

Phosphorus in Fire Prevention and Fire Fighting

Many phosphorus-containing materials are used as flame-retardants for textiles, plastics, coatings, paper, sealants and mastics. The list includes soluble inorganic and insoluble inorganic phosphate salts, organophosphates and phosphonates. There are also halogenated materials containing phosphorus. The different chemicals often operate by differing mechanisms, such as char formation in the case of inorganic polyphosphates and free-radical inhibition in the case of some organophosphates.

Phosphorus is present in a wide range of fire retardant and fire protection products. Ammonium polyphosphates have application in the protection of steel and building components, intumescent coatings and sealants. Common household fire extinguishers often contain ammonium phosphates, usually orthophosphates.

Phosphorus-based flame retardants also control the decomposition of plastics into combustible volatiles. The polyphosphoric acid that is eventually formed during heating helps generate a char layer, which acts as a physical barrier to the formation of gases and the release of heat (1). This results in less volatile reaction products.

Devastating forest or brush fires which are common in the Western United States, Australia and other parts of the world are often pushed by strong dry winds and can quickly get out of control. These wildfires destroy both housing and natural resources. In these situations, phosphorus-based chemicals are often used in prescribed burning techniques to stop the advance of a fire. Ammonium phosphate applied via aerial application to vegetation in advance of the fire's expected path is very effective in helping control wildfire advancement.

In this application, the phosphorus based fire retardant component reacts with the cellulose present in grass or wood, which would otherwise provide fuel for the fire. The formation of this insulating char, in effect, stops the advance of the fire. The fire retarded cellulosic material decomposes to give off water vapor, which helps cool the fire and leaves behind a black carbon based coating which insulates and restricts air flow to any remaining fuel. These products can be applied in a number of ways, including fire hose and from the air.

1. Phosphorus Chemistry in Everyday Living. 2nd ed. A.D.F. Toy and E.N. Walsh, American Chemical society, Wash.D.C., 1987