MAGNESIUM PHOSPHIDE

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As we look at fumigants in general, there are a series of criteria which must be examined very carefully in the selection of the best suited fumigant for each specific situation. According to K.S.U. Professor of Entomology, Donald A. Wilbur, realizing that the primary basic of all successful fumigations is that "there is only one constant -- the Fumigant itself -- all other factors can vary dramatically". Some of these more significant variables require a brief review to determine where development of a new fumigant must be targeted in order to remedy some of the problems presented by these variables.

Fumigant Selection

This requires an examination of the problems involved to determine the specific pests to be controlled, the type of construction of the area to be fumigated, the temperature of the commodity, and the amount of time available for the fumigation. Many pests are not controlled by all fumigants. When I was consulting for the U. S. State Department AID Food for Peace Program in Africa, the Far East, and Central America, I found many areas where only one fumigant was available and this fumigant was being used for all types of pests and all types of fumigations. Failure was imminent. Problems often became far more severe because the fumigant was not effective against a particular pest. The pest problems may have existed in situations whereby the chosen fumigant was not effective because the gas would not penetrate the product packaging, or the gas could not be contained in the structure to be fumigated long enough to be effective. Fumigators must select the fumigant as carefully as a mechanic must select the proper tool for a specific mechanical repair.

Safety Considerations

The most effective fumigant available becomes a worthless tool if it cannot be shipped, stored, applied, aerated and disposed of safely.

Time

All involved in fumigation must realize that a minimum concentration (C) must be contained for a minimum time period (T) for a complete kill. However, all too often, only the exposure

time is taken into consideration, and the time required for the safe application, aeration, and clean up are totally neglected. Consequently, these variables must also be considered in the total fumigation, as well as the development and selection of any new fumigant.

Residues

With the dramatic developments in our ability to analyze commodities for potentially hazardous residues, we find that the entire science or art of the fumigation is completely changed. There is now a strong world-wide concern with the known residues and the latent effects they might have on human life but, equally as important today, are many of the unknown or un-investigated potential problems. For example, we have known and have monitored the inorganic bromine residue resulting from the use of methyl bromide for years, but only recently have we become aware of the organic bromine residues and their potential hazards. We used to talk about residues in PPM (parts per million) terminology, but today we detect PPB (parts per billion) and PPT (parts per trillion).

Environmental Effects

With constant concern for the effects fumigants may have on the environment, whether it be the immediate environment or the future, we see that proper clean up of any physical residues or carriers must be carefully considered. In the U. S. today, as well as some other areas of the world, some states do not allow the disposal of residues of H_3P producing fumigants or empty pesticide containers within their borders. This is basically due to a lack of adequate information on their part, but it must be dealt with. In some cases we have found that careless use of this type of fumigant which might leave a residue of its carrier, such as Aluminum Phosphide or Magnesium Phosphide, has caused an entire shipment to be rejected. There is also a considerable concern for the effect of other fumigants upon the surroundings; such as, effects on plant life, effects on furnishings, and effects on the morale of personnel around an area.

All of these factors bear intense examination when considering the selection of the proper fumigant or the development of a new fumigant pesticide.

Costs

In the selection process, costs become paramount. We have investigated radiation, temperature (both heating and cooling), micro-wave and many other tools for efficacy and find them very effective but, as of yet, they are not cost effective.

Availability and Mobility

Having fumigants available in sufficient quantity and in economically usable sized containers is paramount but, all too often, the mere cost of transporting such tremendous quantities to remote areas become a major problem for fumigants, such as, liquid fumigants or methyl bromide. Consequently, this must also be addressed when developing the new fumigant itself.

Effects of Fumigant Production

The effects of fumigant production on the environment is becoming more and more important. In many countries, some pesticides are not allowed to be produced, primarily because the methods of production cause air or other environmental contamination. The number of these countries grow every day. We may lose some of our very important pesticides for this very reason for, even though it may be possible to produce them without environmental contamination, the resultant costs become prohibitive.

In the same vein, we also see a new evaluation of the production costs in relation to energy consumption requirements. Energy drain, versus desired efficacy which is sometimes referred to as the energy equation, looms as a much more important factor than ever before and will become even more important as time advances.

Effects upon the Commodities Fumigated

It is obvious that fumigants that turn peas black will be rejected, but we are finding many latent effects of some readily used fumigants. It has been noted that ammonia, if not allowed to completely aerate before using the fumigated products, could affect the spreading quality of the dough in cracker flour or methyl bromide could cause a doughnut to have an off odor after deep fat frying, etc. Further investigations and advanced technology could show other areas of concern and present problems which must be carefully addressed.

Penetration

Of course last, but not least, must be the examination of the penetration abilities of fumigants. Obviously, if the gas does not penetrate to the core of the infestation problem, failure or an incomplete fumigation will ensue. Many gases are highly penetrative and many are readily sorbed. Unfortunately, those fumigants that are readily sorbed don't adequately penetrate; conversely, those fumigants that penetrate commodities completely could also penetrate the structure and sealing materials used for the fumigation quickly, making gas containment a very difficult problem.

Taking into consideration the aforementioned considerations, it is easy to understand why Hydrogen Phosphide (H_3P) has long been a major fumigant of choice because it has so many qualities necessary for a successful fumigation. It adapts to most variables extremely well and presents the fumigator many options not available with other gases.

To this date, the primary source of H_3P has been Aluminum Phosphide. This fumigant has proven itself throughout the world time and time again. However, as is all too often the case - "The more a product is used, the more it becomes misused or misunderstood and thus sometimes inaccurately maligned". We have seen major misuse throughout the world, such as:

1. Inadequate sealing of structures to be fumigated or in some cases, absolutely no sealing of any kind, resulting in poor kill. Thus the H_3P is blamed for this failure.

2. Improper application of H_3P in order to attain a kill. Even though H_3P is highly penetrative, if the gas is not properly distributed, failure must result.

3. Inadequate dosage.

4. Inadequate exposure period. This factor alone has caused several papers to be written stating a H_3P resistance, when the actual problems were short exposure or, in some cases, inadequate concentration.

To help alleviate some of the aforementioned problems, a new form of H_3P releasing fumigant has been developed and is now being manufactured - Magnesium Phosphide.

Even though Magnesium Phosphide produces H_3P, the use of this material requires a whole new series of rules and a new understanding of the material itself.

1. First of all, Magnesium Phosphide releases H_3P much more quickly than most Aluminum Phosphide products.

2. The Magnesium Phosphide breaks down more completely, leaving only a minute amount of unreacted Magnesium Phosphide in the spent dust. This should make clean up and handling of the spent dust a much easier task.

3. The Magnesium Phosphide breaks down much more quickly in cooler temperatures, thus allowing more latitude for cool temperature fumigations. This subject is covered in another paper.

4. Some forms of Magnesium Phosphide (Fumi-Strip® and Fumi-Cel®, manufactured by Degesch GMBH of West Germany) do not give off ammonia in the breakdown process, thus allowing these forms of Magnesium

Phosphide to be used around products otherwise affected adversely by ammonia.

The Magnesium Phosphide will be available in several forms: Round Tablets, Flat Tablets, Pellets, Cells, Strips (these contain a series of cells in one long strip) and Prepac, making this product very versatile so that it can readily be adapted to fit most types of fumigation.

A great deal of research is presently being run on a series of new uses, including bulk grain (via dispenser probing and the J-system), space fumigation, as well as an initial study of some types of spot or equipment fumigation.

Because this concept has such versatility and since it can solve so many of the standard problems; such as, residues, time requirements for both application and clean up, environmental concerns (in manufacture, energy consumption, and clean up disposal), availability and mobility, penetration, and many others not mentioned, it shows tremendous promise.

The primary difference in handling Magnesium Phosphide to handling Aluminum Phosphide is basically the breakdown time. The quicker breakdown means simply that gas concentrations will be attained much quicker, consequently a much shorter handling or application time can be allotted when using Magnesium Phosphide. The excellent penetration, plus the fact that H_3P residues have not been shown to present a health hazard, makes this product look very bright on the horizon as we look for new and better pesticide tools.