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## HOUSEHOLD FUMIGATION

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Before any attempt is made to accomplish a successful fumigation the following facts should be taken into consideration:

1. The temperature should be 70° F. or above,
2. The building must be caulked to make it as tight as possible,
3. The correct cubic contents of the dwelling should be determined,
4. The dosage must be made strong enough,
5. Two or even three fumigations may be necessary where the infestation is severe,
6. Permit two or three weeks to elapse between fumigations.

Fumigation cannot be depended on, at the strengths recommended, to kill insects in all stages of their development. Whichever agent is used, the operation should be repeated after two or three weeks, at which time eggs present at the first fumigation will have hatched.

To one who has never fumigated, the idea of generating gas or fumes which will search out all of the insects present and destroy them naturally appeals; however, the attempt is very likely to lead to disappointment. One seldom succeeds in reaching and destroying all the eggs and pupae. A fumigant which will accomplish a 100 per cent kill in the laboratory in absolutely tight containers, may fail to be satisfactory under conditions as found in dwellings. All fumigants are dangerous and, except in the case of unoccupied, isolated buildings, the responsibility incurred is very real.

### HYDROCYANIC-ACID GAS

**Hydrocyanic-acid gas is one of the most deadly poisons known. The only reason that the use of this gas is not more generally recommended is because of the danger to human life involved. The fumes act quickly and are fatal if breathed in any considerable quantity.**

The fumigation, where possible, should always be directed by experienced operators or, in case this is impossible, by responsible individuals who appreciate the danger involved and who are willing to

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familiarize themselves with the necessary details and to follow them explicitly. Operators must never grow careless.

It is a wise precaution to put out all fires before starting the fumigation; for, though hydrocyanic-acid gas is not considered inflammable at the strength used, once the fumigation is started, it is impossible to enter the house until it has been thoroughly aired.

The exact cubic content of each room which is to be fumigated must be determined and the windows fixed so they can be opened from the outside and from a distance. Test the windows out opened in this manner several times to make certain that everything is in good working order. Barricade each entrance and post danger signs. Be certain that all occupants of the building know that the fumigation is in progress and that the building cannot be entered until aired out and pronounced safe by the operator.

The building must be made as nearly air-tight as possible; strips of gummed-paper or damp newspapers are useful in caulking around windows and doors. Fire-places, registers, and ventilating shafts must be closed tightly.

Roll back carpets or rugs away from the gas generators and spread several thicknesses of newspapers under each generator to protect the floor. Earthen crocks or jars of three or four gallons capacity make the best generators, since they are deep enough to prevent the chemicals from spilling over the sides. Examine each generator to see that it is perfect because the heat generated by the chemical action necessary to produce the gas is so intense that it might break an imperfect jar and let the chemicals out over the floor.

Three pounds is the maximum amount of sodium cyanide that should be put in any one generator because the chemical action liberates considerable heat; besides this, there is danger of the liquid's spattering over the top of the container.

The following is the standard formula for 100 cubic feet of air space:\*

Sodium cyanide (98-99%) .....	ounce 1
Sulphuric acid (Commercial) .....	fluid ounces 1½
Water .....	fluid ounces 3

The dosage should be doubled if the building is loosely constructed. The water should be put in the generator first and the acid slowly added. (*If this process is reversed an explosion is almost certain to follow.*) The cyanide should be put in a paper sack within another paper sack. This double sacking makes for safety since it slows up the generation of the gas enough to enable the operator to leave before the fumes become noticeable.

The fumes of hydrocyanic-acid gas are lighter than air and therefore have a tendency to rise; for that reason, begin the fumigation at the top floor and work downward. It is safer for two people to work together, each taking different rooms. Start with the rooms farthest from the exit. Set the sacks containing the sodium cyanide gently into the water and acid. Leave as quickly as possible and close the door.

\*Potassium cyanide was formerly used in place of sodium cyanide for fumigating purposes. It is difficult to obtain now but this is not to be regretted since sodium cyanide, generally, is purer and generates, per ounce, almost a third more gas.



The more rapidly the operators are able to move from room to room and from floor to floor the more effective will be the fumigation and the less danger there will be of the operators' being overcome by the fumes.

It is not safe to fumigate *separately* any part of a building with hydrocyanic-acid gas. Do not fumigate one or more rooms in a dwelling, no matter how well isolated from the rest of the house, unless the entire building is vacated. Never fumigate apartments, double-houses, or houses separated only by a wall unless the entire building is empty. This gas will find the most inconspicuous cracks and seep through into other rooms or buildings.

The fumes of hydrocyanic-acid gas are deadly to all forms of life but some stages of insect life are especially resistant and it is, therefore, necessary to repeat the fumigation in two or three weeks. If pure sodium cyanide is used, and it is this form that gives the best results, little injury is likely to occur to clothing, furniture, decorations or varnish; occasionally, however, polished nickel or brass will be corroded. Liquid foods tend to absorb and hold the fumes, they therefore should be removed before the fumigation is started.

Insects are active at 70° F. or above. When the temperature drops below 50° F. they become torpid and are more resistant to any fumigation. It is, therefore, very desirable if not absolutely necessary that the work be done during warm weather.

It is generally recommended that a fumigation should be continued for from 12 to 24 hours, and, following this, the house must be thoroughly aired before it is entered.

Hydrocyanic-acid gas is colorless. It has an odor which resembles that of peach kernels. The building should never be entered so long as any trace of this odor remains.\*

### SUMMARY FOR HYDROCYANIC-ACID FUMIGATION

1. Determine the cubic contents of the building to be fumigated.
2. Fix the windows so that they can be opened from the outside and from a distance.
3. Caulk the building, making it as nearly air-tight as possible.
4. Remove all carpets, rugs or furniture from the vicinity of the generators.
5. Post danger signs telling that the fumigation is in progress.
6. Put out all fire.
7. Vacate the building, preparing to stay out for at least 48 hours.
8. In each room, place the required number of generators with the proper amount of water and acid in each generator, and with sodium cyanide setting along side in double paper sacks.
9. Both operators should work on the same floor but in different rooms.
10. Begin the fumigation at the top of the house and work as rapidly as possible. Set each sack of cyanide in its generator. Come out quickly and close the door.

\*For further particulars see: L. O. Howard, Hydrocyanic-acid Gas Against Household Insects. U. S. Dept. Agr., Farmers' Bulletin 699, 1916.

11. Leave the building closed for 24 hours.
12. Never enter a building that has been fumigated until after it has been thoroughly aired.
13. Dispose of the refuse left in the crocks by either burying it or by dumping it into the sewer.
14. Familiarize yourself with all the details of the operation before beginning.

### CALCIUM CYANIDE

Calcium cyanide is a comparatively new material that is rapidly coming into use as a household fumigant. It is somewhat more expensive than the pot-method just discussed, but it is easier and safer to apply.

The preparations for calcium cyanide fumigation are simple. Make the room as nearly air-tight as possible, cover the floor with a layer of paper, and distribute the required amount of the dry calcium cyanide as evenly as possible in a thin layer on the paper. There are several different grades of calcium cyanide on the market and it is, therefore, necessary to follow the directions of the makers. When an 88-per cent calcium cyanide is used, 12 to 16 ounces per 1000 cubic feet\* will be sufficient. Leave the room closed for 12 to 24 hours and air thoroughly before using. The dry calcium cyanide unites with the moisture in the air and hydrocyanic-acid gas is given off. Frequently, this gas does not penetrate deeply enough to give a good kill, but a better kill will result where the temperature is between 70° and 75° F. at the time of the fumigation and where electric fans keep the air in circulation.

### SULPHUR FUMIGATION

The fumes of sulphur, if strong enough, are destructive to all forms of insect life. It is especially adapted for use in an empty house or cottage where there is uncertainty about undesirable insect tenants.

There are a number of objections to sulphur fumigation. Besides the danger of fire, the fumes destroy the germinating power of seeds, spoil flour for baking purposes, rot fabrics, bleach wall-paper and tarnish all unprotected metals. Metal surfaces, especially where unprotected by lacquer, should be painted over with vaseline which, to a certain extent, prevents corrosion. The strings of pianos are especially prone to rust after sulphur fumigation. Pianos, together with all other objects unlikely to harbor insects, should be removed before sealing the room.

Sulphur fumigation when directed against insects, unlike fumigation for germs, requires no moistening of the air. Therefore it is possible to kill insects with less injury to furniture and clothing than when one fumigates for disease-germs.

The room or chamber must be made as tight as possible; then, for each thousand cubic feet, allow 3 pounds of sulphur. It is difficult to make certain that all of the sulphur burns but the difficulty will be reduced if a handful of charcoal is mixed in with each lot of sulphur.

\*Calcium cyanide, when used at this strength kills plants.



Take a metal tub or large metal bucket and cover the bottom with two or three inches of **dry** sand or ashes. Above this suspend, from an iron rod, a kettle containing the sulphur mixed with charcoal. The bail of the kettle should be bent so as to keep the kettle at the right height in the bucket. The omission of the charcoal is almost certain to result in the extinguishing of the fire before the sulphur is consumed.

Pour a tablespoonful of denatured alcohol over the surface, drop a lighted match on it, cover tub or bucket with a quarter-inch mesh wire-screen, and close the room. The flames sometimes leap up several feet and burning sulphur has a tendency to boil and sputter during a sulphur fumigation. It is therefore advisable to have fire extinguishers in good condition and close at hand.

Most of the killing is done in the first six or eight hours of the fumigation but it is wise to leave the house closed for 24 hours.



Fig. 1. Equipment used in fumigating with sulphur.

People are readily overcome by the fumes of sulphur when used at the strength needed to control insects; but, since the fumes have a tendency to produce strangulation, escape is usually made before any great harm takes place.

Sulphur candles are in common use when fumigating against disease-germs. There is no reason to doubt that they would be just as effective against insects **if enough of them are used.**

### CARBON TETRACHLORIDE

Carbon tetrachloride from the standpoint of fire hazard is probably one of the safest fumigants known. Though it is not nearly so toxic to insects as carbon disulphide and at least four times the amount per cubic foot is required, it still has a place under certain conditions although it is practical only where the material to be treated can be brought together in closets, small rooms, or fumigation chambers.

It is a colorless liquid and the fumes are heavier than air. They, therefore, have a tendency to settle downward. It is necessary, where the liquid is exposed in shallow pans, that these containers be placed near the ceiling. The rapidity with which the fumes are liberated is important. In warehouses, where merchants employ this method of fumigation, pans containing the correct amount of liquid are placed on electric toasters above the material to be fumigated and the toaster so arranged that the electricity can be turned off from the outside after the liquid has evaporated. Where it is impossible to use electricity in this way, a fair degree of success is attained by dropping hot irons or bricks in the pans. The room should be left closed at least 24 hours and many merchants treat their storage rooms and leave them closed for months at a time.

Carbon tetrachloride leaves no disagreeable odor and furs especially seem to be beautified by this treatment.

The effects of this fumigant on the germination of seeds are not known.

### **ETHYLENE DICHLORIDE-CARBON TETRACHLORIDE MIXTURE**

Ethylene dichloride-carbon tetrachloride mixture, when combined in the proportions of three parts ethylene dichloride to one part carbon tetrachloride, is a non-inflammable, non-explosive fumigant that penetrates readily and does not bleach fabrics or tarnish metal. It is not toxic to human life.

This mixture, like carbon tetrachloride, is heavier than air. It is, therefore, necessary to evaporate the liquid as near the ceiling as possible. In a tight room, use from 12 to 14 pounds of this mixture per 1,000 cubic feet and leave the room closed for 24 hours.

### **PROPYLENE DICHLORIDE-TETRACHLORIDE MIXTURE**

Propylene dichloride-carbon tetrachloride mixture is a volatile liquid that, when properly applied and used in sufficient quantities, has proved itself a satisfactory insecticide. When mixed in the proportions of 90 parts propylene dichloride to 10 parts carbon tetrachloride, the combination is not explosive.

This material has only recently come into use as a fumigant for clothes-moths and carpet-beetles. To date, its use as a household fumigant largely has been confined to overstuffed furniture and rugs. It is desirable to apply this preparation with pressure if possible, otherwise it must be used liberally in such a manner that all parts of the furniture are thoroughly wetted. Where the material is applied with 60 pounds pressure or more, one gallon has been found sufficient to treat a large davenport or a 9- by 12-foot rug, and at least one-half gallon is required to treat each large chair.

It is desirable to collect all articles to be fumigated in a room that can be closed off from the rest of the house. Before making the application, arrange everything so that the room can quickly be made as



tight as possible. The best results are obtained where the temperature of the room has been 70° F. or above for a long enough time that all stages of the insects are active (a period of four or five days will insure this) and where the temperature is kept up for a period of time, at least 8 to 10 hours, after the fumigation has been applied. Leave the furniture undisturbed for 48 hours, if possible, after the fumigation, then open the room and air thoroughly. The odor dissipates rapidly.

This material, as now used, does not moth-proof fabric. It may, therefore, be necessary to repeat the treatment in from three to six months. It is desirable to do the work in a well-ventilated room. The windows should be open when the application is being made and precautions should be taken not to breathe any more of the fumes than necessary. Certain persons appear to be more susceptible to the fumes of this mixture than others. In some instances, it has been found advisable for such operators to use a gas mask. In the absence of a real gas mask, others have worked in comfort simply by breathing through the folds of a wet towel. The fumes are of rather a repellent nature, and no ill effects have been noticed after using the mixture when the operator has gone outdoors and exercised in the open air.

It has been found worth while to inject this mixture back of mopboards and in any protected place where larvae may hide. Before spreading the rugs on the floors, clean the underlying mats or, in case mats are not used, scrub the floors or go over them with wax in order to kill any tiny larvae that may remain in the cracks and crevices.

**Naphthalene**—Naphthalene, or, as it is commonly known, moth-balls, is undoubtedly the best-known repellent. It not only repels, but when used at the rate of one pound for each 10 cubic feet, kills both adults and larvae in any stage of development, provided they are enclosed in a tight container. It is not effective when used in closets or chests that are opened frequently, since the fumes rapidly dissipate. Naphthalene may be found on the market in several forms, but the flakes are preferred because they present a larger surface to the air.

**Paradichlorobenzene**\* used at the same strength recommended for naphthalene gives practically the same results, except that the odor dissipates more rapidly than where naphthalene is used.

\*This material is sold under various trade names, i. e., "Crystal Gas," "P. D. B.," "Paradow," "Paracide," "Dichloride".



