

Unit 5. Methods of Fumigation

Learning Objectives

After studying this unit, the learner will be able to:

- Describe several methods of fumigation used to treat raw commodities and soil.
- Discuss the pros and cons associated with each method.
- Select the most appropriate fumigation method for a particular situation.
- Understand the importance of proper aeration.
- Aerate commodities and soil safely and effectively.
- Calibrate soil fumigation equipment.

This unit describes the most common methods used to fumigate structures, raw commodities and soil. Each method has advantages and disadvantages. You will learn what these are and how to use this information to select the best type of fumigation for a particular situation. This unit also discusses the importance of proper aeration. You will learn about factors that affect the speed and success of aeration. You will also discover how to perform these procedures yourself. Finally, this unit will discuss the importance of equipment calibration and some calibration techniques used for soil fumigation.

Terms to Know

Absorption – When fumigant molecules penetrate into a material (commodity, soil or other item being fumigated).

Adsorption – When fumigant molecules stick to the surface of a material (commodity, soil or other item being fumigated).

Air Wash – A method of aeration used in vacuum fumigation. Air washing involves drawing a second vacuum after the exposure period is complete and then breaking this vacuum with fresh air.

Billowing – When air or gas causes something to bulge outward. In tarpaulin fumigation, this occurs when gusting winds cause a tarp to bulge away from the item or structure that it is covering.

Blower – A machine that generates and directs an air stream in a particular direction.

Boxcar – A large, roofed container with enclosed sides used to transport freight. Boxcars

usually have sliding doors on each side. Trains usually transport boxcars.

Calibration – The process of measuring and adjusting the amount of pesticides a piece of equipment applies.

Chisel – A strong, heavy, tractor-drawn tillage tool with curved points used to stir soil deeply without turning it.

Cultivate – To plow, till or loosen the soil.

Desorption – The liberation or removal of a fumigant from other substances.

Diffusion – The process of spreading out or distributing evenly in a space.

Dosage – The concentration of a fumigant (ounces, ppm, etc.) x the exposure time (hours, minutes, etc.). The dosage requirements depend on the pest, the fumigant, the temperature, the rate of leakage (some leakage is inevitable), and many other factors.

Fumigation Tape – Strips of adhesive material used to seal doorways, windows and other areas where gas might escape during fumigation. You can also use fumigation tape to join together two or more tarps during tarpaulin fumigation. Fumigation tape has a plastic or vinyl coating that reduces fumigant penetration.

Gas Detector – A device used to check the concentration of fumigant in the air.

Gastight – Something that does not allow gas to enter or pass through. Gasproof.

Ground Seal – The sealing of tarps to the ground to prevent fumigant loss during fumigation.

Liquefied Gas – A fumigant that must be kept under pressure in order to remain a liquid. These fumigants change from liquid to gas when released from their pressurized containers.

Nonsparking Fan – A machine that safely recirculates air in potentially explosive environments.

Parts Per Million (PPM) – The number of parts of a substance in one million parts of another substance. For example, if a gas detector reads “5 ppm,” it means that there are five parts of fumigant to every one million parts of air.

Permeable – Having pores or openings that permit liquids or gases to pass through.

Plow Layer – The band of soil that extends from the soil surface to the depth reached by cultivation – usually 5 to 8 inches below the soil surface.

Prepac – Aluminum phosphide fumigant tablets that are packed in a gas-permeable material.

Pulverize – To break something into small particles by crushing or beating it.

Seal – To enclose an area so that fumigant gas cannot escape too quickly. A good seal will contain a lethal amount of gas for long enough to kill the target pests.

Self-Contained Breathing Apparatus (SCBA) – A type of respirator that supplies fresh air from an outside or portable source. Air enters a mask that tightly covers the entire face.

Shank – The curved iron bar that connects the working point of a cultivator to the beam or cross bar of the cultivator. You can attach different types of working points to each shank depending on whether the soil is to be stirred, turned, etc.

Ship Hold – The area or deck of a ship commonly used to transport cargo.

Sorption – The process of taking up or holding a chemical either by adsorption or absorption.

Subsoil – The layer of soil located just below the plow layer.

Tarpaulin – A semipermeable material used during fumigation to confine fumigant in a specific area during the exposure period.

Volatile Liquid – A fumigant that exists as a liquid under atmospheric pressure but evaporates under normal temperatures.

Once you pinpoint a pest problem and decide fumigation is necessary, you are ready to choose a treatment method. There are several types of fumigation. Each has its pros and cons. Your job is to select the best method for a given situation. Your decision will be based on:

- The pest you need to control
- The item, area or structure you need to treat
- The location of the product or condition of the soil
- The product you need to treat or what crop(s) will be planted after treatment
- Your client's budget
- The proximity of the area to other people
- Weather conditions
- The severity of the infestation

All methods of fumigation have one thing in common: they must achieve and maintain an

adequate concentration of toxic gas long enough to kill the target pest(s).

This unit describes the most common methods of fumigation used to treat stored products, whole structures and areas within structures. This unit describes the most common ways to fumigate stored products, whole structures, areas within structures, raw commodities and soil. You will learn how and when each method is normally used. You will learn how to implement each method. You will also discover basic safety considerations associated with each method. With this information, you can make educated decisions.

Finally, you will learn about equipment calibration – its importance and calibration techniques used for soil fumigations.

Remember, fumigants are highly toxic and dangerous. They are reserved for only the most severe infestations. Be sure fumigation is the best option for your situation.

Fumigation Methods

Raw agricultural products are stored in bins, silos and other structures. They may also be kept in boxcars, trucks or in ship holds for short periods during transportation. Because fumigants can move through tiny cracks and crevices, fumigation must occur in structures that are relatively airtight. Some buildings and boxcars are naturally well-sealed. Others may need fumigation tape, polyethylene sheeting or other materials to make them airtight. Still other structures, particularly those that are leaky, may need to be tarped. Fortunately, several fumigation methods are available.

The two most common methods used to fumigate raw commodities are:

- **Vault Fumigation** – Vault fumigation uses atmospheric or vacuum chambers to treat infested products. Other structures such as truck trailers, boxcars, grain bins, silos and other storage structures can be vaults if they are well-sealed.
- **Tarpaulin Fumigation** – Tarpaulin fumigation places commodities under a tarp or covers and entire structure. Fumigant is released beneath the tarp and held until pest control is complete.
- **Spot (Local) Fumigation** – Spot fumigation is used to treat small items or areas with light to moderate infestations. Spot fumigation is also used routinely to prevent infestations from developing or recurring.

Advantages of Tape-and-Seal Fumigation

Nontarget pests such as rats and mice are usually controlled along with the insects. In addition, little material is needed to make the structure relatively airtight. Unfortunately, this advantage is usually offset by the labor required to find and seal leaks.

Disadvantages of Tape-and-Seal Fumigation

Building occupants must leave the structure during treatment. You must also remove items that the fumigant may damage. Tape-and-seal fumigations are notoriously leaky. It is easy to overlook vents, cracks, conduits and other areas that may permit gas to escape. The fumigant may diffuse through interior walls, making it hard to maintain the required concentrations of gas. Insects in the exterior walls and eaves may survive if gas levels are too low to penetrate these sites.

Preparing for Tape-and-Seal Fumigation

Once you decide that tape-and-seal fumigation is necessary, do a thorough on-site inspection. Frequently, the success of a fumigation operation will depend on what you learn, what you decide and how you plan. Ask yourself a number of questions.

General

- Can you move the infested commodity and treat it elsewhere?
- If removing the infested commodity is not practical, can you fumigate it in place without treating the entire structure?
- What is the volume (cubic feet) of airspace or volume (cubic feet) of the commodity?
- What is the cubic footage of the building? See Appendix B for information on how to calculate volume.

Inside the Building

- Are there any broken windows that you need to replace?
- Are there cracks in the ceiling, walls or floor that you will need to seal?
- Are there floor drains, sewer pipes or cable conduits that may leak? Many fumigation

attempts have failed because floor drains under stacked commodities went unnoticed. In another case, a fumigant leaked into a telephone cable tunnel that led to an occupied building. A number of people became ill.

- How will you handle ventilation fans, air conditioning ducts and flues?
- Will interior partitions interfere with fumigant circulation?
- Are the interior partitions gastight?
- Can you rely on them to keep the fumigant from entering other parts of the structure?
- Are there parts of the building that are not under the control of your customer?
- Can you shut down these operations during treatment?
- Will the fumigant damage anything in the building?
- Can you remove these items during fumigation?
- If not, can you protect them?
- Where are the gas shut-offs?
- Where are the pilot lights?
- Where are the electrical outlets?
- What is their voltage?
- Will circuits be live during fumigation?
- Can you use the outlets to operate your circulating fans?
- Does the building contain any high-priority items that may have to be shipped within a few hours notice?

Outside the Building

- From what materials is the structure built? (Fumigants readily pass through certain materials such as wood.)
- Can you make the structure relatively airtight through sealing?
- Will it be necessary to tarp the entire building?
- If you tarp the structure, can you make a tight ground seal?
- Are there shrubs next to the building?
- Will they be damaged by the fumigant or by your digging to create a ground seal?
- Can you move these plants if necessary?

- How far is it to the nearest building?
- Does that building have air conditioning?
- Does it have air intakes that might draw the fumigant inside, particularly during aeration?
- How will you aerate the structure after fumigation?
- Are there exhaust fans?
- Where are the fan switches?
- Are there windows and doors that you can open for cross ventilation?
- Is the structure to be fumigated located where your operations may attract bystanders? If so, consider asking police to assist your own guards.
- Where is the nearest medical facility?
- Do you have the telephone number of a poison control center?

Once you are confident that you have covered everything, prepare a list of things to do. Make a second list of materials that you will need. See Unit 6 and Appendix A for sample checklists. Do not rely on your memory. With the checklists in hand, ask yourself on final question:

What have I overlooked?

Types of Sealed Structures

Silos and Grain Bins

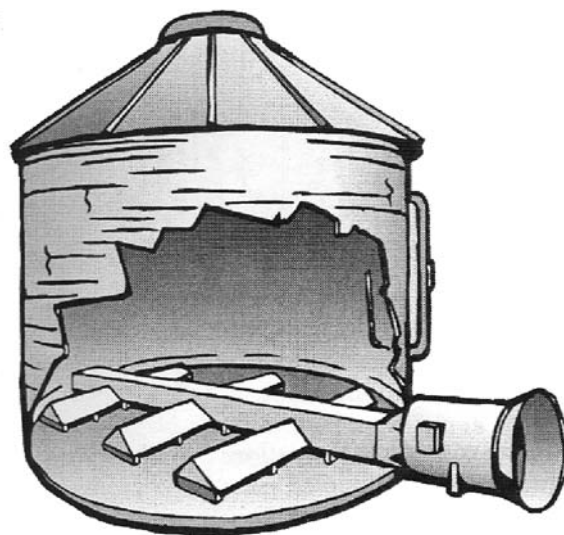
Treating grain in silos and grain bins is one of the most common types of raw commodity fumigation. Well-built silos and grain bins may only require sealing to be gastight. Others, especially those made of wood and other permeable materials, may need to be tarped.

When sealing grain bins and silos for fumigation, be sure you find and seal all potential leaks. Proper sealing will often mean the difference between success and failure of a treatment. There are many places in a bin where gas can escape. These include along walls, roof-wall junctures, seams, roof ventilators, bin doors, aeration fans, and through other gaps. When sealing these gaps with fumigation tape, it is often helpful to apply tape primer first. Tape primer coats the surface you plan to seal with a tacky substance. This helps the fumigation tape adhere better. Both brush-on and spray-on primers are available.

Unlike other types of grain storage structures, wooden bins are often too leaky for tape-and-seal fumigation. The loose

construction of wooden bins and the permeable nature of wood can cause gas to escape despite your best sealing efforts. Instead, wooden bins may have to be tarped to retain enough gas for the treatment to be effective. See “Tarpaulin Fumigation” later in this unit for information about this treatment option.

Once a grain bin or silo is sealed, you are ready to release your fumigant. Some fumigants are heavier than air. These chemicals often require special recirculating equipment such as blowers to adequately distribute them throughout a grain mass. Before releasing such fumigants, be sure your blowers are working properly. First, turn them on to establish airflow. Then, introduce the fumigant on the high-pressure side of the blowers. Run the recirculating system until the fumigant is thoroughly distributed.



Grain storage recirculation system

Some grain storage structures have built-in aeration or recirculation systems. These devices regulate the temperature and moisture content of the grain. During fumigation, you can use them to distribute fumigants throughout the grain mass. Other storage structures may not have such sophisticated systems.

In most cases, if you use fumigants that have good penetrating and distributing power, you will not need special recirculating equipment. Simply apply the fumigant directly into the grain. You can do this while the grain is being stored or as the silo or bin is being filled. If the fumigant comes as pellets or tablets, use a special probe to insert it into the grain mass. If you add the pellets to the grain during filling, use an automatic pellet/tablet dispenser. Fumigant manufacturers often supply these probes and dispensers.

No matter which type of fumigant you use, always wait for a still day to fumigate. Winds around a grain storage structure create pressure gradients across the grain surface. This can result in rapid loss of fumigant. In some cases, using polyethylene or plastic-coated nylon to cover the top of the grain after treatment will help to ensure an effective treatment.

As with other types of fumigation, the fumigant, formulation, dosage and equipment vary depending on the commodity, the storage facility and other factors. Make sure the fumigant is labeled for the intended use. Follow all instructions in the label information exactly.

Tobacco Warehouses

Tobacco warehouses are constructed of many types of materials including metal, wood, brick and concrete block. Some are closed-sided. Others are louvered-sided to allow for airflow. Some have roofs with skylights. Others have solid roofs, ridge vent roofs or other designs. You can find tobacco warehouses in residential areas, industrial areas, commercial areas or areas that have little transit traffic. As the fumigator, you must consider all of these factors during treatment.

To prepare a tobacco warehouse for fumigation, start by sealing the structure as tightly as possible. In some cases, you will need to cover and seal the whole building. In other warehouses, you may only need to cover the openings in the building, such as doors, windows and vents. Polyethylene sheets should be 2 to 4 mils thick. This thickness will cling to the building better than thicker material. Use fumigation tape to seal small cracks and holes.

After sealing the building, check for leaks. Place thermal smoke generators against the walls and sealed openings inside the building. Turn them on and have someone outside mark the place(s) where smoke escapes. Reseal those spots.

In warehouses, producers usually store tobacco in wooden or cardboard cases, burlap bales or barrels called "hogsheads." The tobacco is packed tightly. To reach the insects in the center of a load, the fumigant must have good penetrating power. Currently, phosphine gas is the most common and successful fumigant used in tobacco warehouses. If you seal the warehouse well and apply the correct dosage, phosphine gas can penetrate tobacco containers with no mechanical aid. See Unit 8 for more information on phosphine gas.

During fumigation, it is important to monitor fumigant levels inside the tobacco. This will help you determine its penetration rate. It will also alert you to any leaks. Set up your monitoring equipment before releasing the fumigant. Choose a commodity container far from the fumigant release site. Then insert a metal tube into the container. Attach a plastic tube to the metal tube. Run the plastic tube outside of the building. Take gas readings with a detector specific to the fumigant you are using. Gas concentrations are measured in parts per million (ppm). If the concentration of gas is the right ppm at the end of the exposure period, all pests should be dead. Treatment is complete. Read the label information of each product you use to determine the dosage and exposure times.

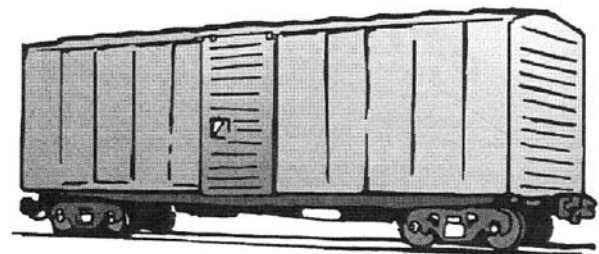
Sometimes only part of the contents of a tobacco warehouse needs treatment. In this case, follow the procedures for tarpaulin fumigation later in this unit.

Wheeled Carriers

NOTE: It is illegal to transport goods over public roads or highways if those goods are undergoing fumigation or have not completely aerated.

Fumigating products inside wheeled carriers such as boxcars and truck trailers is another form of vault fumigation. This method saves time and labor. It avoids extra loading and unloading. It controls the pests in the commodity and ensures that live pests do not remain after unloading. In addition, fumigation of incoming loads prevents the introduction of pests into uninfested areas.

Boxcars and truck trailers are ideal vaults for fumigation. Wheeled carriers must be airtight for fumigation to be successful. Fumigation must stay inside the truck or boxcar long enough to control the pests. Well-built structures can be made relatively airtight by sealing them with fumigation tape or liquid adhesive. Structures with large holes or cracks, or structures made of permeable materials such as wood, may need to



Boxcar

