

## FUMIGATION

# ALUMINUM PHOSPHIDE

## Fumigation using aluminum phosphide

by Dick Bigler and Slade Baker, Douglas Products Inc, USA

**M**aintaining grain quality from grain-infesting insects is a never-ending challenge. To help, Milling & Grain asked two industry professionals from Douglas Products to share their experience using aluminium phosphide fumigant to protect stored grain.

### Why is fumigation important?

Baker: We all want — and food regulations require — safe and nutritious food. Grain-infesting insects are a leading threat to grain quality. Fumigation is an important and proven means to eliminate target pests in grain and other commodities as well as pest harbourages in the storage facility.

Fumigation is a word I hear mistakenly used to refer to fogging treatments. It's true that both are used to control pests in a space, but what fogging does is use application equipment to generate insecticide particles into the air as a smoke, fog or mist. With a fogging treatment, insecticide is suspended into the air, but the insecticide only penetrates grain or insect harbourages to a limited degree in the structure and targets adult and immature stages.

Depending upon airflow, equipment used, and applicator skill, the insecticide may not even reach all the intended treatment areas. In contrast, with fumigation the gas molecules will diffuse throughout the enclosed space and penetrate to reach pests in grain and harbourages. Fumigation is lethal to all life stages of target pests when the proper concentration of the gas is held over the necessary exposure time.

Bigler: I would add that fumigation is highly important both as prevention and infestation treatment, now that grain is being stored longer and longer. In some areas, grain is being stored for multiple years. So, over time you might put into storage a certain grade factor, which does not automatically assume it will have that same grade factor when the grain is removed from the structure. Running aeration fans helps stabilise grain, but you also need to monitor for heat, moisture and manage pests.

### Facts about aluminium phosphide

Baker: Aluminium phosphide is extremely easy to use, economical, penetrates well and can be used on virtually any

grain storage structure, everything from an on-farm bin to tarpaulin enclosures, country elevators, and grain terminals; it can also be used in-transit on barges, rail cars, or ships. Our PH3<sup>®</sup> phosphide label directions allow for fumigation of raw agricultural commodities, processed foods and animal feed ingredients.

It has no known effects on commodities when used according to the label. It can be used on seed and does not harm germination and can be used on some other food products. The label covers the range of dosages for various storage structures.

### How long has aluminium phosphide been used?

Bigler: It is not clear when aluminium phosphide was invented, but we know it was used as a fumigant in Germany as early as in the 1930s, and then used during World War II to treat German stores of grain. After the war, there were patent disputes between two manufacturers, one in East Germany and one in West Germany.

Those lawsuits were eventually thrown out, and in the later 1970s, companies in other countries began to manufacture and market phosphide products. Aluminium phosphide has been used in the US since at least the early 1960s. Douglas Products started marketing aluminium phosphide products in the early 1980s and later purchased the aluminium phosphide labels from Drexel in 2008. Today, we are a registrant and we market phosphine in our PH3 branded tablet and pellet formulations.

### What is the difference in the two formulations?

Baker: Both products perform similarly. Tablets weigh three grams and release one gram of hydrogen phosphide gas. Tablets are packed in aluminium flasks containing 500 tablets each. Pellets weigh 0.6 grams each and release 0.2 grams of hydrogen phosphide gas. Pellets are packed in aluminium flasks containing either 1,660 or 2,500 pellets. Both are solid formulations that contain 60 percent active ingredient with 21 kilograms of material per case.

One tablet of five pellets produces a concentration of 25 ppm of hydrogen phosphide gas in a volume of 1,000 cu. ft. The pelleted formulation tends to react and release a little faster, about a 24-hour faster difference, and tends to be used more often in northern climates where it is cooler. Tablets tend to be used more often in southern states where the climate is warmer.

### What happens chemically with phosphine?

Bigler: When exposed to the air, aluminium phosphide pellets or tablets react with moisture in the air to produce hydrogen phosphide gas, often commonly referred to as simply 'phosphine'. The chemical properties of hydrogen phosphide are what make it a great fumigant.

The combination of its low boiling point, specific gravity and vapour pressure causes it to penetrate grain and fill the space without natural or mechanical ventilation. When the fumigation is completed, the gas desorbs rapidly from the commodity and treated space.

The residue, for the most part, is aluminium hydroxide. The residue can be disposed of without hazard and is not an issue for food, unless the grain is intended for use by a company that has a no-residue policy. If so, the aluminium phosphide tablets or pellets can be placed inside commercially available permeable gas bags during the application to allow the residue to be confined within the bags.

### Are there important use precautions or restrictions?

Bigler: Neither phosphine nor hydrogen phosphide is recommended for use in flour mills, feed mills or warehouses, where electronics and other equipment could be damaged by corrosion. Hydrogen phosphide gas is corrosive to metal, especially gold and silver contact points.

That is not a problem generally in grain storage, but it can be in mills or other facilities where there is computer equipment. One option is to remove the equipment or to protect it from the gas by sealing it. Another option is to fumigate using ProFume<sup>®</sup> gas fumigant (sulfuryl fluoride) which is not corrosive to metals. Exposed to water, or high parts per million concentrations, poses a fire or explosion hazard.

Baker: Aluminium phosphide is a federally Restricted Use pesticide, so it can only be used by licensed professionals. A farmer can use it for their own on-farm storage bins if they have the necessary licensing, but a farmer cannot apply it commercially at other locations.

### What would you tell a mill or elevator manager who might be unfamiliar with fumigation?

Bigler: This is important — any fumigation involves both a science side and an art side. On the science side, the two constants are the gas and the cubic feet of the space to be fumigated. These two factors are a given and won't change. The gas will do what it does.

Each gram of hydrogen phosphide is equal to 25 ppm of hydrogen phosphide gas per 1,000 cubic feet. The space to be fumigated is a constant, but remember that you are fumigating a space, not how many bushels of grain are inside that space.

So, if you have a 300,000-cubic-foot bin, but it is only 1/4 full of grain, you still must fumigate the entire 300,000 cubes. Geometry formulas determine the cubic feet and from that the operator's manual determines the necessary dosage for the intended duration of the fumigation. All other factors involve the art of the fumigation itself.

### And the art side of a fumigation?

Bigler: There are interrelated variables with a fumigation, but the first thing I would say is to look at your past fumigation results. If the results have been good and there have been few problems, then don't change what you have been doing. But if the results are not what you need or expect, then start addressing those other factors.

The place to start is back to the science side, to double-check

your space and dosage computations. If those are correct, then look at the variables. The most overlooked part of any fumigation is how tightly sealed the structure is. The atmospheric conditions in the commodity are important because moisture content is critical to the release of hydrogen phosphide. For example, wheat at about 70°F (21°C) and 11 to 11.5 percent moisture, gives you a relative humidity of about 60 percent, which is fine. But if the moisture level drops below eight percent, then release of the gas will take too long.

Label dosage rates are based on normal temperatures.

The higher the temperature, and the moisture content in the commodity, the faster it will release the gas. But if the temperature is below 40°F (4.4°C), the release of the gas will be slow, and you will want to wait until it warms up. Keep in mind that insect activity slows or even ceases when commodity grain temperatures are cooler unless you have a hot spot.

Another important variable is to know what the gas will do inside that structure. You want to make sure it reaches the entire space. You have to look at the column of grain. So, if the bin is full and you are not getting the desired results, you need to look at air movement in that bin. Hydrogen phosphide gas is light and active and tends to rise instead of moving down, so look at recirculating the air if there are fans. In a column of grain or in flat storage you can pulse the air by running fans for an hour or two and then shut them off for some time to allow the gas to equalise in the space.

Steel tanks and ships tend to be tighter and hold the gas better than concrete, and new facilities are generally tighter than older ones. With any container it's important to inspect and seal openings and vents.

### What can be done to help ensure results?

Bigler: In stored grain you need a kill and what determines that is the concentration of fumigant active ingredient over the time of exposure. That is 'CT' in fumigation talk with C being concentration and T time. You can achieve the same results with less fumigant over more time versus more fumigant over a shorter period.

The important point is the fumigation needs to be extended out long enough. A lethal CT can be ensured by taking readings of concentrations using concentration lines to draw air samples at three or four levels within the grain column.

Baker: Management needs to work with fumigators, whether they are in-house or contracted. The role of fumigation is to prevent insect damage or stop it when necessary. But fumigation is only one part of an integrated pest management program.

The condition of the facility, day-to-day operations, empty bin treatments, how new grain is brought in and more play a role in maintaining grain quality. It's the job of the fumigator to make sure management understands what fumigation can and cannot do. It's the job of management to listen to their expert advice.

### Any other advice?

Bigler: No two grain facilities are the same, so if your results are not as good as desired, we're available to take your questions and offer suggestions. We are experienced former fumigators and are available to help with any type of fumigation. As a leader in fumigation, Douglas Products is committed to safe use of fumigants by offering training on the use of safety equipment, site signage and product stewardship training.

[www.douglasproducts.com](http://www.douglasproducts.com)

Reprinted with permission.