

Diatomaceous Earth

Grain Protectants



IMPORTANT INFORMATION

Diatomaceous Earth Grain Protectants

Alan McLaughlin and David Stang

Background

Inert dusts have been used to control insect pests for several thousand years. Early man probably observed birds, lizards and other animals protecting themselves against parasitic insects by coating themselves with fine particles of sand. Inert dusts also have been used to control insects in stored food commodities over many centuries.

Many mineral dusts, including bentonite clays, zeolites, aluminum oxide and kaolin show insecticidal properties. Among these, diatomaceous earth (DE) dust has proven to be the most effective.

What is Diatomaceous Earth?

Diatomaceous earth is the fossil remains of diatom skeletons. Diatoms are a type of green or brown algae that grow in fresh-water lakes and marine estuaries. Various sources place the number of diatom species somewhere between 3,000 and 12,000, with roughly half being fresh-water and half marine (salt water) types. Deposits are spread over the planet in areas ranging from an acre or less to some covering thousands of acres. It is said many of these deposits are at least 20 million years old.

The amorphous (shapeless) silica skeleton of each species is unique. Differences in physical properties include shape, bulk density, surface area, oil and water absorption capabilities, average pore size and pore size distribution. Although diatoms all share a common chemistry of amorphous silica, DE produced from different deposits has significant physical differences as for example, bulk density or oil absorption properties etc. These differences reflect properties of predominant species in the deposit. To complicate things even further, within a given deposit, species with greatly different properties may be found. *All DE's, therefore, are NOT the same!*

Amorphous silica is chemically inert and non-toxic and has excellent absorption properties. This has led to the use of DE in a number of industrial applications. One of these applications is an insecticide.



Magnified Diatom Skeleton

How Does it Work?

Research at the University of California, Los Angeles in the '70's disproved the commonly held belief that the abrasive nature of inert dust insecticides made them effective. This research showed that the mode of action was actually due to the ability of DE to absorb the insect's waxy cuticle. It is the disruption of this water-proofing layer on the insect's body that leads to rapid desiccation and eventual death. The insect should come in contact with DE particles for this to occur.

Which DE Species Produce the Most Effective Insecticides?

With the enormous number of different species in existence, the task of answering this question is daunting. So far, no one has tackled this huge project of identifying which diatom species yield the most effective insecticides.

Testing DE to determine its ability to effectively function as an insecticide is complicated. To date, no test has shown to be more accurate in determining efficacy than a bioassay. This laboratory

test represents as near as possible a real-life situation. This test exposes live grain insects such as flour beetles and rice weevils to grain treated with the DE dust at different rates and monitoring insect mortality after prescribed times. These tests clearly show that different deposits show different efficacies, with the most effective grades being many times more effective than the least effective. Using a process of trial and error, dozens of deposits have been tested to locate species that meet appropriate purity requirements and quality standards.

Variations in efficacy among different sources have led to varying results in the usage of DE as an effective insecticide. Some inert dust insecticide producers have ignored or failed to recognize this essential difference and marketed DE products that have limited or poor efficacy. This has resulted in poor performance in use and created concern in the grain industry about the genuine benefits of DE products.

Another factor overlooked by many DE insecticide registrants is the variability in cuticle composition of different insect species. The protective cuticle wax varies among insect species. Some insects like the granary weevil have a harder cuticle while others like the red flour beetle have a softer cuticle. This results in most natural DE products being more effective against some species and less effective against others.



Cylindrical Diatom

What Are the Advantages of DE Products?

Many countries have become acutely aware and concerned about toxic residues not only in everyday food products but also in groundwater supplies and the environment. The US is just one of many countries that responded to this concern by imposing stricter limits for pesticide residues in food products, including grain. Some companies have already implemented specifications that allow “no detectable residues” in grain purchases. *Pure DE leaves no toxic residues* and any residual that might remain after handling can easily be separated by physical methods. The use of DE dusts as a component in an Integrated Pest Management (IPM) program allows producers to meet this “zero tolerance” standard.

DE dusts also offer a solution to a major problem in grain storage protection, namely controlling insect resistance to chemical insecticides. In many countries, the old standard, *Malathion*[®], is no longer used as insect resistance has made it totally ineffective. Several species of insects associated with grain are now showing resistance to organophosphate grain protectants and the fumigant phosphine.

The mechanism of action of DE on an insect is purely physical. As such, most scientists feel it will take many years for insects to develop resistance or immunity to DE.

In the last several years, the US EPA has embarked on a program to remove some of the commonly-used pesticides due to potential health risks they present. Recently, one of the major chemical pesticide manufacturers announced they would voluntarily stop producing a very commonly used grain protectant. In spite of strong encouragement from governmental agencies few, if any, new chemicals have been registered for use in an organic market.

Inert dusts can also partially or completely replace the need to use fumigants in some grain-management situations. By replacing or extending the life of fumigants, DE products provide both environmental and economic benefits to the end-user. The use of this IPM application will become increasingly important as the ban on ozone-depleting methyl bromide is scheduled to be implemented in the US by 2005.

Modern pest management practices now recognize the value of cleaning and treating storage structures prior to loading with grain. The interiors of storage facilities can be treated with a DE dust to kill sources of infestation. Then, once the grain has been loaded into the storage area, treating the top several inches will protect the entire mass for considerable periods of time.

What About Problems When Using DE?

In the early commercial days of DE, particularly when used as a grain protectant, it was thought insect protection could only be achieved by treating the entire grain mass. This created some difficulties. When large quantities of DE were mixed into the grain mass, the grain flowability was affected. This created problems when unloading grain from railcars, silos and other storage facilities. With the need to treat only the surface of the exposed area, this is no longer a concern.

Reports from millers using DE have ranged from wear on machinery to baking problems and dust in the workplace. Several tests conducted using current recommended treatment levels have shown these problems are no longer valid concerns. Particle sizes of properly formulated DE exhibit little, if any, wear on mechanical surfaces, dust in the atmosphere or differences in end-use properties of treated grain.

Many of the standard grades of DE will remain effective only if used on grain at 11-12% moisture. Often, the need for a material with enhanced properties is needed to offset the higher moisture conditions, but even then, there are situations when DE is not appropriate for use.

Enhanced DE Products (EDE)

Unfortunately, straight DE products, even those with higher insecticidal activities, still fall short of today's demand for effective grain protection.

Many attempts have been made to enhance the natural insecticidal activity of DE. Until recently, one of the most popular methods consisted of adding an insect "attractant" to the formulation. Two such products, registered in the USA and Canada

respectively, claim enhanced effectiveness. However, the hype far exceeds the reality. In research studies undertaken by an acknowledged independent expert in this field, no increase in effectiveness was demonstrated.

Our company took a different approach and developed a silica gel coating process that yields a genuine improvement in effectiveness. The product, **DRYACIDE®**, has a modified surface architecture that enhances its adsorbent properties and is effective against a wide variety of stored-grain insect pests. It also has the unique ability of being effective when applied as a dry powder or as an aqueous dust deposit. Once dried, the slurry on a silo wall or on the grain itself retains its insecticidal activity.

Health Aspects

DE, when first formed, consists of silica particles that are totally amorphous (shapeless) in structure. However, many deposits are found deep underground and the result of exposure to water, high temperatures and pressures over millions of years causes a partial crystallization of the amorphous particles. This is an important health issue as exposure to crystalline silica dusts may result in silicosis or other respiratory diseases. To avoid this exposure hazard, our own product is only produced from DE deposits that contain less than 0.1% crystalline silica. However, exposure to excessive amounts of air-borne dusts, even inert dusts, is not advisable and the use of a disposable dust mask and goggles is recommended when handling the product.

It should be noted that apart from the naturally occurring crystalline silica found in some DE deposits, amorphous silica is converted into crystalline silica when exposed to high temperatures. This occurs in the production of a number of DE products such as filter-aid. Filter-aids are widely used to clarify water in swimming pools and remove any trace of cloudiness in beer and wine.

It is important that prior to handling and using an inert dust insecticide based on DE, the user should check the Safety Directions on the label and the Material Safety Data Sheet (MSDS). These will record the level and type of crystalline silica contamination, if any, and identify the appropriate safety equipment to be used.

Conclusion

The purpose of this booklet is to make the reader aware that although all DEs share a common chemistry of amorphous silica, *all DE based products are NOT the same* in their effectiveness against insects!

With the heightened concern for our health and environment, alternatives must be found to replace some of the more toxic materials we have used to control insects in our everyday life. DE and EDE products can play a useful role in integrated pest management (IPM) systems in the grain industry. However, it is important that the constraints on this technology are properly understood, appropriate application techniques are employed and correct treatment rates are used. Some products on the market stipulate contact rates that are unrealistically low and invariably result in failure.

More information and application instructions for the use of DRYACIDE in both structural and grain treatment applications are provided in the DRYACIDE PRODUCT MANUAL, a copy of which may be obtained by contacting us at the telephone number included in this booklet.