

FUMIGATION

A fumigant is a chemical vapor or gas that, when released, penetrates objects or enclosed areas in concentrations that are lethal to pest organism. This definition excludes aerosols, which are particles suspended in the air, often referred to as smokes, fogs or mists.

Fumigation techniques have great adaptability in pest control. They can be used to control wood-destroying insect in structures and furniture where liquid or dust formulations are ineffective or where these materials may cause damage.

Most fumigants are highly toxic to all forms of life. Fumigation is a highly specialized operation that requires equipment, techniques, and skills not generally used for applying other types of pesticides. Applying a fumigant may be time consuming and expensive, usually requiring more labor than other pest-control methods.

Structural fumigation is disruptive, since it requires that tenant and other occupants leave the building. Because of the special hazards and conditions of fumigation, strict legal restrictions exist concerning its use.

HOW FUMIGANTS WORK

Fumigants kill by interfering with the respiratory function of the target pest. Molecules of some fumigants (for instance, carbon dioxide or inert gases) replace oxygen molecules in the air, so the pest-control action involves smothering (asphyxiation) due to lack of oxygen.

The killing action of a fumigant is influenced by its concentration in the atmosphere, the length of time it stays in the atmosphere, and the temperature and humidity of the area at the time of fumigation. Fumigants are designed to enter cracks, crevices and other areas

where target pests may occur. They must be applied in enclosed areas. Fumigation has no residual effect, and re-infestation may occur after the fumigant has diffused from the area.

ADVANTAGES OF FUMIGATION

Fumigation has several advantages over other methods of pest control:

- Fumigants are usually quick acting and can result in total eradication of the pest.
- Because fumigants are gases, they diffuse through all parts of the structure or commodity being treated and can reach pests control materials or techniques.
- For certain commodities, fumigation is the only practical way to control pests.

DISADVANTAGES OF FUMIGATION

- The control achieved through fumigation is temporary – there's no residual action from fumigants. Where untreated populations of the pests remain, re-infestation of the treated site can take place quickly.
- Fumigants are toxic and often highly hazardous to the applicator, requiring special precautions during application.
- Fumigants must be retained in the gas form for a period of time to be effective, often calling for extra supervision.
- Fumigation must never be done by just one person, which requires added labor.
- Some commodities or pieces of equipment may be damaged by certain fumigants and must be removed or otherwise protected.
- Fumigant activity may be greatly affected by temperature and humidity.

TYPES AND NATURE OF FUMIGANTS

Many of the active ingredients used earlier have either been canceled entirely or had their uses restricted. All space fumigation products and several soil-fumigant products (especially those containing chloropicrin and/or methyl bromide) are now restricted use pesticides.

Active ingredients that are still legal to use include:

1. Methyl Bromide
2. Chloropicrin
3. Aluminum phosphide
4. Magnesium phosphide
5. Sulfuryl fluoride
6. Carbon dioxide

Methyl Bromide

Methyl Bromide readily penetrates many materials and is in wide use for space fumigation. Methyl bromide is also used in agriculture as a soil fumigant to control fungi, weeds, nematodes and insects. Methyl bromide is sold as a liquid pressure. Upon release, it vaporizes to form a gas that is about 3.3 times heavier than air.

Methyl bromide is a colorless, odorless and tasteless gas, but it's highly toxic as a respiratory poison and can cause serious eye and skin damage. It's usually formulated with a small amount of chloropicrin as a warning agent. Fluids in the lungs and heart irregularities may develop two to 48 hours after exposure. These effects can result in death.

Methyl bromide reacts chemically with sulfur products and should not be used to fumigate materials such as fur, leather, rubber, wool, and feathers.

Following Materials should NOT normally be fumigated by Methyl Bromide :

- Butter, lard, fats, avocado, soybean flour, flours and baking powder.

- Bone meal, charcoal and cider blocks.
- Furs, felts, horsehair, pillows, rugs, papers.
- Lodised salt, leather goods & photographic chemical (excluding film)
- Photographic prints, rubber and woolen goods.

Guideline quantities :

- For ANZ destination – 5.0 lbs/1000 cft or 80 gms/cbm.
- For USA dest – 4.5 lbs/1000 cft or 72 gms/cbm.
- For Europe dest 32 gms & 48 gms.
- For Australia dest – 3.0 lbs/1000 cft or 48 gms/cbm (but mostly fumigator applied double does)

Chloropicrin

Chloropicrin fumigants include products marketed under the names Chlor-O-Pic, Lavacide 100 and Quasar. These products contain nearly 100-percent chloropicrin and are marketed as liquids. Chloropicrin volatilizes to form a dense gas that is about 5.7 times heavier than air.

Chloropicrin is highly toxic to insects, vertebrates, and many soil microbes, such as fungi. It's highly irritating to eyes and is powerful "tear gas." Concentrations as low as 1.0 part per million (ppm) cause intense eye irritation, and prolonged exposures cause severe lung injury. Chloropicrin can cause severe injury upon skin contact. Uses of chloropicrin on foodstuff have been restricted in recent years. Right now, use is prohibited on most food, and direct -grain treatment uses are under review.

Aluminum Phosphide

Aluminum-phosphide fumigants include products marketed under the trade names Detia, Fumitoxin, Gastoxin, Phostex and Phostoxin. These products contain aluminum phosphide in combination with inert ingredients such as ammonium carbamate and urea. The formulated material is a solid molded into pellets or tablets. The active ingredient, aluminum



*Fig. 17: DEGESCH PLATE:
placed inside a container*

phosphide, reacts with atmospheric water to produce hydrogen-phosphide gas. This gas is known as phosphine. Phosphine is a colorless gas with an odor that smells different to different people. The odor is often described as similar to garlic, commercial carbide, or decaying fish.

Phosphine is only slightly heavier than air, about 1.2 times heavy. Fumigators can't rely on the gas moving through a solid storage such as grain bin, so they need to set up one or more fans to mix the fumigant with the air.

Hydrogen phosphide (phosphine) gas is reactive and very corrosive metals, especially copper, silver, gold, and platinum.

Magnesium Phosphide

Magnesium phosphide is similar to aluminum phosphide, releasing hydrogen phosphide gas in reaction with water. Release of the gas is faster than occurs with aluminum phosphide.

Common magnesium phosphide products contain the solid magnesium-phosphide material attached to a strip or blanket that can be put in place very quickly. Because this application method may not provide good distribution of the gas in a grain mass, it isn't usually used in grain storage fumigation. Magnesium-phosphide

fumigants can be used effectively for warehouse and processing plant fumigations.



*Fig. 3: DEGESCH PHOSTOXIN TABLETS
(round form) and PELLETS; made of aluminium
phosphide bulk packaged in resealable flasks*

DETERMINING A NEED FOR FUMIGATION

Several criteria should be considered in determining the need and suitability of fumigation for pest control. These include:

1. Characteristic and habits of the pest.
2. Life stages of the pest
3. Characteristics of the treatment area
4. Hazards located in the treatment alternative
5. Available pest-management alternative
6. Established pesticide-residue tolerances

FACTORS AFFECTING FUMIGANT PERFORMANCE

For a fumigant to work effectively, the correct concentration of gas molecules must be present in the atmosphere surrounding the target pest. Molecule concentration may be affected by several factors. Some important ones are:

1. Sorptive quality of the treated commodity, either through absorbing (taking fumigant into the commodity) or adsorbing (fumigant condensing on the surface of the commodity).

2. Temperature and humidity during treatment.
3. Speed of diffusion of the fumigant through the commodity.
4. Reactions of the fumigant with other chemicals or articles in the treated area.
5. Amount of fumigant applied.

6. Susceptibility of the target pests.
7. In fumigation chambers, the pressure of the gas in the chamber.

DETIA DEGESCH Phosphine products and fields of application							
FIELD OF APPLICATION	TABLETS and PELLETS	BAG	BELT	BLANKET	BAG CHAIN	PLATE	STRIP
Grain in silo	X	X					
Bulk grain in flat storage	X	X	X	X		X	X
Stack	X	X			X	X	X
Space, container		X		X	X	X	X
Ship				X			X
AGRICULTURAL COMMODITIES							
Grain	X	X	X		X	X	
Pulses	X	X			X	X	
Oil seeds	X	X			X	X	
Nuts		X		X		X	X
Coffee Beans		X		X		X	X
Cocoa Beans		X		X		X	X
PROCESSED FOODS							
Cereal		X		X	X	X	X
Dried Fruits		X		X	X	X	X
Dried Vegetables		X		X	X	X	X
Herbs		X		X	X	X	X
Tea		X		X	X	X	X
Dairy Products		X		X	X	X	X
NON-FOOD ITEMS							
Tobacco		X		X	X	X	X
Cotton		X		X	X	X	X
Wood	X	X		X	X	X	X
Bambo/Rattan	X	X		X	X	X	X
Leather products		X		X	X	X	X
Seeds	X	X		X	X	X	X

RECOMMENDED MINIMUM EXPOSURE TIMES

Temperatures	TABLETS AIP	PELETS AIP	BAGS/BAG CHAIN BAG BLANKET
Under 5° C	No fumigation	NO fumigation	NO fumigation
5-10° C	10 days	8 days	14 days
11-15° C	5 days	4 days	7 days
16-25° C	4 days	3 days	4 days
Over 25° C	3 days	3 days	3 days
	TABLETS Mg ₃ P ₂	PELLETS Mg ₃ P ₂	PLATES & STRIPS
Under 5° C	Up to 15 days	Up to 15 days	Up to 15 days
5-12° C	4 days	4 days	4 days
12-20° C	4 days	3 days	3 days
Over 20° C	3 days	3 days	3 days

MOLD

What is Mold?

Mold a group of organisms that belong to the fungi kingdoms. Although the terms mold and fungi have been commonly referred to interchangeably, all molds are fungi, but not all fungi are molds.

Molds are visible clusters of microscopic filaments of fungal growth. They are ubiquitous in every natural and man-made habitats and environments including buildings and houses. Molds can grow on wet and warm materials with organic matters. **The optimal conditions are above 80% for relative humidity and temperature between 20° to 30°C.**

Mold and Moisture

Mold can be found almost anywhere; they can grow on virtually any substance, providing moisture is present. There are molds that can grow on a within wood, paper, carpets, and foods. When excessive moisture accumulates in buildings or on building materials, mold growth will often occur, particularly if the moisture problems remain undiscovered or undressed. There is no practical way to eliminate all molds and mold spores in the indoor environment; the way to control indoor mold growth is to control moisture.

Molds grow best on damp materials at a temperature of 32.2° C (90°F) with a 75% relative humidity. In order to remediate an infested building, damp and moldy building materials and personalty must be discarded, the temperature must be reduce below 21.11°C (70°F) and the air must be conditioned to below 50% relative humidity.

MOLD ON GOODS

Mold grow vigorously on paper, wood, plaster, paint, leather and fabric that contain 12-15% water. But we wont find any growth of mold if it is properly

transported, stored, handled, installed, and maintained. However, mold spores are present everywhere and when condition are favorable, mold can grow on practically any surface.

1) Mold and Wood

Mold fungi cause no damage to the wood other than unsightly discoloration and are typified by their colored spores (usually green or black). Differentiating between mold fungi and decay fungi is important because decay fungi actually weaken the wood structure. Brown rot, the most destructive type of deterioration cause by decay fungi, is typified by darkening and shrinking of the wood, with eventual crumbling in advanced stages of decay.



2) Mold on Gypsum Board

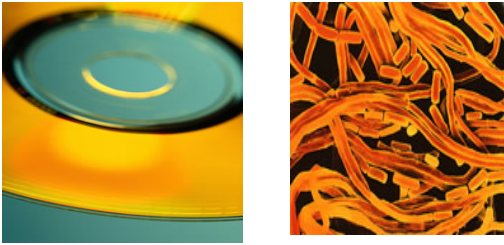
Gypsum board does not generate or support the growth of mold when it is properly transported, stored, handled, installed, and maintained. However, mold spores are present everywhere and when conditions are favorable, mold can grow on practically any surface. GYPSUM BOARD MUST BE KEPT DRY to prevent the growth of mold.

3) Mold on CD

Computer get viruses. Code gets bugs. Now CDs get fungus. Researcher in Spain have discovered a fungus that eats holes in compact discs, corrupting the information stored in them.

After visiting Belize in Central America, Victor Cardenes of Madrid's National Museum of Natural Sciences (MNCN),

found one the CDs discolored, transparent and unreadable. The disk's aluminium and polycarbonate layers were riddled with fungus.



Burrowing in like worms from the side of the disk, "the fungus destroyed crucial information pits". Pits in CD's aluminium and polycarbonate sandwich store binary data, which is ready by a laser. Some fungi are known to live on plastic and polymers, but this is the first report of CD being eaten by a fungus. The researchers believe that the spores probably entered the CD in Belize.

4) Mold in Furniture – A piece of furniture may become contaminated by mold if it has come into contact with excessive moisture or with settled mold spores. These settled spores might aggravate allergies in some people.

BASIC PRINCIPLES OF SALVAGE

REDUCE THE HUMIDITY: Moisture control is the key to mold control, moisture initiates mold growth. Reducing the humidity is essential to stopping the mold growth.

DO NOT TURN UP THE HEAT: This will not help to dry out collections and storage areas. Additional heat in the presence of moisture will cause the mold to grow faster.

IF COLLECTIONS ARE WET, DRY OR FREEZE THEM: Mold will normally grow on wet materials in about 48 hours (sometimes sooner). If you know you cannot get the affected material dry within 48 hours, it is best to freeze it. This will not kill the mold, but it will stop further growth until you have a chance to dry and clean the

material.

CONSIDER THE HEALTH RISKS: A few mold species are toxic to people, and many molds are powerful sensitizers. Exposure to mold can lead to debilitating allergy even among people not prone to allergies. Everyone who works with moldy objects must be properly protected.

AVOID "QUICK AND EASY" CURES: "Quick cures" that you may have heard about (such as spraying Lysol on objects or cleaning them with bleach) may cause additional damage to items or be toxic to people; they are also often ineffective. In the past, mold-infested collections were often treated with fumigants. Ethylene oxide (ETO) will kill active mold and mold spores; other chemicals that have been used are less effective. **All** of these chemicals can have adverse effects on both collections and people, and none of them will keep the mold from recurring.

Take daily readings of temperature and relative humidity, and be sure that the climate is moderate. It is particularly important to keep humidity below 55% to insure that mold will not reappear. Temperature should not exceed 21.11° C (70°F).

"Fumigation will not control mold and mildew if the library materials are placed back into the same conditions from which they came. In most instances library materials that have been fumigated are then stored in areas which do not have an environment conducive to mold growth. The success of the fumigation is given as a reason for the control of the mold and mildew, when in fact, the new area in which the materials are stored is the governing factor as to why mold and mildew is now being controlled."

Tobacco Beetles

There are many species of stored food pests found at various times in food pantries. Most of these pests are

1. Flour beetles
2. Saw-toothed grain beetles
3. Cigarette beetles
4. Drugstore beetles
5. Larder beetles
6. Granary weevils
7. Rice weevils
8. Spider beetles
9. Grain moths
10. Flour moths
11. Psocids and grain mites.

Although there are many different kinds of insects that attack stored food, the damage they produced and the control procedure are similar.

Life History

The length of the cigarette beetle life cycle is highly dependent on temperature and the food stored but usually takes 40 to 90 days. Female lay 10 to 100 eggs singly in the food and the larvae emerge in 6 to 10 days, after feeding for 5 to 10 weeks, during which they go through 4 to 6 instars, Pupation takes from 1 to 3 weeks and after emerging the adults live from 1 to 4 weeks, in warmer climates there may be 5 or 6 overlapping generations with only one generation in the more temperate regions. Adult beetles may live from 23 to 28 days.

Development periods of 26 days at 37°C and 120 days at 20°C have been reported. Development is in-completed at 17°C and adults die when exposed to 4°C for six days. Under European conditions, in climate-controlled rooms and humidors and at a temperature of 20°C, the beetles are laying eggs only once.

Damage

This is the most important insect pests of stored tobacco. Package and chewing

introduced into our homes in infested food. Some invade homes through normal methods of entry.

Some of the common pantry pests are:

tobaccos, cigars, and cigarettes that have been attacked by cigarette beetles have holes eaten through the tobacco. Cigarette beetle adults and larvae also are omnivorous pests of other stored products. They can found in stored grains, where they feed on debris or dead insect and damage the grain.

Larval feeding causes direct damage to foodstuffs and non-food items. These products are contaminated by the presence of beetles, larvae, pupae, cocoons, frass (fecal material), and insect parts. Beetles chewing through cardboard boxes and containers, and packaging cause indirect damage. Cocoons are often attached to a solid substrate and in severe infestation form large clusters. Larvae will sometimes bore their way through cardboard boxes and other packaging in search if a place to pupate.

Management

Good management is required on the part of growers to maintain the quality and value of tobacco which is stored from one season to another. In general, tobacco should be store in a clean, dry, insect free facility, such as a packhouse or bulk curing barn. The cost of production, harvesting, and curing of carryover tobacco have already been invested and proper storage. Care should be taken to insure that the tobacco is sufficiently dry when placed in storage. Storage facilities should be maintained insect free and the tobacco should be checked periodically to insure proper storage and the absence of insect or moisture damage. If damage tobacco is located, steps should be taken to minimize the amount of tobacco damage.

Bamboo Powderpost Beetles

Bamboo powderpost beetles order *Coleoptera* Family of *Bostrychidae* and also know as False powderpost beetles.



There are 16 *Bostrychid* species attacking post-harvest bamboos in Asia.

The most important species are all from the genus *Dinoderus* and include *D.*

japonicus Lesne, *Dinoderus minutus* Fab., *D. ocellaris* Stephens and *D. brevis* Horn. They are responsible for over 90% of insect damages on harvested culms and finished bamboo products. These species have very similar life histories and damaging habits. Both adults and larvae feed inside felled culms, but the latter causes the major damage.

BIOLOGY and HABITS

This beetle is probably the most destructive and widespread insect pest on felled culms and finished bamboo products. The adults is about 1/8 inch (3-4 mm) long, reddish or dark brown in colour and covered with dense punctums and hair which are more obvious on the rear end of the wings.

Eggs, laid individually in tunnels mined by adults, hatch in 5-8 days. The life cycle from egg to adult varies from 44 to 73 days. In general, the warmer the temperature, the slower the developmental period. Pupation occurs in cocoons made at the terminal end of larval tunnels; The newly developed adult beetles may fly away or may explore other parts of the same bamboo.

DAMAGE CAUSED

Adult beetles burrow into felled culms through wounds, cracks and cut ends, and make horizontal tunnels along the

fibrovascular tissues of the culm; larvae make longitudinal tunnels. The beetles' shows strong preference to newly-felled culms of some species, while – such as *Pseudosasa amabilis* and *Pleioblastus* species--is hardly ever attacked. Culms from level sites are more susceptible to attack than those felled from sloping sites. A large population of the borer will leave numerous tunnels in the culm, making it useless.

CONTROL

The bamboo powderpost beetle may infest bamboo and rattan furniture, ornaments, curtains, cotton fabrics, drugs and foodstuffs such as chestnuts, sweet potatoes, rice, sugarcane, chocolate, wheat flour, corn and dried bananas. Control of this beetle pest largely depends on the type of material or product infested.

In general, the beetles attack bamboo within 24 hours of harvesting, when it still contains high starch content. Previously infested bamboo is *not* an attractive oviposition site; therefore, it is rarely reinfested. As a result, infested bamboo items probably do not require treatment. Removing adult beetles and sealing the round exit holes limit the effects of the cosmetic damage to the infested material.

Heating of culms by fire or boiling water, or putting them under direct sunlight in hot summer can kill borers in the culms.

