# Phosphate Based Forest Fire Retardants

Wildland fuels (trees, brush and grasses) are composed primarily of cellulose and smaller amounts of other aromatic hydrocarbons. Phosphate salts containing a thermally volatile cation are most effective for fire retarding cellulosic fuels. As the treated fuel is heated, the cation is released and the residual phosphoric acid then reacts with the cellulose molecule producing an ester. The phosphate ester subsequently thermally degrades via dehydration resulting in the release of water vapor and the deposition of graphite-like carbon that is not flammable in atmospheric conditions. The ammonium phosphates have been found to be the most effective and environmentally safe fire retardants for reducing the intensity and rate of spread of fire in wildland fuels such as forests and brushlands.

Monoammonium phosphate (MAP) and diammonium phosphate (DAP) and mixtures of the two have been shown most desirable for use in dry powder type retardant concentrates. Fertilizer grade liquid concentrates (10-34-0 and 11-37–0) are used in liquid concentrate type retardant formulations because they contain condensed ammonium phosphates (pyro and poly and longer chains) that result in greater water solubility which allows the preparation of more concentrated solutions.

Strict government environmental and toxicological requirements exist that define the acceptability of wildland fire retardant compositions. The only wildland fire retarding agents permitted by federal land management Agencies are those identified in the preceding paragraph.

Most wildland fire retardants are applied aerially, i.e., from either a fixed or rotary wing aircraft. While the ammonium phosphates (MAP, DAP, liquid ammonium polyphosphates or mixtures) are the primary components, a number of other functional components are required. They are supplied as either a dry-powder or a liquid concentrate. Both concentrate types are mixed or diluted with water prior to transferring them in special tanks on the application platform at the time of use. The mix ratio is determined during fire performance testing in government laboratories. When the retardant solution is applied indirectly (to form a firebreak in front of the advancing fire), the mix or dilution water evaporates prior to arrival of the flame front and thus does not significantly impact retardant performance.

Wildland fire retardants are most effective when applied indirectly. Firebreaks formed by an ammonium phosphate based retardant maintain their effectiveness until physically removed from the fuel via rainfall or other means of solubilization. For this reason, ammonium phosphate based retardants are referred to as *long-term retardants*.

Rheological modifiers are used in wildland fire retardant formulations to maintain a compact retardant cloud when exposed to the shear of exiting the aircraft. Ideally a properly thickened solution would impact and cling to the fuel in such a manner that a continuous retardant line is formed in which the ladder and ground fuels are both covered at a predetermined application rate.

Generally several aerial drops are required to prepare the desired retardant firebreak configuration. This requires that the solution is visible to the pilot so that drops can be tied together to maintain effective line continuity. This is accomplished by inclusion of a colorant. The incorporation of a red iron oxide pigment is used as a colorant for aerially applied retardants where a semi-permanent stain on the landscape is not an issue. Fugitive colored retardants are preferred in areas visible to the public in order to avoid long-lasting red stains. Fugitive colored retardants contain a color pigment that degrades when exposed to natural sunlight; returning to an earth-tone color that blends in with its surroundings.

Other components that may be incorporated in wildland fire retardant formulations include corrosion inhibitors and flow conditioners such as tricalcium phosphate (TCP). It is important that the retardant formulation meet rigid government requirements relative to steel, aluminum and brass corrosion of the ground and aerial hardware with which it comes into contact. TCP is used to insure that dry powder retardants flow freely from the container to the mixing vessel at the time of use.