# *Fire Retardant*



## *I INTRODUCTION*

**Flame Retardant**, material added or applied to a product to increase the resistance of that product to fire. Flame retardants, also called fire retardants, are less flammable than the materials they protect, burn slowly, and do not propagate fire. Some flame retardants prevent the spread of flame; others burn and thereby create a layer of char that inhibits further combustion.

Flame retardants are generally added to wood, paper, plastics, textiles, and composites to meet governmental regulations for buildings, aircraft, automobiles, and ships. Flame retardants can be incorporated into a material either as a reactive component or as an additive component. Reactive-type flame retardants are preferable because they produce stable and more uniform products. Such flame retardants are incorporated into the polymer structure of some plastics. Additive-type flame retardants, on the other hand, are more versatile and economical. They can be applied as a coating to wood, woven fabrics, and composites, or as dispersed additives in bulk materials such as plastics and fibers.

The chemicals in a flame retardant determine how it works. Most flame-retardants contain elements from any of three groups in the periodic table of elements (*see* Periodic Law): group IIIa (including

boron and aluminum); group Va (including nitrogen, phosphorus, arsenic, and antimony); and group VIIa (including fluorine, chlorine, and bromine). Elements of different groups that are combined in a single flame retardant may work more effectively together than they would separately.

## II GROUP IIIA FLAME RETARDANTS

Flame retardants that contain boron or aluminum increase the amount of char, or burnt material, formed in the early stage of a fire. The char forms a protective layer that prevents oxygen from reaching the inner layers of the material and thus sustaining the fire (*see* Combustion). Chemicals commonly used for this purpose include borax, boric acid, and hydrated aluminum oxide.

## III GROUP VA FLAME RETARDANTS

Phosphorus can function as a flame retardant in both its solid phase and its liquid phase. Phosphorus-containing compounds such as phosphoric acid work by forming a surface layer of protective char. Nitrogen is used mainly in combination with phosphorus; such combinations have proved effective in cellulose, polyester, and polyurethane products. Arsenic, because of its toxicity, is now rarely used in flame retardants. Antimony by itself is ineffective as a flame retardant and is used only in combination with halogens, especially bromine and chlorine.

## IV GROUP VIIA FLAME RETARDANTS

Bromine works as a flame retardant in its gaseous phase. Bromine-containing compounds are incorporated into flammable materials. When these materials are exposed to flame, the bromine dissociates from the material and forms a heavy gas. This dissociation disperses heat, and the bromine gas forms an insulating layer around the material. The layer prevents flames from spreading by inhibiting access to oxygen and by slowing the transfer of heat. Chlorine works in a similar manner in both its liquid and gaseous phases. The most important fluorine-containing flame retardants are the chlorofluorocarbons, which are used as blowing agents in polyurethane and polystyrene foams. The use of bromine and chlorine in fire retardants is somewhat restricted, however, because a high concentration of these elements can diminish the flexibility, mechanical properties, and durability of materials.