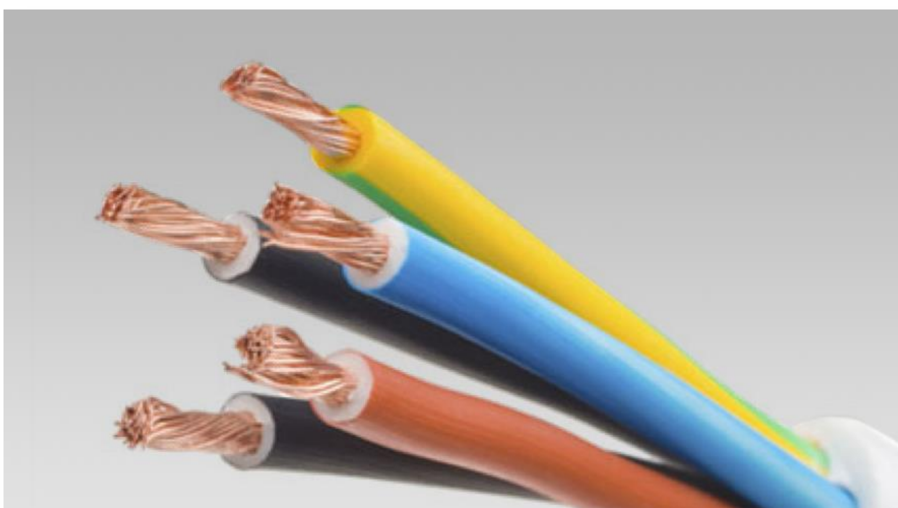
Limiting Oxygen Index Test (LOI): LOI is used as a screening tool. It quantifies the minimum concentration of oxygen expressed as volume percent in a mixture of oxygen and nitrogen that will just support flaming combustion of a material initially at room temperature.

UL-181: This test method is used for the fabrication of air duct and air connector systems for use in accordance with the standards of the National Fire Protection Association for installation of air conditioning and ventilating systems.

UL-214: This test method is a standard for flame propagation of fabrics and films.

E-84: This fire-test response standard for the comparative surface burning behavior of building materials is applicable to exposed surfaces such as walls and ceilings. The purpose of this test method is to determine the relative burning behavior of the material by observing the flame spread along the specimen.

Motor Vehicle Safety Standard 302: This standard specifies burn resistance requirements for materials used in the occupant compartments of motor vehicles. Each car manufacturer has its own standards.



For more information on Ampacet **Flame Retardants**, their uses and complete Regulatory Status, contact your Ampacet Account Executive or visit **www.ampacet.com.**

Ampacet Website: www.ampacet.com
Global Regional Headquarters:
Ampacet North America: 660 White Plains Road, Tarrytown, NY 10591-5130
Ampacet South America, S.A.: Dardo Rocha 2454 – 2o Piso, (B1640FTH) San Isidro, Buenos, Aires, Argentina
Ampacet Europe, S.A.: Zoning Industriel Riedgen, L-3451 Dudelange, Luxembourg
Ampacet Asia: Eastern Seaboard Industrial Estate (Rayong), 64/19 Moo 4, Highway 331, Pluakdaeng, Rayong 21140

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